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Improving Students Mathematical Understanding by Using Discovery Learning Models for Senior High School Students in Kampar District

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A B S T R A C T

Mathematical understanding is a very important ability possessed by students in solving mathematical problems. The purpose of this study is to find out the improvement in students mathematical understanding using discovery learning models. This research was a quasi-experimental study with a non equivalent control group design. The samples in this study were SMAN 1 Bangkinang, SMAN 1 XIII Koto Kampar and SMAN 2 Koto Kampar Hulu taken by purposive sampling technique. The data analysis technique used was the t test, and the Mann-Whitney U test. The results showed an increase in mathematical understanding of students learning using discovery learning models is better than students learning to use conventional learning models at the top level of school, medium and as a whole, but at the lower level schools have not increased.

1. Introduction

Mathematics has a significant role in providing various abilities to students in order to organize thinking skills and ability to solve problems, especially in solving everyday life, more specifically local life where students come into direct contact with their environment. As stated by Saragih et al. (2015) that students are expected to use mathematics and mathematical thinking patterns in everyday life. Thus it can be understood that mathematics integrates with the patterns of human life.

Mathematical understanding is an essential competency that students must possess. This is in line with the core competencies contained in the 2013 curriculum, namely: a) living and practicing the teachings of the religion they hold; b) behave honestly, discipline, responsibility, care (mutual cooperation, cooperation, tolerance, peace, courtesy, responsiveness, and proactivity and

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interact effectively with the social environment, nature, and world relations; c) understand, apply, analyze factual knowledge , conceptual, procedural based on curiosity about science. Items a) and b) are part of social competence and item c) is part of knowledge and skills competencies. In mathematics learning what is meant by mathematical understanding is knowledge and skills competence.

Learning mathematics aims to make students have the ability to understand concepts in solving mathematical problems. In fact, most Indonesian students consider mathematics a difficult subject. This can be seen from the average results of the National Mathematics National Examination at the National High School level in 2017, the Natural Sciences department is 53.47 and the Social Sciences department is 48.18. Whereas in 2018 there was a decline, the science department was 51.76 and the social science department was 46.31 (Kemendikbud, 2018). The results of the Mathematics National Examination majoring in Natural Sciences decreased at the national level by 1.71 and the Social Sciences majors decreased at the national level by 1.87. Based on reports from senior high school UN data managers in Riau Province (Irfan, 2018), information was obtained that the average high school mathematics UN score in Kampar District in 2018 was still in the low category, with an average score in the natural science majors of 29.12 and the social science majors in 40.84. According to Junita (2018) the high school UN scores in Kampar Regency in 2018 were ranked 11th out of 12 districts in Riau province. The Mathematical National Exam in 2018 consists of 40 questions with 36 multiple choice questions and 4 essay questions. The problem consists of mathematical understanding problems, mathematical problem solving and mathematical reasoning. Most mathematics UN questions consist of mathematical understanding questions. If the average value of the mathematics UN in Kampar Regency is still low, the researcher assumes the ability of mathematical understanding is also low. Therefore, efforts are needed to improve mathematical understanding in Kampar District. One effort to improve the average high school mathematics UN in Kampar District is to improve students' mathematical understanding.

Based on the results of a preliminary study of research in class XII MIPA-1 SMAN 2 Koto Kampar Hulu by using a mathematical understanding test instrument in class XII MIPA-1 on matrix material with an average total value of a mathematical understanding indicator is 42. This shows the average total the value of mathematical understanding is less than 50. Of the six indicators, only three indicators are above 50. Thus the conclusion is that the mathematical understanding is still low and far from the minimum completeness criteria. From the results of the preliminary study it can be said that students' mathematical understanding is still low.

One of the causes of students' low mathematical understanding is the teacher-centered learning process. Teachers do not actively involve students in the process of building their own knowledge so students find it difficult to understand mathematics and become bored. This is confirmed by Susanti et al. (2017) that learning that does not actively involve students in building their own knowledge results in a weak mathematical understanding ability of students. If learning like

this is allowed, students tend to forget quickly the material taught by the teacher. If students are given a question that is different from the example given, students are confused, because they do not know where to start from where they work (Mettes in Ansari, 2009). Such a condition if left unchecked will have a negative impact on students' mathematical understanding of mathematics.

One learning model that is suitable for overcoming these problems is to apply discovery learning learning models. Dina et al. (2020) states that discovery learning is one of the models that allows students to be directly involved in teaching and learning activities, so that students are able to use their mental processes to find a concept and theory being studied, and demand to find a the concept with the help of stimulus provided, this will make learning oriented towards students. Bruner (in Dahar, 2010) said that students should learn through active participation with the concepts and principles of gaining experience and conducting experiments to find the principles themselves. Knowledge obtained by learning discovery (discovery learning) will last longer because it produces knowledge that is truly meaningful so that the learning outcomes of the discovery have a better transfer effect than other learning outcomes. As Putri et al. (2020) said that the discovery learning model is a learning model that makes students active in discovering mathematical concepts.

Discovery learning based learning is cognitive learning theory, which means learning discovery that was introduced by Jerome S. Bruner "Learning discovery is a way of learning that involves students in the process of mental activities through brainstorming, with discussions, seminars, reading by themselves, so that students can learn by themselves ". Students who find ideas or ideas he will understand the concepts they find, so students are able to solve problems by themselves. Based on the description, that is what encourages research to be conducted which focuses on increasing mathematical understanding by applying discovery learning learning models in class XI IPS of Kampar Regency High School.

2. Methodology

This research was a quasi-experimental research. The study was conducted in two sample groups namely the experimental group and the control group. The experimental group was a group of students who obtain discovery learning models, while the control group was a group of students who obtain conventional learning. The research design used in this study was Nonequivalent Control Group Design (Sugiyono, 2010).

$$\begin{array}{ccc} O_1 & X & O_2 \\ O_3 & & O_4 \end{array}$$

Information:
O1: Provision of mathematical understanding pretest in the experimental class.
O2: Giving posttest mathematical understanding to the experimental class.

O3: Provision of mathematical disposition pretest in the control class.
O4: Provision of mathematical disposition in the control class.
X: Learning by using discovery learning models.

The population in the study were high school students in Kampar Regency on T.P 2017/2018 consisting of 41 public high schools and 9 private high schools. The steps in sampling are; (a) looking at SMA national exam data in Kampar Regency in 2018; (b) find the average total UN scores of all Kampar district high schools; (c) looking for standard deviations; (d) grouping UN ranking data based on rank; (e) determine the school level criteria; (f) after the criteria for school level are determined, then based on considerations obtained 3 schools, namely: one high school level, one secondary school, and one lower school level; (g) from each school selected as a sample two classes with the same abilities and the same majors were randomly selected; (f) of the two classes selected as samples, one experimental class and one control class were determined based on consideration (Riduwan et al., 2010). The research sample and its size are summarized in Table 1.

Table 1. Research Samples Based on School Level

School Level	School Name	Class	Number of Students	Group
Top	SMAN 1 Bangkinang Kota	XI IPS-4	32	Experiment
		XI IPS-3	31	Control
Middle	SMAN 1 XIII Koto Kampar	XI IPS-1	30	Experiment
		XI IPS-2	33	Control
Low	SMAN 2 Koto Kampar Hulu	XI IPS-1	26	Experiment
		XI IPS-2	26	Control
	Total		**178**	

The learning tools used in this study consisted of a Syllabus, Learning Implementation Plan (RPP), Student Worksheet (LKPD). While the data collection instruments consist of a mathematical understanding test. Before being used the learning tools and data collection instruments are first validated by experts in the field of mathematics education. The data collected in this study is the data of students' mathematical understanding tests through the description test in the form of mathematical understanding questions. The data obtained in this study are quantitative data. Pretest and posttest data results will be processed through the following stages: 1) Calculating the pretest and posttest scores of the experimental and control classes, 2) Calculating the magnitude of increasing students' mathematical understanding using the Hake normalized gain formula (in Kartini, 2011) as follows.

$$Ngain\ (g) = \frac{posttest - pretest}{maximum - pretest}$$

After the N-gain data is obtained, a normality test and a homogeneity test are then performed. If the N-gain data is normally distributed and homogeneous, a t-test is proposed by (Riduwan, 2010) with the formula:

$$t = \frac{x_1 - x_2}{SD\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}} \qquad \text{Where} \qquad SD^2 = \frac{(n_1-1){S_1}^2+(n_2-1){S_2}^2}{n_1+n_2-2}$$

If the data is not normally distributed homogeneously, we will do a t test. If the N-gain is not normally distributed and homogeneous, then a noparametric test is carried out, the mann whitney U test.

3. Results and Discussion

This research was conducted for one month from January 21 to February 20, 2019 with eight times class meeting. The implementation of class meetings are as following details: once for pretest, six times for discovery learning, and once for posttest, in which the same pretest and posttest questions , where this meeting took place for 2 lesson hours (90 minutes). Learning in the experimental class uses the discovery learning model, which is guided by the syllabus and lesson plans assisted by LKPD. Research documentation at each school level can be seen in Figure 1.

Figure 1. Research Photo (left, SMAN 1 Bangkinang; middle SMAN 1 XIII Koto Kampar; Right, SMAN 2 Koto Kampar Hulu)

Data on average pretest, posttest, and N-gain scores of students are described and analyzed based on: (a) learning groups, (b) school level. General description of the average mathematical understanding of students before and after the study is presented in Table 2. In the Table 2, it can be seen that before learning, the average mathematical understanding of students who got discovery learning was only 12,795, while the average mathematical understanding of students who received conventional learning was 13,733. The average mathematical understanding of students from these two groups, it can be said that the average is almost the same. After learning, the average mathematical understanding ability of students who got discovery learning was 26.398 (increased by 0.488), and participants who received conventional learning gained an average mathematical understanding of 19.389 (increased by 0.124). Based on the Hake category, an increase in mathematical understanding of students who got discovery learning is included in the medium category and an increase in mathematical understanding that gets conventional learning is included in the low category.

Table 2. Mathematical Understanding of Students Based on Study Groups, and School Level

Category		Stat	P-DL			P-KV		
			Pre-Test	Post-test	N-*Gain*	Pre-Test	Post-test	N-Gain
School Level	Top	n	32	32	32	31	31	31
		Mean	19,281	32,500	0,594	21,935	20,387	-0,125
		SB	9,524	5,913	0,209	7,974	11,418	0,747
	Middle	n	30	30	30	33	33	33
		Mean	9,333	23,733	0,442	11,645	18,516	0,165
		SB	4,071	6,079	0,22	5,283	7,161	0,427
	Low	n	26	26	26	26	26	26
		Mean	8,807	21,961	0,411	6,269	19,191	0,370
		SB	4,858	9,522	0,286	4,565	8,717	0,247
Totality		n	88	88	88	90	90	90
		Mean	12,795	26,398	0,488	13,733	19,389	0,124
		SB	8,306	8,535	0,249	8,883	9,169	0,558

Note: The ideal pretest and posttest score is 41, the maximum N-gain is 1

Test the normality of N-gain data for mathematical understanding

The N-gain data on students' mathematical understanding can be seen in Table 3.

Table 3. Normality of N-gain Data Mathematical Understanding of Students

Hypothesis	Data	N	Mean	SD	Sig.	ket
Hypothesis 1	Experiment Top (X_1)	32	0,5941	0,209	0,033	Abnormal
	Control Top (K_1)	31	-0,1255	0,747	0,012	Abnormal
Hypothesis 2	Experiment Midle (X_2)	30	0,4420	0,2862	0,200	Normal
	Control Midle (K_2)	33	0,1658	0,4271	0,900	Normal
Hypothesis 3	Experiment Bottom (X_3)	26	0,4115	0,2862	0,200	Normal
	Control Bottom (K_3)	26	0,3708	0,2573	0,142	Normal
Hypothesis 4	Experiment (All)	88	0,4883	0,2490	0,178	Normal
	Control (All)	90	0,1247	0,5580	0,000	Abnormal

Hypothesis 2 uses the t test because the data are not homogeneous, hypothesis 3 uses the t test. While hypotheses 1 and 4 use the mann withney test. The results of the hypothesis test analysis can be seen in Table 4. Based on Table 4, hypothesis 1 can be seen that sig <α, this shows that an increase in mathematical understanding of students who get discovery learning is better than students who get conventional learning in high school level. Hypothesis 2 can be seen that sig <α, this shows that increasing the ability of mathematical understanding of students who get discovery learning is better than students who get conventional learning in secondary schools. Hypothesis 2 can be seen that sig> α, this shows that the increase in mathematical understanding of students who get discovery learning is

no better than students who get conventional learning in lower level schools, although the average N-gain mathematical understanding of experimental class better than the average N-gain control class in the lower level schools. While hypothesis 4 is obtained sig <α, this shows that increasing students' mathematical understanding using discovery learning models is better than students who get conventional learning as a whole.

Table 4. Hypothesis Test Analysis Results

Hypothesis	Data	N	Mean	Sig.	Conclusion
Hypothesis 1	Experiment Top (X_1)	32	0,5941	0,000	H_0 Rejected
	Control Top (K_1)	31	-0,1255		
Hypothesis 2	Experiment Midle (X_2)	30	0,4420	0,002	H_0 Rejected
	Control Midle (K_2)	33	0,1658		
Hypothesis 3	Experiment Bottom (X_3)	26	0,4115	0,585	H_0 Rejected
	Control Bottom (K_3)	26	0,3708		
Hypothesis 4	Experiment (All)	88	0,4883	0,000	H_0 Rejected
	Control (All)	90	0,1247		

The results of research between the experimental class and the control class for each school level, show that it is found that the average N-gain of mathematical understanding for upper-level schools increased by 0.719 with a high category, for secondary-level schools increased by 0.277 with the low category, lower-level schools increased by 0.041 with the low category. But in lower level schools the average N-gain did not show a better improvement. While overall the average N-gain mathematical understanding shows an increase. So, schools that show a better improvement among students who get discovery learning and conventional learning are high school, middle school and schools that are reviewed as a whole. While those who did not show better improvement among students who got discovery learning and conventional learning were lower level schools.

The hypotheses 1, 2 and 4 (in general mathematical understanding) have increased between students who have learned discovery learning with students who have conventional learning. This is caused by the experimental class using discovery learning, whereas in the control class using conventional learning with a scientific approach. Discovery learning is a way of learning that involves students through their own reading, discussion and brainstorming activities. In the learning process, students are given a Student Activity Sheet (LKPD) which contains subject matter and practice questions. Practice questions done by students with group discussion and then followed by class discussion. The group responsible for answering questions to LKPD presents the results of their group's work, while the other groups match the answers they have. It aims to evaluate the work of students.

At the first meeting students find it difficult to undergo learning by discovery learning and solving the questions given. This is considered reasonable because students in previous learning are accustomed to conventional learning. The teacher is always motivating, giving explanations about what they have to do and convincing students until the second meeting and so students begin to be trained to work on problems so that their mathematical understanding increases. This strengthens and complements research from Susanti et al. (2017), Moreno (2018) and Kartika et al. (2020) who conclude that discovery learning can improve students' mathematical understanding.

Increased mathematical understanding of students in upper and secondary level schools through discovery learning in this study has been significant. If we look closely at the results of the research that has been put forward shows that discovery learning is significantly better in improving students' mathematical understanding compared to conventional learning. These findings reinforce and complement the findings of Saragih et al. (2012) who concluded that using discovery learning assisted by autograph software can improve the understanding of vocational students' concepts. Furthermore, the research results of Setyaningrum et al. (2018) who said that by applying the discovery learning model of learning can improve mathematical understanding of students in class X of Kesatrian 1 High School Semarang.

While hypothesis 3, mathematical understanding does not show an increase or mathematical understanding at lower level schools in this study is less significant. Based on the research there are several factors that cause the mathematical understanding of lower level students through discovery learning to be less significant, including: 1) prefer conventional learning; 2) the characteristics of social studies students who tend to choose social studies majors because they avoid learning mathematics, so that students are lazy to learn.

In addition, the teaching and learning process for classroom experiments in lower-level schools has not shown an increase in mathematical understanding, as well as conventional classes. This is because students are less focused when the teacher presents the steps of learning in front of the class, and when discussing most students just keep quiet, in the sense of not wanting to express opinions and not looking for solutions to the problems given and not looking for answers to the problems given the teacher. So that the increase in mathematical understanding among students who get discovery learning is no better than students who get conventional learning at lower level schools.

Discovery learning is a learning process that requires students to build their own knowledge to find a principle of problem solving (Joolingen in Putrayasa, 2014). Students are not presented with lessons in their final form, but are expected to organize themselves (Kemendikbud, 2014). Learning that applies discovery learning makes students at the lower level difficult to understand the lesson. Students at the lower level schools are groups of students who were selected as research samples based on the lowest mathematics UN scores in Kampar District. Therefore, lower level students prefer conventional learning over discovery

learning. This is in line with Setiawan's research (Kartikasari, 2016) which concludes that the application of discovery learning models is not optimal to improve students' higher-order thinking skills. If the ability to think at a high level does not increase, the researcher assumes that there is a possibility of students' mathematical understanding also not increasing.

Another factor that causes mathematical understanding at the lower level of school does not increase is the lack of confidence of students in answering hypotheses and verifying the results of their group discussions. In addition to the lack of self-confidence of students, the discovery learning model is also not suitable for lower level schools, this is reinforced by one of the deficiencies of the discovery learning model that is this model raises the assumption that there is a readiness of the mind to learn. For students who are less clever, will have difficulty expressing the relationship between concepts, written or oral, so that in turn will cause frustration (Kemendikbud, 2013)

4. Conclusion

The results of research and discussion show that the increase in mathematical understanding of students who get discovery learning is better than students who get conventional learning in upper, middle and overall level, but in lower level schools do not show an increase, although the average the average N-gain experimental class in lower-level schools is higher than the average N-gain control class. Based on the results of research that has been done, several suggestions can be put forward. The application of discovery learning models can be used as an alternative learning model that can be applied to improve the learning process and improve students' mathematical understanding. In addition, the suitability of the material to be studied using discovery learning models needs to be considered, in order to obtain optimal mathematical understanding. Then to see an increase in students' mathematical understanding with discovery learning models are recommended for further research at lower level schools.

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