ME – 52

Improving Students' Logical Thinking Mathematic Skill Through Learning Cycle 5E and Discovery Learning

Gida Kadarisma
STKIP Siliwangi Bandung : Mathematic Education Dept.
gidakadarisma@yahoo.com

Abstract— This research is motivated by low of logical thingking mathematic skill junior high school students based on the results of the TIMSS 2011. This study aims to determine the increase logical thinking skill junior high school students who were taught by *learning cycle 5e* and *discovery learning*. This study is a quasi experimental and instrument of this research used the logical thinking skill tests include the skill to think mathematically proportional, probabilistic and correlational form of description as much as 4 questions that have been tested for validity and reliability. Population of this study is a junior high school students, the sample was taken two classes of ninth grade there is to be a experimental class 1 (using the learning cycle 5e) and experiment class 2 (using discovery learning). Before and after the experiment each class are given a pretest and posttest. Based on this research, it is known that there is no different improvement of students' logical thingking mathematic between students taught by using *Learning Cycle 5e* model and students taught by using discovery learning model.
Keywords: *Logical thinking Mathematic, Discovery Learning, Learning Cycle 5E.*

I. INTRODUCTION

Mathematics is the science which very useful for many people; therefore mathematics became one of the compulsory subjects that must be learnt by students at every level of formal education from elementary to high school. Mathematics and its learning are two things that can not be seen partially, due to the rapid of mathematics influenced by its learning in high school and college level. According to the Ministry of Education (2006), the aim of mathematics learning is to train how to think systematically, logically, critically, creatively and consistently [1].

The ability to think logically in learning mathematics is emphasized by every individual when need to take decisions, draw conclusions up to problem solving in everyday life sanely. The importance of the ability to think logically encountered in the vision and goals of mathematics teaching is to develop mastery of mathematical concepts, understanding and being able to apply mathematical concepts well in other subjects and in everyday life.

Apparently, based on the results of the study, mathematical logical thinking ability of students is still low. Lack of logical thinking ability of students can be seen from the results of the study by TIMSS in 2011. TIMSS is one of the international study to evaluate special education for the study of 14 year-old students at the level of junior high school (SMP), followed by Indonesia, where questions tested included measures of the students' ability to think logically. Rosmiati (2013) states that the average achievements of Indonesia on TIMSS 2011 is at a low level which is at rank of 386 and the mean of Indonesian participants' achievement has decreased from an average of the TIMSS 2007 which is the 397th rank [2]. Innovative and constructivism-based learning can be a solution to improve the ability to think logically for junior high school students. one of which is learning cycle 5E model. Learning Cycle 5E model aims to help developing students' thinking from concrete to abstract thinking. This model isnot only commonly used in the fields of science, but also is applied in mathematics. there are five phases in the Learning Cycle 5E model, namely engagement (attract attention-binding), exploration, explanation, elaboration (expansion), and evaluation.

Besides, learning model that can be used as a solution is discovery learning. Ruseffendi (2006: 329) argues that discovery is a method of teaching that is arranged normatively so that children can acquire the knowledge they do not know previously through their own effort and within their teacher's

help[3]. As noted by Taba (Trisnadi, 2006: 21), the discovery method involves an inductive sequence. this sequence begins not with the explanation on a general principle but exposes students to some examples of principles where they can analyze, manipulate and experiment [4].

One of the advantages of learning through discovery learning is to lead the development of intellectual potential of students. By discovering relationships and regularities of the material being studied, the student becomes easier to understand the structure of the material being studied. So, students will more easily remember the concepts, facts, algorithms / procedures and principles in mathematics.

Based on the explanation above, the formulation of the problem in this paper is "Is there a significant difference in improvement on the logical thinking between students who use learning cycle 5e with those who use discovery learning?

II. THEORITICAL REVIEW

A. Mathematical Logical Thinking Ability

Logic can be defined as something that is in accordance with the logic, true by reasoning and reasonable. Logic in mathematics is often associated with the use of the rules of logic. Someone who played by the rules of logic can be said that the person is able to think logically. Saragih (2006) revealed that the logical thinking has differences with memorization [5]. Memorizing only refers to the achievement of a mere memory skills, whereas a more logical thinking refers to the notion of understanding, application ability, analytical skills, ability to synthesis, even the ability to develop skills evaluation (a process). Edward de Bono in Rosnawati (2011) divides the thinking patterns into a pattern of vertical and lateral thinking. Conventional patterns of thinking logically has been known and commonly used included into the mindset of vertical. This pattern of thinking is done step by step based on the facts to seek various alternative solutions to problems, and ultimately chose the most likely alternative according to normal logic[6].

In some discussions,the term of logical thinking (logical thinking) is often interchangeable with the term logical reasoning (logical reasoning) because both contain some similar activities. Indeed, the term logical thinking has a wider scope than logical reasoning . The term logical reasoning will contain activities to explain why and how a result is obtained or why and how to draw conclusions from available premises, or as a conclusion based on inference rule. While the term logical thinking load broader activities include completing mathematical problems in a rationally or reasonable (Sumarmo, 2011) [7].

Capie and Tobin (1980) in Sumarmo (1987) measure the ability of logical thinking based on the theories of mental development of Piaget to distinguish students stage of concrete operations and formal operations through the Test of Logical Thinking (Tolt) which consists of five components: Controlling variable , proportional reasoning, probabilistic reasoning, correlational reasoning, and combinatorial[8].

Logical thinking which the author want to examine adjusted with the level of junior high school students' thinking is the ability of probabilistic and correlational thinking, and the ability to think proportionately.

B. Learning Model Learning Cycle 5E

Learning Cycle model is a science-based contructivistic learning model. The model was developed by J. Myron Atkin, Robert Karplus and SCIs Group (Science Curriculum Improvement Study), at the University of California, Berkeley, USA since 1967. The theory of constructivism views that learning is a process of knowledge building bit by bit, which then the results are expanded through a limited context and it is not a sudden process. Knowledge is not a set of facts, concepts or rules that are ready to be retrieved or remembered. Man must construct knowledge and give meaning through real experience.

According to Soebagio, et al (2001: 50), Learning Cycle is a learning model that allows students to find their own concept or solidify concepts learned, prevent misconceptions, and provide opportunities for students to apply the concepts learned in new situations[9]. Learning Cycle model implementation in accordance with the view of constructivism learning where knowledge is built on self-learners.

The steps in each phase Learning Cycle 5E described by Lorsbach (2002) are as follows:

a. Engagement Phase. At this stage, the teacher prepare the students to learn, generate students' interest in math, and do a debriefing in exploring the students' prior knowledge. In the engagement phase, this interest and curiosity of the learners on topics which will be taught are tried to be resurrected. In this phase, learners are also invited to make predictions about the phenomenon to be studied and proven in the exploration stage.
b. Exploration Phase. At this stage, students work together in small groups to work on worksheets without direct instruction from the teacher. Students learn the concept itself from various sources and then discuss it with their friends n group..
c. Explanation phase. This stage is the stage of classical discussion. At this stage, the students explain the concept of the findings whitin their group with their own words, evidence and clarification of their explanations as well as comparing the arguments they have with the arguments of the other students.
d. Elaboration phase. At this stage, the students apply the concepts they got to solve the problems.
e. Evaluation Phase. Evaluation can be done through the provision of tests (quiz) or open-ended question at the end of the study to determine the extent of students' understanding of concepts learned, to evaluate the effectiveness of the previous phases and also evaluation of the knowledge, and to understand the concepts or competence of learners through problem solving in new contexts that sometimes encourage learners to investigate further[10].

Based on the stages in a cyclical learning method as described above, students are expected not only to hear the statements of teachers but it can also play an active role to explore and enrich their understanding of the concepts learned. Based on the above explanation, the learning cycle can be implemented in the areas of science and social.

Learning cycle should put forward because it is based on the learning theories of Piaget (Renner: 1988), constructivism learning theory. Piaget stated that learning is the development of cognitive aspects include: structure, content, and functionality[11].

C. Discovery learning

Discovery learning is a learning process in which a concept is not presented in the final form, but students are required to organize themselves in finding a way of learning concepts (Department of Education, 2013)[12]. Model Discovery learning is to understand the concept, meaning, and relationships, through an intuitive process to finally come to a conclusion. Discovery occurs when an individual is involved, especially in the use of mental processes to find some of the concepts and principles. Discovery is done through observation, classification, measurement, prediction, determination and Inferi. As a learning strategy, Discovery learning has the same principle as the inquiry and Problem Solving. There is no difference in principle on these three terms; Discovery learning is more emphasis on the discovery of concepts or principles that were previously unknown. The difference with the discovery learning is that the discovery problem that confronted the students is some sort of problem that is created by the teacher, while the problem in inquiry is not the result of the teacher's creation, so students have to put all of their effort, mind and skill to get the findings in the matter through the research process.

Problem Solving puts more emphasis on problem-solving ability. However, the principle of learning clearly visible in Discovery learning is that the material or learning material to be delivered are not delivered in final form, but students as learners are encouraged to identify what they want to know followed by finding the information them selves, then they organized and formed (constructively) what they know and they understand in a final form.

In the end, the objectives of the Discovery learning model proposed by Bruner is to let the teacher provides the opportunity for students to become a problem solver, a scientist, historian or mathematician. Through these activities, the students will master, implement, and find things that are beneficial to them. The most obvious characteristic of the Discovery as a model of teaching is that after the initial teaching levels (with the previous), teachers' guidance would be less involved compares with other teaching methods. It does not mean that teachers stop to give a guidance after the problems

presented to students. The guidance given is not only reduced directly but students are given greater responsibility for their own learning.

The stages of discovery learning (Department of Education, 2013)

a. Stimulation (Giving Stimulation)

First of all, students are faced with something that causes confusion, then proceeded to not give a generalization, so that they have desire to investigate it by them selves. Besides, teachers can start teaching and learning activities by asking questions, suggestions reading books, and other learning activities that lead to the preparation of problem solving.

b. Problem Statement (Identification of Problems)

After stimulation, the next step is teachers allowed students to identify as much as possible the agenda of issues which relevant to learning materials, then one of them is selected and formulated in hypothetical form (temporary answer to the question problem)

c. Data Collection (Data Collection)

When the ongoing exploration happens, teachers also provide an opportunity for the students to gather as much information relevant to prove the correctness of the hypothesis. This stage serves to answer questions or to prove the truth of the hypothesis. Thus the students are given the opportunity to collect (collection) of various relevant information, read the literature, observing the objects, interviews with informants, do their own trials and so on.

d. Data Processing (Data Processing)

Data processing is an activity to process the data and information that has been obtained by the students through interviews, observation, and so forth, and then interpreted. All information results of readings, interviews, observation, and so on, are all processed, randomized, classified, tabulated, even it is calculated and interpreted in a certain way at a certain confidence level. Data processing is also called the coding / categorization that serves as the formation of concepts and generalizations. From generalizations, students will gain new knowledge about alternative answers / settlement that needs proof logically.

e.Verification (Proof)

At this stage, the students perform a careful examination to prove whether or not the hypothesis set forth earlier by finding alternatives, associated with the results of data processing Verification according to Bruner, aimed to make the learning process will go well and creative if the teacher gives students the chance to find a concept , theory, rules or understanding through examples that he encountered in his life. Based on the results of processing and interpretation or information, statements or hypotheses that have been formulated earlier was then checked, whether answered or not, whether proven or not.

f. Generalization (Interesting Conclusion)

generalisation / conclusion drawing phase is an interesting process that can be used as a general principle and application to all event or the same problem, taking into account the results of the verification[12].

III. RESEARCH METHOD

This study is a quasi-experimental research, with pretest-posttest control group design which used two classes as sample. The first class is the experimental class 1 that was taught using 5E learning cycle and the second group is the class that was taught using Discovery Learning and called as the experimental class 2. The population is one of the junior high school in Cimahi. Sample was selected 2 class from 9 class available. According Ruseffendi (2010) Design research is as follows [13]:

:

O X_1 O

- - - - - - - - - - - - - - - -

O X_2 O

Information :

O : pretest and posttest of mathematic logical thinking ability

X1 : Learning activity using learning Cycle 5E model

X2 : Learning activity using discovery learning model
------ : Sampling is not randomly taken

IV. DISCCUSION

Here are the finding of students' logical thihnking ability :

TABEL 1. Statistical description of Mathematic Logical Thinking Ability

Data	*Learning Cycle 5E*				*Discovery Learning*			
	Pretes	**Postes**	**Gain**	**N**	**Pretes**	**Postes**	**Gain**	**N**
$\bar{x}$	1.45	5.21	0.36	33	2.85	5.78	0.33	33
S	1.54	2.88	0.25		1.50	2.20	0.19	

From the data served in Table 1, it can be seen that the improvement of the mathematic logical thinking ability of the students who used learning cycle 5e is higher than those who used discovery learning (means of the gained score). Based on this finding, t-test is applied to examine the significant difference between the two means of score.

Tabel 2. T-test of Mathematic Logical Ability

Test	Sig	Finding	Interpretation
Gained mathematic logical thinking	0.588	Ho is accepted	There is no significant difference between the improvement of mathematic logical thinking ability of the students who used learning cycle 5e method and those who used discovery learning method.

From the finding obtained, there is no significant difference between those two methods. It means that both learning cycle 5e method and discovery method serve the same good effect on improving the students' logical thinking. It can be seen from the gained score of each method which comes to the average category.

Based on the data analysis above, it can be concluded that there is no significant difference on the students' mathematic logical thinking ability between the students who used learning cycle 5e model and discovery learning model. The two models are able to improve mathematic logical thinking ability of the junior high school students well.

References

[1] Ministry of Education, "Kurikulum 2006 Standar Isi Mata Pelajaran Matematika,"Jakarta : Ministry of Education, 2006.

[2] Rosmiati, R.(2013*). Kemampuan Penalaran Matematika Siswa SMP Indonesia pada TIMSS 2011*. Prosiding Seminar Nasional Penelitian, Pendidikan dan Penerapan MIPA, Fakultas MIPA, Universitas Negeri Yogyakarta, 18 Mei 2013.

[3] Ruseffendi, E.T. (2006). Pengantar kepada Membantu Guru Mengembangkan Kompetensinya dalam Pengajaran Matematika untuk Meningkatkan CBSA. Bandung : Tarsito

[4] Trisnadi, A. (2006). *Meningkatkan Kemampuan Pemahaman dan Generalisasi Matematika Siswa Sekolah Menengah Pertama melalui Pembelajaran Penemuan Terbimbing dalam Kelompok.* Tesis UPI Bandung: Tidak diterbitkan

[5] Saragih, S. (2006). Menumbuhkembangkan Berpikir Logis dan Sikap Positif terhadap Matematika Melalui Pendekatan Matematika Realistik. *Jurnal pendidikan dan kebudayaan Departemen Pendidikan Nasional*. Badan Penelitian dan Pengembangan, Edisi Juli 2006.

[6] Rosnawati, R. (2011). *Berpikir Lateral Dalam Pembelajaran Matematika*. Prosiding Seminar Nasional Penelitian, Pendidikan dan Penerapan MIPA, Fakultas MIPA, Universitas Negeri Yogyakarta, Edisi Mei 2011

[7] Sumarmo, U. (2011). Pendidikan Budaya dan Karakter serta Pengembangan Berpikir dan Disposisi Matematik: Pengertian dan Implementasinya dalam Pembelajaran". *Makalah yang Disampaikan pada Seminar Pendidikan Matematika di Universitas Siliwangi Tasikmalaya*. Tasikmalaya

[8] Sumarmo, U. (1987). Kemampuan Pemahaman dan Penalaran Matematika Siswa SMA Dikaitkan dengan Kemampuan Penalaran Logik Siswa dan Beberapa Unsur Proses Belajar Mengajar. Disertasi Doktor pada FPS IKIP Bandung: Tidak Diterbitkan

[9] Soebagio., Soetarno., Wiwik (2001). Penggunaan Daur Belajar untuk Peningkatan Kualitas Pembelajaran dan Pemahaman Konsep sel elektrolisis pada Siswa Kelas III SMU Negeri 2 Jombang.*Jurnal Ilmu Kimia dan Pembelajarannya*. 5(1)

[10] Lorsbach. (2002). *The Learning Cycle as A Tool for Planning Scince Instruction*. (Online), (http://www.coe.ilstu.edu/scienseed/lorsbach/257lrcy.htm, diakses tanggal14 Mei 2014)

[11] Renner, J.W., Abraham M.R.,Birnie, H.H. 1988. The Necessity of Each Phase of The Learning Cycle ini Teaching High School Physics. *J. of Research in Science Teaching*. Vol 25 (1), pp 39-58.

[12] Depdikbud. (2013). *Materi Pelatihan Guru Implementasi Kurikulum 2013.*Kementrian Pendidikan dan Kebudayaan

[13] Ruseffendi, E.T. (2010). *Dasar-dasar Penelitian Pendidikan & Bidang Non-Eksakta Lainnya*. Bandung: Tarsito