

The Influence of Mathematical Thinking Ability with Modified MOORE Method on Learning Outcomes of Basic Mathematic II Chemical Education Students

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Abstract. Developing the ability of absolute thinking is needed in mathematic class where the subject has a characteristic as a branch of science which the object of study is abstract-natured and related with a pattern of thinking. Basic mathematics is one of the courses that can develop student's ability to think. The results acquired by the students are still not maximized; this is because the students struggle to develop their own knowledge to form concepts. Student's activities in the learning process are only skill-natured in solving problems. One of the learning methods that can be implemented is the Modified Moore method. This research aims to discover the effects of mathematical thinking capabilities with the Modified Moore Method towards the learning achievement of Basic Mathematic II of Chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year. The form of this research is a quasi-experimental research. The experiment design used in this research is the Single Group Pretest/Posttest Design which includes Quasi Experimental Design without control group. The population in this research is the students of Chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year. The sample of this research is all students of Chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year consisting 36 peoples. The sample is obtained through purposive sampling technique. Based on data analysis using t test on mathematical thinking capabilities by applying modified Moore Method, it was found that students scores during post test is better than pre-test. The influences of mathematical thinking capabilities with modified Moore Method of the results learning mathematics basic II Chemistry Education in second semester academic year 2013/2014 is equal to 98,85%. It can be concluded that there is an influence on the mathematical thinking capabilities by applying Modified Moore Method towards the students learning achievement of Basic Mathematic II of Chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year.

Keyword: *Learning outcomes, Modified moore method, Thinking ability*

1. Introduction

Thinking mathematically is a mathematical process that covers five aspects; mathematical understanding, mathematical communication, mathematical connection, mathematical reasoning and mathematical problem solving. To properly understand mathematics, the thinking ability of students must be developed. According to Priatna (2003), the lack of reasoning ability towards the basic principle of mathematics is causing the students to create mistakes in solving mathematical problems. Because of that, without increasing and utilizing qualified mathematical learning that demands student to think, it will be difficult to reach the proper thinking ability that can bring out good mathematical learning outcomes.

Developing absolute thinking ability is needed in mathematics class where the subject has a characteristic as a branch of science which the object of study is abstract-natured and related with a pattern of thinking. With these characteristics, the concept of mathematics should be introduced to students through a process of thinking, and not in a completed form. Because of that, the thinking ability in mathematical learning process should be developed.

The difficulty of students in mathematical problem solving is caused by the questions given are not present in the previous simple and easy questions the students are accustomed to. Mathematics should put more emphasis to the aspect of developing students' thinking ability. According to Sumarno (2004), mathematics should be focused more as an education to enhance problem solving, creativity, working habit and independence, honesty, discipline, having a good social attitude, as well as good public relationship are potentials in a student that must be developed.

One of the subjects in chemistry study program that is hoped to be able to develop student's thinking ability is Basic Mathematics II. In this subject, students are faced with thinking abilities of constructing and understanding concepts and principles outside of doing calculations.

The research experience in teaching this subject shows that many students simply memorizing the results from existing questions that had been done, so that when the questions are modified, they won't be able to solve them. In the even semester of 2013/2014 academic year, students of chemistry study program that follow the subject of Basic Mathematics II with researchers of 36 people, 12 of them are students that repeated with grades of D and E with other lecturers and 24 freshmen that took this subject.

The researcher attempts to conduct an interview to obtain information regarding the cause of low grades being the cause of why they are repeating the subject. The results from the interview provides information that a lot of students think that the subject is too difficult, there is too many formulas

that needed to be memorized and they don't really like mathematics in general.

The researcher realizes that the low results from students are also caused by the learning process still not being optimal. Suryanto (2002) stated that the mathematical learning at this time is often presented as a "finished product", which is a deductive system. The job of students is to memorize theories and definitions, solving problems or practice implementing formulas. According Pitadjeng (2005), in order for students to be able to learn mathematics in a pleasurable environment, teachers have to provide a situation, strategy, and mathematical materials that is also delightful.

To resolve student's problem, there needs to be a learning that can activate students in the learning process. One of the learning that can be implemented is Moore method. According to Maya (2009), Moore method is a learning method that teaches independence in learning for students. They are involved actively in the learning process, and motivated to solve a certain problem by using critical analysis skills and their own creativity. Mathematical learning in class puts more emphasis in student's presentation. Independently, students do tasks or solve mathematical problems that was given, based on the teaching materials that has been prepared by the teacher, which then written on the whiteboard to be presented to their fellow classmates. The role of the teacher is simply as a motivator, facilitator, mentor, referee and guide. According to Mahavier (2006), the purpose of the learning of modified Moore method is: (1) Students develop a solution and argument that supports independently. The requirement in developing this skill is hard work and knowledge of adequate prerequisites, (2) Students communicate solutions through supporting arguments. This communication is done in writing and orally to the other students in class, (3) Students maintain their arguments. In Moore method, presentation is a necessity to express solutions of exercise questions that were given and maintaining arguments. Moore method is modified so that it becomes modified Moore method. The modification done with the students are divided into small groups, with the rule that the groups are not allowed to help one another. Cooperation is only done within each group. Group division is done so that it is within heterogeneous groups.

Thinking in mathematics is expected to produce several abilities. Thinking ability can be divided into three levels which is reproduction, connection, and analysis of Shafer, Foster, 1997 (within Sabandar, 2009). Within the level of reproduction, individuals demonstrate the ability of recognizing or identifying basic facts, using algorithms, and developing technical skills. This ability is found in students in a form of memorizing and utilizing formulas or theories. Within the level of connection, individuals demonstrate the ability to integrate information, creating linkages between mathematical concepts, choosing correct formulas or strategies to be used in solving a

certain mathematical problems, looking for solutions in non-routine problems. In the analysis level, students can perform mathematical thinking ability, analyzing (comparison, difference and analogs), doing interpretations, developing models and strategies, expressing arguments or logical reasoning, discover general patterns, conjectures and also creating generalization formally, such as doing verifications.

The research question that become the formulation of the problem in this research is: Is there any effect to the mathematical thinking ability with modified Moore method towards the learning outcomes of Basic Mathematics II of students from chemistry study program of Universitas Riau in the even semester of 2013/2014 academic year?

This research aims to determine the effect to the mathematical thinking ability with modified Moore method towards the learning outcomes of Basic Mathematics II of students from chemistry study program of Universitas Riau in the even semester of 2013/2014 academic year.

This research is expected to contribute to: (1) Students: a) Can improve the abilities of students of chemistry study program of Universitas Riau in understanding the concept of Basic Mathematics II, b) Can improve the mathematical thinking ability through a braided cooperation in learning, so that the difficulties students face in understanding the concept can be minimized through a systematically arranged teaching materials,c) Can nourish and cultivate a sense of confidence and responsibility in understanding mathematical concept through a presentation exercise. (2) Lecturer: a) Can develop the lecturers' ability in arranging teaching materials and developing learning strategies, b) Can improve the learning.

The proposed research hypothesis is as follows: There is a significant effect of mathematical thinking ability with modified Moore method towards the learning outcomes of Basic Mathematic II from students of chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year.

2. Methodology

This research is done in the chemistry study program from the FKIP of Universitas Riau. The time this research is done is in the even semester of 2013/2014 academic year.

Form of Research

The form of this research is a quasi-experimental research. According to Sugiyono (2010), quasi-experimental research is a research method that is used to search for the effect of certain treatment towards others within a

controlled environment. The experiment design utilized within this research is *The Single Group Pretest/Posttest Design* (Jackson, 2003) which includes *Quasi Experimental Design Without Control Group*.

This design involves one experiment group that will receive treatment of mathematical thinking ability of modified Moore method (X). O_1 is the pretest result which was given to the samples about the course material that has been studied before treatment, while O_2 is the posttest result which was given to the samples about the course material of Basic Mathematic II after treatment (giving the mathematical thinking ability with modified Moore method). In this research exercise, the researcher acts as the executor in giving mathematical thinking ability with modified Moore method.

Population

According to Sugiyono (2010), population is the generalized area that consists of: object/subject that has certain qualities and characteristics which is determined by the researcher to be studied which then draws the conclusion. The population in this research is the students of chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year that took a course of Basic Mathematics II.

Sample

The sample of this research is the whole students of chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year that took a course of Basic Mathematics II with a total of 36 people. Samples are taken by using purposive sampling.

Research Variable

Research variable is everything that can be shaped as anything that has been determined by the researcher to be studied so that information can be obtained about it, which then can create a conclusion (Sugiyono, 2010). This research involves two variables which is independent variable and dependent variable. According to Sugiyono (2010), independent variable is a variable that affects or become the result of existing independent variable. In this research, the independent variable is the mathematical thinking ability with modified Moore method and the dependent variable is the learning outcomes of Basic Mathematic II of students of chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year.cd

Conducting Research

This research consists of three steps, which is preparation step, presentation step, and the final step.

Preparation Step

- a. Preparing research instruments
 - b. Carrying out research instrument validity and revising instruments
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- c. Giving initial ability test in solving questions within the material of Basic Mathematic II.

Class Presentation

In the class presentation step, it consists of three steps of activities: (1) Preliminary activity, (2) Presentation activity, (3) Closing activity.

Preliminary Activity

Delivering the purpose of study, motivating and presenting information about the learning that will be done within groups and every groups are given materials that must be mastered by every member of the group. Teacher will group students where every group will have 4 members. Grouping is formed by taking 1 student from the higher group, 1 student from the lower group, and 2 students from the middle group which is controlled by the researcher so that it will become heterogeneous. Teacher distributes learning material sheets and students' activity sheets.

Presentation Activity

Students read and discuss learning material sheets and student's activity sheets within their own study groups; Teacher facilitates and motivates class discussion and gives direction toward questions asked by students during discussion; A number of students present the results of discussion and the other students respond to the result while the teacher guides the flow of the presentation.

Closing Activity

Teacher facilitates and guides the students to summarize the material of the course; Teacher provides a formative test and homework (if needed).

Final Step

Provide an ability test to solve questions of Basic Mathematic II; Calculate the average of the ability test and conducting a hypothesis test; Report the result of the research.

Research Instrument

The instruments in this research consist of:

1. Learning Media, consists of: Lecture Unit, Learning Material Sheet and Students' Activity Sheet.
 2. Data collecting instrument: The data collected are about the learning outcomes of Basic Mathematic II of students of chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year, before and after the process of learning (treatment). The data are collected through tests. The form of test utilized in this research is description test.
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Data Collection Technique

The data collection technique utilized in this research is the technique of test results from Basic Mathematic II. The data collected are test scores before and after treatment. The test given before treatment is a test about basic mathematic II questions without the treatment of mathematical thinking ability with modified Moore method, while the test after treatment is the test about basic mathematic II with the treatment of mathematical thinking ability with modified Moore method.

Data Analysis Technique

The analysis technique utilized is the inferential statistical analysis technique. According to Sugiyono (2010), inferential statistic is the statistic technique used to analyze data samples and the results are enacted for the population.

3. Results and Discussion

Data Analysis of Learning Outcomes

The data analysis of student's learning outcomes is done by analyzing data of the learning outcomes of basic mathematics in pretest and posttest. The data is then analyzed to test the research hypothesis.

Paired observation test for the data of learning outcomes of basic mathematic II for students of chemistry study program

Paired observation test is done to test the hypothesis; there is a significant effect of mathematical thinking ability with modified Moore method towards the learning outcomes of basic mathematics II from students of chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year.

The steps of testing the hypothesis above are as follows:

(1). Determine a verbal hypothesis and a statistic hypothesis.

H₀ ; The average afterward is the same with the average before treatment

H₁ ; The average afterward is different with the average before treatment

H₀: $\mu_1 = \mu_2$ H₁: $\mu_1 \neq \mu_2$

(2) $\alpha = 0,05$ $sd = 3,62$ $\bar{d} = -29,03$

(3) Calculate the value of t with the formula of $t_{count} = \frac{\bar{d}}{(S_d/\sqrt{n})} = \frac{-29,03}{(3,62/\sqrt{36})} = -48,12$

(4) $db = n - 1 = 36 - 1 = 35$, $t(0,025, 35) = 1,960$

(5) The criteria accepting H₀ if $-1,960 < t_{count} < 1,960$, otherwise reject H₀. Because $t_{count} = -48,12$ is outside the reception range of H₀. Then H₀ is rejected and H₁ is accepted.

(6) Conclusion: The average afterward is different with the average before treatment, in this case, the average after treatment is higher than the average before treatment.

As explained in the previous chapter, if the t test result shows that the H_0 is rejected, then there needs to be an advanced test to find out how much the effect of mathematical thinking ability with modified Moore method towards the mathematical learning outcomes of basic mathematic II from students of chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year.

After the testing had been done, the value of $r^2 = 0,9855$ is obtained with the coefficient effect or $K_p = 98,55\%$. In other words, it can be concluded that the effect of mathematical thinking ability with modified Moore method towards the mathematical learning outcomes of basic mathematic II from students of chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year is as much as 98,55%.

From the learning that had been done, there are several important things obtained from mathematical thinking ability, as follows:

Students' thinking ability in learning Basic Mathematics II, at the level of thinking reproductive, students are able to identify some basic formulas that will be used in integration technique, some of them are some formulas of trigonometry: identity, half-angle formula, tangent formula, cotangent, and process of elimination and substitution and basic integral natures.

At the level of thinking in connection, students are able to relate some basic trigonometry concepts, elimination techniques and substitutions, factorization with trigonometry integration technique, substitution integrating technique that rationalizes and integrating rational functions. integrating technique that rationalizes and integrating rational functions

At the level of thinking in analysis, students are not yet fully developed in their thinking ability in solving integration technique. Students still experience problems in expressing arguments in solving proving problems.

Based on the data analysis by using t test, the students' mathematical thinking ability with Modified Moore method during posttest is overall better compared to the thinking ability during pretest. As previously described, if the result of the t test shows that the H_0 is rejected, then there needs to be an advanced test to find out how much the effect of implementing mathematical thinking ability with Modified Moore method. After the test is done, it is obtained that the effect of implementing mathematical thinking ability with Modified Moore method towards the mathematical learning outcomes of basic mathematic II from students of chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year is as much as 98,55%.

4. Conclusion

Based on the results and discussions of the research, it can be concluded that: there is an effect in mathematical thinking ability with Modified Moore method towards the mathematical learning outcomes of basic mathematic II from students of chemistry study program from the FKIP of Universitas Riau in the even semester of 2013/2014 academic year. Based on the experiences during this research, the researcher provides some recommendations such as; the mathematical thinking ability with Modified Moore method can be utilized as an alternative of innovative learning; the development of students thinking ability through the habit of creative thinking should be done continuously and should be explored further.

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