



The development of geometry concepts understanding based on NCTM reference in learning using discovery learning model

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Abstract

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Mathematics Concepts Understanding is an important foundation for solving mathematical and everyday problems. In reality, students' mathematics concepts understanding are not optimal. Learning based on NCTM standard is effective to help students in understanding mathematics material. Discovery Learning is suitable to be used to understand the development of students' conceptual understanding of geometry. The purpose of this study was to find out the development of geometry concepts understanding in *Discovery Learning*. The research was qualitative. The subjects of this study were 6 students. The 2 subjects were selected for each upper, middle and lower class based on the results of the initial test of understanding geometric concepts in one of the seventh grade in a junior high school in Rembang which had previously been ranked. The results showed that (1) both U-12 and U-17 subjects were able to fulfill all indicators of understanding geometry concepts 1 to 7 very well, (2) the two middle-class research subjects were U-19 subjects and U-24 have been able to fulfill all indicators of understanding geometric concepts well, (3) the two lower class research subjects namely U-30 and U-10 were finally able to fulfill all indicators of understanding geometric concepts from 1 to indicator 7 even though they were not good and rather slow compared to the upper and lower groups. They still experienced some difficulties, especially in the indicators of understanding the 4th, 5th and 7th concepts.

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1. Introduction

The development of Indonesia education at the International level can be seen in TIMSS. TIMSS (*Trends in International and Science Study*) is an international study about mathematics and science in junior high schools that is held every four years since 1995. Indonesia has participated in TIMSS several times. In 2003, Indonesia only got an average score of 411 and ranked 25 out of 46 participating countries, in 2007 Indonesia received an average score of 397 and was ranked 36 out of 49 countries, while in 2011 Indonesia only got an average score 389 ranked 38 out of 42 participating countries. It shows that the average score obtained by Indonesia from the last three years of participation in TIMSS always decreases

and less than the international average score that is 500.

Therefore, mathematics learning in Indonesia still needs to be improved. In mathematics learning outlines students must learn mathematics through understanding and actively building new knowledge and knowledge experienced before. According to Permendiknas No. 22 Year 2006, one of the objectives of mathematics learning is students have ability to understand mathematical concepts, explain the relevance of concepts and apply concepts or algorithms flexibly, accurately, efficiently, and precisely in solving problems. Based on that objective of mathematics learning, the ability to understand concepts is one of the important indicators that must be mastered by students in mathematics learning.

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According to Duffin & Simpson (2000) concept understanding as the ability of students is realized by: (1) explaining the concept, it can be interpreted that students are able to re-express what has been communicated to them, (2) using concepts in a variety of different situations, (3) developing some consequences of the existence of a concept, meaning that students understand a concept as a result students have the ability to solve each problem correctly. Understanding mathematical concepts is realized restating the concept, classifying objects according to certain characteristics, providing examples, presenting concepts in mathematical representation, using certain procedures and applying concepts to problem solving in the mathematics learning process (Mawaddah & Ratih, 2016).

The material that became the focus of this study was geometry material. According to van de Walle (1994: 325) as quoted by Khoiri (2014: 264) there are five reasons why geometry is very important to be learned, they are: (1) geometry helps people have complete aspirations about their world, (2) geometric exploration can help developing skills of problem solving, (3) geometry plays a major role in other mathematics, (4) geometry is used by many people in everyday life, and (5) geometry is full of riddles and fun.

The results of the interview with one of the mathematics teachers at one of junior high school in Rembang stated that students' geometry concepts understanding was not optimal. This was indicated by the number of students who only memorized the formula given by the teacher without understanding the concept until the formula was obtained, so students tended to have difficulties when asked to do the different questions from the example given by the teacher. Many students considered that mathematics was a difficult lesson. It was indicated by the daily geometry test results of students in the odd semester, namely only 40% students reached the completeness of 70.

Based on the explanations above, there were some conclusions, they are: (1) the importance of understanding concepts, (2) the importance of geometry in mathematics and everyday life, (3) the importance of understanding mathematical concepts especially understanding geometry and geometry concepts in life. However, in reality, students still consider geometry as a difficult lesson and it is proved that students' understanding of geometric concepts is not optimal.

Mathematical learning and some ways to advance the learning have been widely discussed in NCTM. *National Council of Teacher of Mathematics* (NCTM) is the National Mathematics Teachers Council which is a public voice of mathematics education, supporting teachers to ensure fair mathematics of learning with the highest quality for all students through vision, leadership, professional development, and research founded in 1920. The largest organization in the world that cares about mathematics education. It has nearly 100,000 members throughout the United States and Canada, and international. NCTM has published Curriculum and Evaluation Standards for School Mathematics in 1989, Professional Standards for Teaching Mathematics in 1991, Assessment Standards for School Mathematics, and in 2000 NCTM has published Principles and Standards for School Mathematics.

NCTM tries to outline the important components of high-quality school mathematics programs. One of the components presents five standards process that students must have in order to achieve high-quality of mathematics learning, namely Problem Solving, Understanding and Evidence, Communication, Relationships, and Presentation. Understanding is one of the important aspects in learning. It covers understanding concepts that must be mastered by students. Several studies of students' mastery of mathematics as an implementation of the realization of classroom mathematics learning were done by the National Assessment of Educational Progress (NAEP) and The Third International Mathematics and Science Study (TIMSS). Some studies state that learning based on NCTM standards, it is effective to help students understand mathematical material. Kusumawati (2005: 103) states that learning by applying the NCTM standards can help students understand the material.

The application of the Discovery Learning model in the process of learning mathematics is one of alternatives model option that can increase understanding of concepts and get a positive response from students. This is in line with some previous studies, such as the results of a research conducted by Syaifudin (2008) which shows that Discovery Learning can reduce students' misconceptions of geometry that is indicated by an increase in mastery of concepts and a decrease in the level of student error in working on geometry problems. Therefore, learning with the Discovery Learning model is suitable to be applied to

improve students' understanding of concepts, especially geometry material.

In this study the applied learning was learning by using the Discovery Learning model. The research question in this study was how the development of understanding geometric concepts in each syntax step of the Discovery Learning model from time to time was, while the objective of this study was to find out the development of understanding geometric concepts of students in detail based on the NCTM reference by using the Discovery Learning model in quadrilateral material.

2. Method

The type of research used in this study was qualitative research. According to Sugiyono (2016: 366), qualitative research methods are research methods based on post positivism philosophy. It is used to examine the conditions of natural objects, (as the opponent is experiments) where the researcher is a key instrument. For more, purposive sampling and snowball were done for sampling. And, data collection techniques were carried out with triangulation, while data analysis was conducted inductively/qualitatively, and the results of qualitative research emphasized more on meaning than generalization.

The approach taken in this study was a qualitative descriptive approach. It meant the data collected were the result of a written test (concept understanding test) and interview results processed descriptively in writing that sought to describe the development of understanding geometric concepts of VII grade students in learning using model of Discovery Learning. The election of this method was based on the aim of the researcher who wanted to reveal in detail the development of the understanding of geometric concepts of students in learning using the Discovery Learning model.

The population in this study were the seventh grade students of one of junior high school in Rembang. From the population, sample was taken by random sampling technique. It resulted class VII I as the experimental class. In this study there was only one class was used as an experimental class, and there was no control class. To find out the development of geometric concepts understanding of VII I class, 6 research subjects were taken with stipulation that two students were ranked top, two students who got the lowest ranking, and two students who received middle ranking as what was reported in odd semester

report cards. The technique used in taking the subject of this research was purposive sampling. Purposive sampling is a sampling technique of data sources with certain considerations (Sugiyono, 2016: 368).

Methods of collecting data in this study consisted of monitoring and observation methods. They were used to observe research subjects and obtain wanted information, written test methods of understanding geometric concepts were used to get data on the results of the development of understanding of geometric concepts of students, documentation methods used to get written data or images related to this study, and interview methods used to get data directly about the development of understanding geometric concepts and also in completing written tests.

3. Results & Discussions

Research on the development of understanding geometric concepts based on NCTM's reference in learning using the Discovery Learning model in quadrilateral material was conducted at SMP Negeri 1 Rembang with 9 classes for class VII. This study did not use the control class. This research was conducted in VII I class with the only experimental group class and VII F class as a trial class.

Before the treatment given to experimental class students from VII I class, geometry concept understanding test questions were tested first to the trial class that was VII F class. The questions tested previously have been consulted to supervisor and the seventh grade mathematics teacher of one of junior high school in Rembang. The trial test of this question test aimed to determine the validity, reliability, power of difference, and the level of difficulty of the items in the test of understanding the geometry concept. After that, the research was carried out in VII I class with Discovery Learning models for 4 meetings and 1 time geometry concept understanding test to determine the development of understanding geometric concepts of students of VII I class of one of junior high school in Rembang

3.1. Findings of Research Subjects

Based on the results of the ranking of VII I class, then 6 students were obtained as follows.

No	Ranking	Students' Code	Students' Name
1.	1	U-12	Ilham Maulana Putra
2.	2	U-17	Muhammad Syamsuddiin
3.	16	U-19	Mutiara Indah Cahya Ningrum
4.	17	U-24	Nyamiyati Ningrum
5.	31	U-30	Sony Eka Aditiya
6.	32	U-10	Fatika Nur Rahmadani Cantika

Research Subjects	Students' Code	Students' Name
Upper Group	U-12	Ilham Maulana Putra
	U-17	Muhammad Syamsuddiin
Middle Group	U-19	Mutiara Indah Cahya Ningrum
	U-24	Nyamiyati Ningrum
Lower Group	U-30	Sony Eka Aditiya
	U-10	Fatika Nur Rahmadani Cantika

3.2. The Development of Geometry Concepts Understanding Based on NCTM Reference in Learning Using Discovery Learning

The Indicators of geometry concepts understanding based on NCTM reference which used in this study were: (1) Defining concepts verbally and in writing, (2) Identifying, making examples and not examples, (3) Using models, diagrams and symbols to present a concept, (4) Changing a form of presentation into another form, (5) Recognizing various meanings and interpreting concepts, (6) Identifying the characteristics of a concept and recognizing the conditions that determine a concept, (7) Comparing and distinguishing concepts.

After conducting process of learning for 4 meetings and 1 test of geometry concepts understanding, the results of the development of geometry concepts understanding geometric concepts students of VII I class based on the NCTM reference are as follows.

3.3. Details of Development of Understanding of Geometry Concepts for U-12 and U-17 Subjects

indicators	U-12 meeting				U-17 meeting			
	1	2	3	4	1	2	3	4
1	√	√	√	√	√	√	√	√
2	√		√		√		√	
3		√		√		√		√
4		√		√		√		√
5	√	√	√	√	√	√	√	√
6	√	√	√	√	√	√	√	√
7	X	√	√	√	√	√	√	√

Notes:

- : the students have been able to fulfill the indicators
- X : the students have not been able to fulfill the indicators
- : the indicators are not included in the meeting material

3.4. Details of Development of Understanding of Geometry Concepts for U-19 and U-24 Subjects

indikator	U-19 meeting				U-24 meeting			
	1	2	3	4	1	2	3	4
1	√	√	√	√	√	√	√	√
2	√		√		√		√	
3		√		√		√		√
4		√		√		√		√
5	X	√	√	√	X	√	√	√
6	√	√	√	√	√	√	√	√
7	X	√	√	√	X	√	√	√

Notes:

- : the students have been able to fulfill the indicators
- X : the students have not been able to fulfill the indicators
- : the indicators are not included in the meeting material

3.5. Detail of Development of Understanding of Geometry Concepts for U-30 and U-10 Subjects

indicators	U-30 ,meeting-				U-10 Meeting-			
	1	2	3	4	1	2	3	4
1	√	√	√	√	√	√	√	√
2	√		√		√		√	
3		√		√		X		√
4		X		√		X		√
5	X	X	√	√	X	√	√	√
6	√	√	√	√	X	√	√	√
7	X	X	√	√	X	X	√	√

Notes:



: the students have been able to fulfill the indicators



: the students have not been able to fulfill the indicators



: the indicators are not included in the meeting material

3.6. Specifications of Achievement Indicators of Geometry Concepts Understanding for Each Research Subject

3.6.1. Research Subjects of Upper Group

U-12 and U-17 subjects have been able to fulfill all indicators of geometry concepts understanding 1 to 7 very well. The prominent thing from the U-12 subject was this subject was more detailed and coherent in explaining or defining concepts verbally and in writing. However, this subject had weaknesses in calculations. This subject often did not use coherent methods but rather fast ways according to him; this was due to good mastery. Whereas, U-17 subject was very good at mastery and had high level of concentration so that his understanding the geometric concept was also very good, but this subject was less able to explain well and coherent in writing what he understood.

3.6.2. Research Subjects of Middle Group

The two research subjects of middle group namely U-19 and U-24 subjects have been able to fulfill all indicators of geometry concepts understanding well. The thing that was prominent from U-19 subject was a good ability to explain or clarify, detailed, coherent and very neat. However, this subject was less accurate in some final calculations which contained the form of the square root.

Whereas, the U-24 subject had good ability in defining the characteristics of a concept and identifying examples. However, U-24 subject still lacked of explaining or clarifying in detail, coherent and neat.

3.6.3. Research Subjects of Lower Group

The two research subjects of lower group namely U-30 and U-10 have been able to fulfill all indicators of geometry concepts understanding from 1 to indicator 7, although they were not as good and as perfect as the upper group. This has been very good considering that their initial abilities which have not met with many indicators at the beginning and still often got initial difficulties. The prominent thing from the development of geometry concepts understanding of the U-30 subject was the good ability to explain/clarify the definition coherently, although it cannot be as detailed as the abilities of the upper group subjects. The weakness of this subject was the lack of time management; for example, in answering questions, this subject often could not solve the questions completely or there were some numbers that have not been answered although she was actually able to solve them.

U-10 subject had a deficiency in terms of concentration and mastery of the material so that the development of student' geometry concepts understanding of this subject can be said to be slower than others so that it required special guidance for several indicators which she thought were difficult. However, this U-10 subject had been able to define/explain a concept well from the beginning.

In this study, there were several limitations, namely: (1) The timing of the study was too close to the implementation of the *Ulangan Kenaikan Kelas* (UKK) so that the research was rather hurried and students were not too focused, (2) The materials used in the research were only square and rectangular while the main rectangular subject was still wide.

4. Conclusions

Based on this research the development of understanding of geometric concepts was obtained as follows: (1) U-12 subject, meeting 1: have been able to fulfill most of the indicators of understanding geometric concepts well, except using models, diagrams and symbols to present a concept, and still having difficulties in distinguishing and comparing concepts, meeting 2:

have begun to be able to use models, diagrams, symbols to present a concept, change a form of presentation to another form and compare and distinguish concepts, meeting 3: at this meeting the development was not so striking compared to meeting 1, only the ability to understand improved to be better, detailed, coherent, and neater than before, meeting 4: compared to the previous meetings, at this meeting, geometry concepts understanding of the U-12 subject student was very good; (2) U-17 subject, meeting 1: have started to be able to compare differences and concepts compared to U-12 subjects, meeting 2: increasing achievement of indicators that have previously been met and have begun to be able to use models, diagrams, symbols to present a concept, change a form of presentation to another form, meeting 3: the development was not so striking, only the understanding ability got better, detailed, coherent, and more thorough than before, meeting 4: has been better than the previous meeting; (3) U-19 Subject, meeting 1: have been able to meet 3 out of 7 indicators, namely defining concepts verbally and in writing, identifying, making examples and not examples and identifying the characteristics of a concept but still having difficulty recognizing various meanings and interpreting concepts, meeting 2: have been able use models, diagrams, symbols to present a concept, change a form of presentation into another form, and have begun to be able to recognize various meanings interpret concepts and compare and distinguish concepts even though they are not good enough, meeting 3: the fulfillment of the indicators of understanding concepts was much better than previous meetings; (4) U-24 Subject, meeting 1: has been able to meet the indicators defining concepts verbally and in writing, identifying, making examples and not examples and identifying the characteristics of a concept and still having difficulty comparing and distinguishing concepts, meeting 2: has begun to be able to distinguish concepts from good enough, meeting 3: understanding ability better than meeting 1, meeting 4: fulfillment of concept understanding indicators far better than previous meetings; (5) U-30 subject, meeting 1: U-30 subject was able to well fulfill 3 out of 7 indicators, there were defining concepts verbally and in writing, identifying, making examples and not examples and identifying the characteristics of concepts, meeting 2: have begun to be able to use models, diagrams, symbols to present a concept, meeting 3: has been able to meet the indicators that

he had experienced difficulties, namely recognizing various meanings and interpreting concepts and comparing and distinguishing concepts, meeting 4: The development seen in this last meeting for U-30 subjects was for the first time being able to change a form presentation into other forms quite well, besides that the development was the ability to fulfill the indicators that have previously been fulfilled is better than before; (6) U-10 Subject, meeting 1: U-10 subject was able to good enough fulfilling 2 out of 7 indicators, they are, meeting 2: U-10 have begun to be able to fulfill Using models, diagrams and symbols to present a concept, and identifying the characteristics of a concept and recognizing the conditions that determine a concept, although they were not fully good and still needed guidance, meeting 3: U-10's developments that a few indicators that have been fulfilled, and have developed better than before, and have also begun to be able to meet recognizing various meanings and interpreting concepts, meeting 4: U-10 in the first time, the subject was able to fulfill, change a form of presentation into another form quite well. Besides, another development was the ability to fulfill the indicators that have previously been fulfilled to be better than before.

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