

The Implementation of Discovery learning Assisted with Manipulative Teaching Tools on The Mathematical Understanding Concept of Students

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Abstract

This study has a purpose of examining the differences in the improvement of the mathematical understanding concepts of students between the class using discovery learning assisted with manipulative teaching tools compared to the class using discovery learning without the manipulative teaching tools. This study was a quasi-experimental design study. The sampling technique was applied in this study is the purposive sampling technique, a sampling technique which conducted using certain considerations. Therefore, the samples were obtained Public Elementary School Dukuh 05 Salatiga as the experimental class and Public Elementary School Dukuh 01 Salatiga as the control class with a total of 54 students for each class. The data collection techniques in this study were used test of mathematical understanding concepts. The results showed that there was a difference in the improvement of the mathematical understanding concepts in the experimental class using the discovery of learning assisted with manipulative teaching tools. This is indicated by N-Gain score in the experimental class at 0.55, whereas, the control class at 0.29. This result is supported by the independent sample t-test, which shows that the sig. (2-tailed) is $0.000 < 0.05$. The mathematical understanding concepts in the class using the discovery of learning assisted with manipulative teaching tools is higher. The implementation of the discovery learning assisted with manipulative teaching tools can be used as a solution for teachers in improving the mathematical understanding concepts of students.

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INTRODUCTION

Education has an important role in the development of a nation. Education can create quality human resources (Anugraheni, 2017). The educational process is influenced by several factors, including (1) student input, (2) educational facilities and infrastructure, (3) teaching materials, and (4) human resources (educators) who can support the creation of a conducive atmosphere (Anugraheni, 2017). Ministry of Education and Culture of the Republic of Indonesia Number 20 of 2003 Article 3 states national education functions to develop capabilities and shape the character and civilization of a dignified nation in order to educate the life of the nation, has the aim to develop the potential of students to become human beings who believing in and fear of The Almighty God, having noble, healthy, knowledgeable, capable, creative, independent, and being a democratic and responsible citizen.

One of the contents of the lessons in Curriculum 2013 is the content of mathematics lessons. Mathematics is a way to find answers to problems faced by humans; a way of using information, using knowledge about counting, and the most important thing is to think in humans themselves in seeing and using relationships (Hasratuddin, 2014). Mathematics education is expected to purpose for students to learn about themselves and the natural environment, as well as the prospect of further knowledge in applying it in everyday life.

Understanding concepts is a very important aspect of learning mathematics. Understanding mathematical concepts are to understand correctly about mathematical concepts, namely students can translate, interpret, and infer a mathematical concept based on the formation of their knowledge, not just memorizing (Utari, Fauzan, and Rosha, 2012). Also, students can find and explain the connection of concepts with other concepts. By understanding concepts, students can develop their abilities in learning mathematics; students can apply the concepts they have learned to solve simple to complex problems.

Based on observations and interviews with a teacher at Public Elementary School Dukuh 05 Salatiga, there are still many students who have difficulty in understanding the mathematical concepts. This can be seen from the results of the semester I learning outcomes, 17 of 27 students received grades below the minimum completeness criteria (Kriteria Ketuntasan Minimal, KKM) (60). At this time the learning process is centered on the teacher and in the implementation of learning process (*Kegiatan Belajar Mengajar, KBM*) students tend to be passive, the learning process is less attractive, students' confidence in answering questions from the teacher is still lacking, and there is no learning experience to students.

According to Heruman (2013) mathematics is an abstract goal object, relies on the agreement, and deductive mindset. The appropriate learning model to overcome these problems is the application of discovery learning assisted with manipulative teaching tools. Manipulative teaching tools are handy, especially for students who have no experience of certain objects. In addition to its original form, the use of manipulative teaching tools can be modified. Manipulative teaching tools can be held or can be used. According to Murniasih, Ferdiani, and Fayeldi (2017) manipulative media can be manipulated by students in understanding a mathematical concept.

The discovery activities carried out by humans themselves and carried out actively would provide the best results, and would be more meaningful for students (Rosarina, Sudin, and Sujana, 2016). Discovery is done through observation, classification, measurement, prediction, determination, and inferring. The process is called cognitive process while discovery itself is a mental process assimilating concepts and principles in mind (Masdariah, Nurhayati, and Rachmawaty, 2018).

Ramdhani, Usodo, and Subanti (2017) stated that there was a difference between mathematics learning achievement in the discovery learning model group and the direct learning model. Pangaribowo, Keliat, Sastrodihardjo, and Hutangoal (2017) also

explained that the application of discovery learning combined with smart case games could improve cognitive, psychomotor, and affective learning outcomes of students. Other research conducted by Setiaji, Kristin, and Anugraheni (2018) shows that the application of the discovery learning model can improve collaboration and student learning outcomes.

In this study, discovery learning assisted with manipulative teaching tools is applied to improve the mathematical understanding concepts of students. The manipulative visual tools here is any object modified or given treatment, which is designed as a real object (concrete) and is close to the daily life of students. Setiawan, Akina, and Sudarman (2014) stated that the application of concrete media is not only helping to make the abstract things to be some concrete material, but it is also expected to be able to attract the learning interests of students so that the learning can be fun and enjoyable. Hidayah (2018) suggested that manipulative material (teaching tools) should often be used in the learning of mathematics optimally by the learning objectives. Manipulative material must be used together with other tools, including drawings, diagrams, textbooks, films, and similar materials.

The aims of this study have a purpose of examining the differences in the improvement of the mathematical understanding concepts of students between the class using discovery learning assisted with manipulative teaching tools compared to the class using discovery learning without the manipulative teaching tools.

METHODS

The population in this study were the fifth-grade elementary school students in the region of Gajah Mada Sidomukti Subdistrict Salatiga, Central Java consisting of 7 schools, the school had implemented Curriculum 2013 in the academic year of 2018/2019. The sampling technique was applied in this study Purposive Sampling technique. Based on these considerations, Public Elementary School Dukuh 05 and Public Elementary School Dukuh 01 were chosen as the sample of the study. Public

Elementary School Dukuh 05 as an experimental group using discovery learning assisted with manipulative teaching tools, whereas, Public Elementary School Dukuh 01 as a control group using discovery learning without the assistance of manipulative teaching tools.

The research design used in this study was a quantitative model in the form of quasi-experimental design (quasi-experimental). The analysis of the data used to determine the mathematical understanding concepts of students obtained from pre-test – post-test control group design. The data collection technique used in this study was an essay test consists of 7 questions.

This study has two variables, the independent variable, and the dependent variable. The independent variable in this study was the discovery learning model and manipulative teaching tools. The dependent variable was the mathematical understanding concepts of students. The research instrument used was a test of the mathematical understanding concepts taken from pre-test and post-test essay questions. The material of the test given is the volume of geometry. The tests given in each class come from the same problem. Before the data collection was done, the validity of the test items was tested to students outside the sample to determine the validity, reliability, and sensitivity of the test items (Susiawan, 2013). Test results provide valid, reliable, and sensitive information that meets the criteria. Thus, the test instrument was prepared and adjusted with the learning so that it can be used as the data collection instrument for the mathematical understanding concepts of students. The ability on the mathematical understanding concepts in this study consists of restating a concept, classifying objects according to certain properties according to the concept, determining examples of a concept, presenting concepts in various forms of mathematical representation, developing necessary or sufficient conditions of a concept, using, utilizing, and choosing a particular procedure or operation and, applying the concept.

The data on the ability of the mathematical understanding concepts of students after

following the learning process were analyzed using the statistical tests to find out the difference in the improvement of the application of discovery learning assisted with manipulative teaching tools. Before conducting a statistical test, it is necessary to conduct a prerequisite test, which is a test for determining the normality and homogeneity of the data, so that the results can be seen from a population of normally distributed samples. Homogeneity test results explain that the two samples have the same variations.

Final test evaluation was done to find out the difference in the mathematical understanding concepts by calculating N-Gain from the results of pre-test and post-test of the experimental class and the control class. After determining the N-Gain from the experimental class and the control class, then to test the significant difference

between the class using discovery learning assisted with manipulative teaching tools and the class using the discovery learning without manipulative teaching tools using the independent sample t-test with SPSS 22. The decision making can be seen from the significance value. If the significance value is less than 0.05, then H_0 is rejected, and H_1 is accepted.

RESULTS AND DISCUSSION

The differences in the test of the improvement of mathematical understanding concepts of students calculated using the N-Gain from the results of pre-test and post-test of the experimental class and the control class can be seen in Table 1.

Table 1. The Result of the Improvement of Mathematical Understanding Concepts of Students

	Experimental class			Control class		
	Pre-test	Post-test	N-gain	Pre-test	Post-test	N-gain
Average	74.56	87.11	0.55	70.85	78.89	0.29

Table 1 shows the average improvement in N-Gain of the mathematical understanding concept of students in pre-test and post-test in the experimental class by 0.55; meanwhile, the control class was 0.29. Thus, it can be interpreted that there is an improvement in the mathematical understanding concepts of students between the class using the discovery learning assisted with the manipulative teaching tools and the class using the discovery learning without the manipulative teaching tools. Therefore, it can be said that the mathematical understanding

concepts of students in the class using the discovery learning assisted with the manipulative teaching tools is higher than the class using the discovery learning without manipulative teaching tools.

After determining the N-Gain from the experimental class and the control class, then to test the significant difference using the independent sample t-test with the help of SPSS 22. The complete independent sample t-test results can be seen in Table 2.

Table 2. Result of the Significance Different Test of Mathematical Understanding Concepts of Students

		t-test for equality of means		
		t	df	Sig. (2-tailed)
Result of a test of mathematical understanding concepts	Equal variances assumed	6.098	52	.000
	Equal variances not assumed	6.098	37.407	.000

Based on Table 2, the calculation which is obtained from N-Gain value of the experimental class and the control class showed a sig. (2-tailed) of $0.000 < 0.05$ where the decision making in the independent sample t-test, if the significance

value or sig. (2-tailed) < 0.05 then H_0 is rejected, and H_1 is accepted, which means that there is a significant difference between the experimental class and the control class.

According to the explanation above, it can be concluded that there are differences in N-Gain between the experimental class and the control class. This result is accordance with the research conducted by Zulkifli, and Tetty (2018) which showed that the learning of mathematics using manipulative teaching tools has a positive impact on the learning achievement and mastery of subject matter as evidenced by the increasing value of students' mathematics lessons. This means that there needs to be a carrying capacity to maximize the learning process. This research utilizes manipulative teaching tools that can arouse the students' enthusiasm in the learning.

In the implementation of the discovery, learning assisted with the manipulative teaching tools can provide student learning experiences. Match to the results of Sihombing, Sinaga, and Mukhtar (2017) which showed that the learning model of discovery learning influences the mastery of mathematical concepts. Learning discovery on mathematical concepts is higher since students are directly involved in the learning process including taking several examples of concepts, seeing, and testing patterns through examples and generalizing their findings by using their sentences correctly. The implementation of the discovery learning activities assisted with the manipulative teaching tools. First, the students were asked to find their answers to the problems given; then, the teacher divided students into groups. During the student discussion, the teacher distributed worksheets that students must work on. Then, the teacher facilitated them by giving manipulative teaching tools to each group. The teacher provided guidance when students experience some difficulties. By using worksheet (*Lembar Kerja Siswa, LKS*), students were directed to solve problems regarding the volume of geometry by proving directly using manipulative teaching tools.

The use of manipulative teaching tools as a supporter in enhancing students' understanding of mathematical concepts, this is in line with the research results of Haloho, Prambudi, and Hidayah (2019) that the discovery learning is one of the learning models that can be applied to teach mathematics to students. Its application can be

supported through various alternative media, such as the manipulative teaching tools (*Alat peraga Manipulatif, APM*). Through the learning process with the help of manipulative teaching tools, the learning process indeed becomes more efficient and creates a more productive learning environment.

Students were then asked to present the results of their discussion in front of the class. This was done to find out the correctness of the students' answers. If the student's answer were false, then the teacher would lead to the correct answer. Therefore, it turns out that by using manipulative teaching tools, the mathematical understanding concepts of students were improved. In the experimental class, as seen from the results of the students' answers, they were able to provide ideas perfectly. They were able to answer the questions given by the teacher well. They were also able to provide variations of answers following the existing problems. Meanwhile, in the control class, the mathematical understanding concepts of students were still low since there were no supporting facilities such as manipulative teaching tools.

Problem-solving that is displayed in the problem was able to be answered properly. The answers given were the ideas of student originality. This idea arose since the application of the discovery learning assisted with the manipulative teaching tools presented problems. Therefore, through the existing problems around, students were able to generate new ideas to solve those problems. The similarity to Kania (2018) that the understanding concept of students who obtain mathematics learning using manipulative objects is better than the understanding concepts of students who obtain mathematics learning using conventional learning. Students behave positively towards the learning of mathematics by using manipulative objects since the learning of mathematics by using manipulative objects can encourage them to be more active and directly involved in the learning, more enthusiastic and make them enjoy the learning, and this makes them show more understanding on the concepts learned due to discovering results on the

problems, gaining new knowledge and experience so that they can obtain wider insights.

National Research Council (Gazali, and Atsnan, 2016) to develop mathematical thinking and the ability to solve problems, students need to "do" mathematics. This means that students need to combine activities such as solving challenging problems, understanding patterns, formulating conjectures and examining them, drawing conclusions through reasoning and communicating ideas, patterns, conjectures, and conclusions. Furthermore, it is stated that mathematics is a science of patterns and orders. That is, mathematics is the science of discussing patterns or order (pattern) and levels (order). It is clear now that mathematics can be seen as a language that explains patterns, both patterns in nature (kauni) and patterns found through the mind. These patterns can be in the form of real (real) or the form of imagination, can be seen or only in the form of mental (mind), static or dynamic, qualitative or quantitative, original related to real daily life or not more than just for recreational purposes.

The learning of mathematics is an effort to facilitate, encourage, and support students in learning mathematics. Learning mathematics at the elementary school level is one of the studies that are always interesting because of differences in characteristics, especially between the nature of students and the nature of mathematics. For this reason, a bridge is needed to neutralize these differences. Primary school-age children are experiencing development at the level of thinking.

For students at the Elementary level (SD) at the age between 7 and 12 years old, their intellectual development is included in the concrete operational stage because logical thinking is based on physical manipulation of objects (Amir, 2014). In other words, the use of teaching tools in learning mathematics in elementary is very necessary, since it is following the stage of thinking of children. By using the right teaching tools, the child will experience mathematics more clearly based on clear and visible facts. Therefore, students can easily understand the material being taught. Hidayah,

Isnarto, and Asikin (2019) the use of integrated manipulatives in learning is assisted by a series of oral and/or written questions to help students understand concepts optimally when learning is carried out following the learning design.

According to Curriculum 2013 (Fuadi, Johar, and Munzir, 2016) the aim of mathematics learning emphasizes the modern pedagogic dimension in learning, which uses a scientific approach. In mathematics learning activities, there are some steps in learning to provide meaningful learning that consists of observing, asking, trying, reasoning, presenting, and creating. All abilities stated above are expected to be possessed by students.

The implementation of discovery learning assisted with manipulative teaching tools can increase the activeness of students in the classroom using students presenting the results of their group discussions. The teacher acts as a facilitator if students experience difficulties. Measuring the results of understanding students' mathematical concepts, teachers can provide test evaluations. Therefore, the test results of the mathematical understanding concepts of students have been achieved. Following the results of research conducted by Maharani, Hartono, and Hiltrimartin (2013) the ability to understand students' concepts can be seen from the test results. Realistic problems are used as sources for the emergence of mathematical concepts or formal mathematical knowledge that can drive problem-solving activities, look for problems, and organize the subject matter. This method can improve students' understanding of mathematical concepts better than before (Fahrudin, Zuliana, and Bintoro, 2018).

The discovery learning model influences the ability to understand mathematical concepts. This is following the research of Sinambela, J. H., Napitupulu, Mulyono, and Sinambela, L. (2018) that there is an influence of Discovery learning models on the ability to understand students' mathematical concepts, whereas in the application of direct learning models there is no effect on understanding mathematical concepts. This is following the results of Yuliani, and Saragih research (2015) the device-based

discovery learning model can improve students' understanding of mathematical concepts and critical thinking. Asrul, Ridlo, and Susilo (2018) research findings showed that discovery learning model is better to be applied in improving the understanding concept compared to the conventional learning model.

Learning mathematics with a deep and meaningful understanding will bring students to feel the benefits of mathematics in everyday life (Agustina, 2016). Understanding concepts is a type of learning outcome that is higher than knowledge. For example, it can explain in its sentence structure, something that is read or heard provides another example of what has been exemplified or uses application instructions in other cases. Mathematics is meaningless if only memorized. Many students are only able to memorize concepts without being able to use them in problem-solving. Martaida, Bukit, and Ginting research results (2017) showed that students' cognitive abilities in understanding concepts using the discovery learning model are better than conventional learning.

The implementation of discovery learning has a positive impact on student learning outcomes. The similarity to Ba'ru (2018) discovery learning model and learning interest influence student learning outcomes in mathematics. Also, the use of manipulative teaching tools can provide direct experience to students. Following the results of Basri, Rohana, and Pagarra research (2018) there was an increase in learning both in the activities of teachers and students as well as student learning outcomes. Mathematics learning using manipulative teaching tools can improve student understanding and support the learning process (Fachrurazi, 2018).

The application of discovery learning further enhances student mathematics learning outcomes. Match to the results of the study Fitriyah (2017) the results of students' mathematics learning using the discovery learning model is better than the mathematics learning outcomes of students who do not use the discovery learning model (conventional models). The similarity to Pratiwi, Hasyim, and Sudirman

(2015) the use of the discovery learning model with a scientific approach can improve and increase the quality of the learning process and improve the student learning outcomes.

The use of manipulative teaching tools can arouse students' enthusiasm in mathematics. Following the results of the research Hendriana (2014) there is an influence between the use of manipulatives on understanding mathematical concepts. Students are more enthusiastic in taking mathematics lessons because they are given the confidence to find a mathematical concept through manipulative media provided by the teacher.

The use of manipulative teaching tools can also support students' success in cognitive aspects. This result is following the research conducted by Suwardi, Firmiana, and Rohayati (2014) there is an influence of the use of teaching tools on student learning outcomes. The application of teaching tools model helps students to build knowledge by using a variety of learning resources available using tools that can demonstrate real/concrete concepts to facilitate student understanding in learning. Manipulative teaching tools is one of the learning media that supports the process of learning mathematics (Sasongko, 2014).

Besides the cognitive aspect, the use of manipulative teaching tools also improves the psychomotor aspects. This is consistent with the results of Sugiharti (2013) research activities of students during the learning by using more enthusiastic manipulative media. Students are active in answering and asking questions, able to collaborate with groups, able to encourage creativity in solving problems and communication between teachers and students. Learning using manipulative media is more lively and colorful.

CONCLUSION

The implementation of discovery learning assisted with manipulative teaching tools can improve the mathematical understanding concepts of students. It can be seen from the result of the average increase in the N-Gain of the

mathematical understanding of concepts concept of students in pre-test and post-test in the experimental class by 0.55 and the control class by 0.29. After determining the N-Gain from the experimental class and the control class, then tested the significance difference using the independent sample t-test with the help of SPSS 22. Based on the independent sample t-test, it was obtained a sig. (2-tailed) of $0.000 < 0.05$. In the decision making in the independent sample t-test, if the significance value or sig. (2-tailed) < 0.05 then H_0 is rejected, and H_1 is accepted, which means that there is a significant difference between the experimental class and the control class. These results prove that by applying the Discovery learning assisted with manipulative teaching tools can improve the mathematical understanding concepts of students. The implementation of discovery learning assisted with manipulative teaching tools can be concluded to further enhance students' understanding of mathematical concepts than the application of discovery learning without the assistance of manipulative teaching tools. Also, the implementation of discovery learning assisted by manipulative teaching tools can make the learning process more active and enjoyable.

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