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Mathematical Problem Solving Ability And Student Response with Differentiation Learning on Statistical Material

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Abstract. This research aims to determine the difference in improving the mathematical problem solving abilities of students who receive differentiated learning and students who receive conventional learning models and to determine students' responses to the application of differentiated learning. The method in this research is an experimental method with a true experimental design type. The research design is Pretest-Posttest Control Group Design. The population in this study were all class VIII students at SMPN 1 Serang Panjang with sampling using purposive sampling, namely class VIIIB as the experimental class and class VIIIA as the control class. The instruments used are test instruments in the form of a Pretest-Posttest to measure students' mathematical problem solving abilities, and non-test instruments in the form of questionnaires to determine students' responses to the differentiated learning model. Based on the results of this research, the results showed that: the increase in mathematical problem solving abilities of students who received the differentiated learning model was higher than students who received the conventional learning model; students show a positive response to the application of differentiated learning.

Keywords. differentiated learning, response

INTRODUCTION

Learning mathematics is required as a sufficient requirement when continuing to the next level of education. Because by learning mathematics, we will learn to reason critically, creatively, and actively (1). Mathematics is an abstract idea that contains symbols. Basic mathematical concepts must be understood first before using the symbols. Indonesia places mathematical problem-solving skills as one of the main goals of mathematics learning, but based on the assessment results conducted by the Organization Economic Cooperation and Development (OECD) called the Program for International Student Assessment (PISA) in 2015 Indonesia was ranked 63 out of 70 countries with an average score of 386 out of 490 OECD average scores. These mathematical abilities are influenced by low abilities in terms of, among others: algorithms, interpreting data, steps in solving problems, and findings in the field of mathematics according to Tjalla (2). Students' ability to solve mathematical problems includes understanding the problem, planning strategies and procedures for solving, implementing the steps for solving, and rechecking the steps that have been taken. The indicators of mathematical problem-solving abilities according to Polya (3), there are four steps that can be taken in solving mathematical problems, namely 1) understanding the problem, 2) planning a problem-solving strategy, 3) implementing problem solving, and 4) reviewing the results obtained. Based on the results of observations made by researchers, information was obtained that there are three problems that often arise in mathematics learning, namely understanding mathematical concepts, creative thinking, and students' mathematical problem solving and new information was obtained using

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Differentiated learning. Students' difficulty in understanding
the material will have an impact on solving mathematical problems that are considered difficult. Students tend to have difficulty understanding the material which has an impact on students' mathematical problem solving being lacking. Systematic problem solving and using formulas that make children memorize the formulas so that students answer questions in the same way as explained by the teacher, as a result when given different questions students cannot answer the questions.

From the problem above, it was found that students lack confidence in their abilities, especially in solving mathematical problems. This is in line with research conducted by Muhaimin et al (4) which states that the low ability to solve mathematical problems is influenced by the application of learning models that are less in accordance with learning objectives so that learning becomes less effective and efficient because it tends not to involve students which results in students becoming passive and less discussion in learning. Effective learning that is expected is to involve students to play an active role and be more skilled. One of the factors is because many teachers still apply a teacher centered learning model, so that it does not facilitate students to be active and creative in solving mathematical problems. Researchers agree that the selection of learning methods or models must also be adjusted to the interests, abilities of students and materials, educational goals, environmental conditions, because it will greatly affect the achievement of educational goals themselves. According to Fitra (5) education is also required to be more innovative and dynamic in helping to develop students' abilities and potential and their characteristics in a better and more positive direction. One of the learning methods that can make students play an active role and strive to improve their mathematical problem-solving abilities is Differentiated learning. This is in line with Afdillah, et al. (6) that learning that can facilitate diversity is differentiated learning. Gusteti, M. U. and Neviyarni. (7) differentiated learning is an effort to align the learning process in meeting the learning needs of each student. However, to implement differentiated learning in accordance with this concept, teachers must act as very competent facilitators, requiring dedication and hard work. According to John Hattie, differentiated learning is more related to handling different phases of student learning from beginners, capable, to advanced, not just providing different activities to different (groups of) students. Differentiation of instruction is often misconstrued (8). Differentiated learning will only be useful if teachers create a variety of learning options to address different levels of student readiness, interests, and learning preferences. Figure 1 below shows the important elements that must be considered when using differentiated learning.

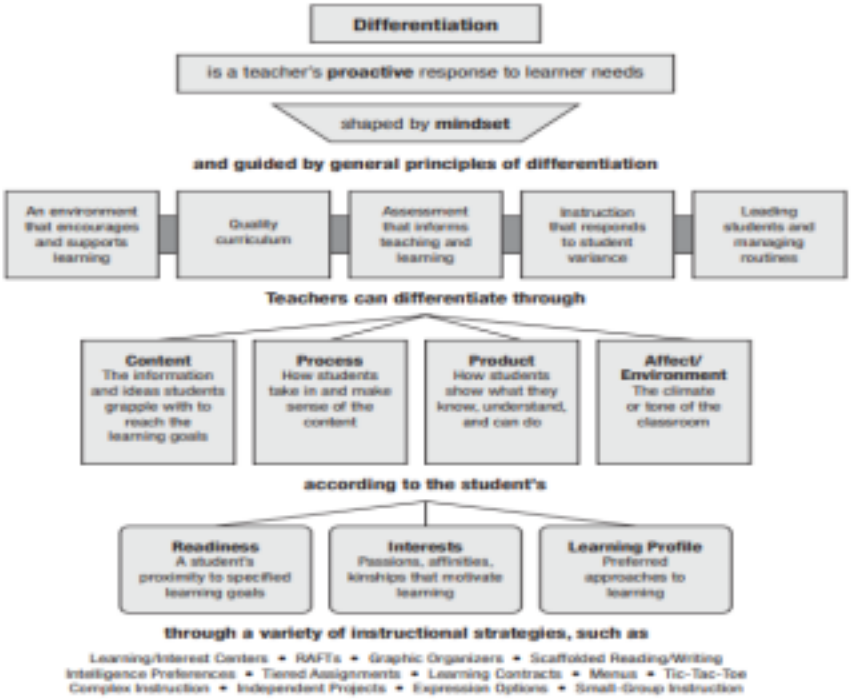

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Figure 1. Key Elements of Effective Differentiated Instruction (8)

Mathematics is one of the compulsory subjects in elementary education units. It must be responded to well by students and teachers. According to the Big Indonesian Dictionary (KBBI), response means a response or reaction. Low student response to the usual learning model can cause boredom and saturation, especially if each meeting only focuses on listening and taking notes. Students are passively involved, only taking notes, and some of them seem uninterested in the teacher's explanation and prefer to chat with classmates. Therefore, a structured and effective learning model is needed to increase interest in learning mathematics. Based on data from the Central Statistics Agency (BPS) of Subang Regency, there are still around 35% of poor families in Subang Regency, even four sub-districts, namely: Purwadadi, Cikaum, Binong and Tambak Dahan have a percentage of poor families of up to 50% (9). According to Schunk & Zimmerman (10), independent learning is a learning process that occurs as a result of the thoughts, feelings, strategies, and behaviors of individuals who are goal-oriented.

METHODS

The method in this study is an experimental method with a true experimental design type. The research design is Pretest-Posttest Control Group Design. The data collection technique used in this study is in the form of test and non-test instruments. The test instrument consists of pretest and posttest questions in the form of descriptive questions to measure students' mathematical problem-solving abilities, while the non-test instrument is in the form of a questionnaire to determine students' responses to the application of Differentiated learning. The population in this study were all students of class VIII of SMP Negeri 1 Serang Panjang Subang in the 2023/2024 academic year. which consists of six classes with a total of 197 students. Sampling in this study used a purposive sampling technique where the sample was not selected randomly (11). The samples used in this study were class VIIIA as the control class with 31 students, and class VIIIB as the experimental class with 33 students. The research design used is Nonequivalent Pretest-Posttest Control Group Design, which is described as follows:

O X O
O O

Description:
X : treatment given (independent variable) in the form of Differentiated learning
O : Pretest/posttest (dependent variable observed) in the form of experimental class and control class ---- : indicates the placement of samples that is done non-randomly so that the groups formed are NonRandom

Before being used as a test tool, the research instrument needs to be developed first to determine the quality of the instrument based on the validity, reliability, discriminatory power, and difficulty index of each question item. The data obtained in this study are quantitative and qualitative data. Quantitative data were obtained from the results of the pretest and posttest given to the experimental class and the control class, while qualitative data were obtained from the results of filling out the questionnaire in the experimental class. Non-test instruments are usually used as a tool to measure affective or psychomotor aspects. And the form of the instrument used is a questionnaire. This questionnaire is used to determine students' attitudes towards the application of differentiated learning in mathematics learning. This assessment scale is given to the peer tutor class after they have taken the posttest. The questionnaire approach used in this study is a Likert scale consisting of five answer choices, namely Strongly Disagree (STS), Disagree (TS), Neutral (N), Agree (S), and Strongly Agree (SS) (12).

RESULTS AND DISCUSSION

The results of the study in Figure 2 show that the results of the initial pretest mathematical problem solving

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ability test of experimental class students got lower scores than the control class. The average score of the experimental class during the pretest was 14.52. While in the control class the initial test (pretest) the average score was 14.70, higher than the average score of the initial test of the experimental class.

Figure 2 Pretest Average Score Diagram

As shown in Figure 3, the results of the mathematical problem solving ability test of the experimental class students got higher scores than the control class, this can be seen from the results of the final test (posttest) of the two classes where the minimum score of the experimental class is 19 higher than the minimum score obtained by the control class which is 16. Then the maximum score obtained by the experimental class is 49 higher than the control class which is 41. The average score of the experimental class at the time of the pretest is 14.52, this can be seen from the increase in the average class score at the time of the posttest to 32.72, an increase of 18.20 from the pretest. While in the control class, the initial test (pretest) average score was 14.70 higher than the average initial test of the experimental class, and there was also an increase and got an average posttest score of mean of 11.89. The difference in the average mathematical problem solving ability of students between the experimental class and the control class is 6.31.

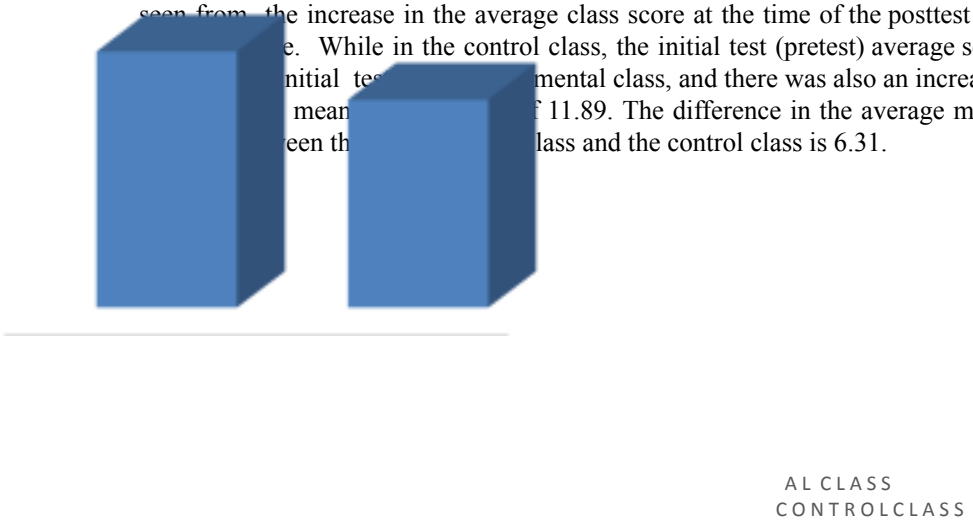

Figure 3 Posttest Average Score Diagram

The results of the study showed an increase in students' mathematical problem-solving abilities after differentiated learning was carried out on class VIII B students of SMP Negeri 1 Serangpanjang. It was found that the results of the mathematical problem-solving ability test of students in the experimental class got higher scores than the control class. The following is the recapitulation of the N-Gain from the experimental class and also the control class which explains the N-Gain of the two classes which can be seen in Figure 4.

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Figure 4 N-Gain Comparison Diagram

The results of the N-Gain calculation of the control and experimental classes show a difference where the control class obtained a minimum N-Gain score of 0.21 and the experimental class 0.25 where both are classified as low categories. Then for the maximum N-Gain score in the experimental class it was 0.77 and in the control class it was 0.49. This means that there are students who have experienced high increases in the experimental class and there are students who have experienced moderate increases in the control class. Then the overall average score of N-Gain for the experimental class is 0.4438 and for the control class is 0.285. This means that there is a moderate increase in the experimental class and a low increase in the control class in terms of mathematical problem solving ability. From the results of the analysis it is known that the sig of the experimental class = 0.013, then we can conclude that the significance value of the Gain index for the experimental class is less than 0.05 which means that the Gain index of the experimental class is not normally distributed. While the control class with sig. = 0.200 is more than 0.05 which means it is normally distributed. Since the N-gain value of the experimental class is not normally distributed, we then conduct a non-parametric test for the Mann-Whitney Gain index test. The Mann Whitney test aims to determine the difference in the average of the two samples. The formulation of the hypothesis used in the Mann Whitney Test of the gain index data is as follows:

Ho : the increase in mathematical problem-solving abilities of students who receive differentiated learning is not better than students who receive regular learning.

H_1 : the increase in mathematical problem-solving abilities of students who receive differentiated learning is better than students who receive regular learning.

The significance level criteria (��) used is �� = 0.05. If the Asymp.Sig. (2-tailed) value> 0.05, then Ho is accepted, while if the Asymp.Sig. (2-tailed) value <0.05, then Ho is rejected. The Mann Whitney test in this study uses SPSS software. The results of statistical tests using Man Whitney on N-Gain data show that there is a significant difference in improving mathematical problem-solving abilities between students who learn with differentiated learning and students who learn with regular learning. With a significance level of 0.05, a significance value of 0.00 is obtained, which means that differentiated learning is statistically better at improving students' mathematical problem-solving abilities compared to regular learning models. The results of this study are in line with those conducted by Siburan, R. et al. (13) where there was a significant increase in students' mathematical problem-solving abilities with differentiated learning.

The pretest was conducted at the beginning of the meeting to determine the extent of students' mathematical problem solving abilities. Before the two classes were given the learning model treatment, each class was given a pretest in the form of essay questions, the questions had previously been tested for validity, reliability, discriminatory power, and difficulty index. Another purpose of giving this pretest was to determine whether there was a difference in students' initial abilities in solving, the results of the study showed that the initial abilities of the control class and the experimental class had the same initial abilities. Furthermore, in the second meeting to the last meeting, students were given Differentiated learning treatment for the experimental class and the regular learning model for the control class. It was seen that students in the experimental class who received Differentiated learning treatment played a more active role in learning and were able to work on questions systematically because there were practice questions at each meeting. Based on the stages that have been explained, it can be seen that by using Differentiated learning, students
can be active in learning, there is interaction, discussion, questions and answers between students and students, students and teachers who can train students' mathematical problem solving skills, and with the results of the analysis it can be concluded that the increase in mathematical problem solving skills of students who receive Differentiated learning treatment is higher than the usual learning model. The mathematical problem solving skills

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of students at SMP Negeri 1 Serangpanjang Subang, which were previously one of the problems in understanding mathematics lessons, turned out to increase significantly after being given different differentiated learning treatment than usual. This problem solving ability is aimed at students being able to formulate and understand problems from mathematical problems in everyday life, plan strategies to solve various problems in mathematics, be able to carry out plans with models that have been made, and be able to re-examine the process and results that have been obtained. In addition, the results of the study showed that the mathematical problem-solving abilities of students of SMP Negeri 1 Serangpanjang Subang after being given Differentiated learning treatment showed that students could be directed according to learning objectives, this can be seen from the ability of students to determine the average (mean) of a data set, students are able to solve problems related to the average value (mean), students are able to determine the median and mode values of data, students are able to analyze the average value and draw conclusions from data. Furthermore, these students can analyze, present and solve problems related to data distribution, average values, medians, modes, and data distribution to draw conclusions, make decisions and make predictions. Gusteti, M. U. and Neviyarni. (7) state that differentiated learning is an effort to align. Riyanto (14) stated that to achieve learning objectives, students are required to pay attention to all directions of learning stimuli. This is in line with the results of research showing that there is an interaction between the learning model and students' initial mathematical abilities in improving students' mathematical problem-solving abilities, as well as in increasing students' self-confidence (15). Differentiated Digital Instruction (DDI) is the right solution to meet students' personal learning needs in 21st century education. Although this model has many benefits, not all teachers have the ability or desire to adopt it, especially because of its perceived complexity. Teachers are mediators between differentiated digital learning and the availability of digital infrastructure to implement differentiated digital learning (16).

In this study, the questionnaire used to measure student responses consisted of three indicators with the aspects measured being student responses to mathematics lessons, student responses to Differentiated learning, student responses to mathematics problems. The questionnaire consisted of 20 statements consisting of positive statements and negative statements. The approach used in this questionnaire was a Likert scale with answer choices, namely Strongly Agree (SS), Agree (S), Disagree (TS), and Strongly Disagree (STS). The neutral scale was deliberately not included because to avoid hesitant answers from students, students were expected to be more assertive about the answers between agreeing or disagreeing. The processing of the questionnaire data results in this study used Microsoft Excel, then the average on the student response scale was compared with a neutral score of 3.00 on the Likert scale. If it is more than 3.00 then the student's response is interpreted positively, if it is equal to 3.00 then the student's response is interpreted neutrally, conversely if the response is less than 3.00 then the student's response is interpreted negatively. The results of the study regarding the classification of student responses can be seen in Table 1.

Table 1. Classification of Student Responses

No	Indicators Measured Aspects		Statement Number	Mean	Classification	(+)	(-)
1	Satisfaction Responds	Student responses to mathematics learning	15	3,84	Positive	1,11, 4, 5,12	6, 7,
2	Willingness to Respond/Actively	Participate differentiated learning	14	3,71	Positive		
3	Willingness to Respond/Actively	Participate Student responses to math problems	2, 3, 8	9,10, 13	3,71	Positive	
Total Average				3,75	Positive		

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Then one of the successes in the mathematics learning process using differentiated learning in this study is the positive response of students to the learning. Based on the results of the calculation of the average score of the student questionnaire consisting of 15 statements with 8 positive statements and 7 negative statements, the overall average of the response questionnaire was 3.75, in other words, the response given by students was positive. A positive response to mathematics learning using differentiated learning can be seen from the activeness of students during the learning process. With the calculation of the overall average percentage, it was also obtained that 75.04% of student responses were included in the category Almost All students responded positively to mathematics learning using differentiated learning. Differentiated learning is something that helps teachers in terms of the effectiveness of using exercises so that students achieve extraordinary improvements in learning. Differentiated learning increases students' willingness to participate actively, provides a positive response to mathematics learning and mathematics problems and students' skills in working on mathematics problems with controlled practice, or independent practice. The exercises in question include project assignment sheets, which are a series of questions or commands to develop a systematic idea or concept. According to experts that Differentiated learning is a teaching and learning process where students can learn subject matter according to their abilities, what they like, and their respective needs so that they do not get frustrated and feel like they have failed in their learning experience (17). Tomlinson and Moon in 2013 as figures from differentiated learning stated that there are five basic principles that help teachers in implementing this differentiated learning including; Learning Environment; Quality curriculum; Continuous assessment; Responsive teaching; Leadership and Routines in the classroom (17). Sumarno (10) stated that there are several indicators that form students' learning independence, namely; Having initiative and intrinsic learning motivation; Having a habit of diagnosing learning needs; Being able to set learning goals/targets; Being able to monitor, organize and control learning; Viewing difficulties as challenges; Being able to utilize and find relevant sources; Being able to choose and apply learning strategies; Being able to evaluate the learning process and results. This is also in line with research stating that teachers have a high perception of Differentiated Learning, while there is no statistically significant difference in teachers' perceptions based on their experience and qualifications. In addition, lack of resources, time, support, knowledge, and class size were identified as barriers to the implementation of Differentiated Learning (18). In addition, learning styles will determine the success or failure of differentiated learning with statistical materials. This is in line with several studies stating that there are very significant differences in the ability to solve story problems based on students' learning styles (visual, auditory, and kinesthetic) (19). The application of learning models that are adjusted to the right learning style can maximize student learning outcomes (20). Students are better prepared to face mathematical problems by looking at their abilities (21). When students' mathematical problem-solving abilities are low and forced, the results are less than optimal. This is in line with research stating that mathematical problem-solving abilities viewed from low logical intelligence are able to understand questions, but are less able to formulate problem-solving plans, implement solution plans, and are less able to recheck (22). In the indicator of rechecking answers, some students do not do it (23). Students with a field dependent cognitive style (who tend to depend on their environment) have sufficient and less contextual mathematical problem-solving abilities (24). The research results also show that the mathematics learning process using differentiated learning is very necessary to improve students' mathematical abilities. This is in line with research which states that the application of a differentiated approach can improve students' learning outcomes (25).

CONCLUSIONS

Based on the results of the study and discussion, it can be concluded that the increase in mathematical problem-solving abilities of students who receive Differentiated learning is higher than students who receive regular learning models. Then the students' responses to Differentiated learning show a positive response. In addition, based on the results of the study, discussion and conclusions that have been presented, the researcher provides several suggestions as follows; Differentiated Learning can be used as an alternative in choosing a learning model that can increase student learning activity, especially in efforts to improve students' mathematical problem-solving abilities; For teachers, in an effort to improve students' mathematical problem-solving abilities, they should prepare questions that can train students to improve their mathematical problem-solving abilities; For students, it is advisable to get

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used to working on questions sequentially, systematically, and completely by writing down the information stated in the questions; For researchers who will conduct similar research, it is advisable to develop this research by preparing materials optimally, reducing the use of student aids such as calculators/gadgets and being able to optimize learning
time in order to improve better results; There is a need for further exploration of additional factors related to the implementation of differentiated learning at various levels of education.

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