Analysis of creative mathematical thinking ability by using model eliciting activities (MEAs)

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Abstract. Lack of creative mathematical thinking ability can lead to not accustomed with open ended problem. Students’ creative mathematical thinking ability in the first grade at one of junior high school in Tangerang City is not fully developed. The reason of students’ creative mathematical thinking ability is not optimally developed is so related with learning process which has done by the mathematics teacher, maybe the learning design that teacher use is unsuitable for increasing students’ activity in the learning process. This research objective is to see the differences in students’ ways of answering the problems in terms of students’ creative mathematical thinking ability during the implementation of Model Eliciting Activities (MEAs). This research use post-test experimental class design. The indicators for creative mathematical thinking ability in this research arranged in three parts, as follow: (1) Fluency to answer the problems; (2) Flexibility to solve the problems; (3) Originality of answers. The result of this research found that by using the same learning model and same instrument from Model Eliciting Activities (MEAs) there are some differences in the way students answer the problems and Model Eliciting Activities (MEAs) can be one of approach used to increase students’ creative mathematical thinking ability.

1. Introduction

The function and purpose of education is the "National education serves to develop skills and form the character and civilization of dignity in the context of the intellectual life of the nation, aimed at developing the potential of learners in order to become a human of faith and piety to god almighty, noble, healthy, knowledgeable, skilled, creative, independent, and become citizens which democratic and responsible". Based on the function and purpose mean that education is very important to be developed in every field of study mathematics in particular [1]. Particularly in the learning of mathematics, expected more teachers emphasize student involvement in utilizing math through a process, rather than results-oriented. Learning math should give the opportunity to the students to see and think about a given idea. In learning mathematics, students are often faced with the problem that is not quickly obtained the result, meanwhile students are expected to complete. For cases like these students need to think, suspect, looking for a simple formula, and then prove his righteousness then students need to increase the ability of thinking in order to find the right way to solve the problem.
The importance of developing students’ thinking ability is contained in Permendiknas No. 22 the purpose of learning mathematics are: “(1) understand the concepts of mathematics, explain the linkages between concepts and apply concepts or algorithms in a flexible, accurate, efficient and precise in problem, (2) use the reasoning on patterns and properties, do the manipulation of the mathematics in making generalizations, compile evidence, or explain ideas and statements in mathematics, (3) solve the problem which includes the ability to understand the problem, design a mathematical model, solve the model and interpret the solution, (4) communicate ideas with symbols, tables, diagrams or the other media to clarify the circumstances and problems, (5) have the attitude to appreciate mathematics in life such as have the curiosity, attention, and interest in studying mathematics as well as attitude of the tenacious and confident in problem solving” [2].

Based on this, one of the goals of learning mathematics is carrying out mathematical thought processes. In this study, researchers developed the ability to think creatively with consideration to familiarize students with open ended questions and the paradigm of students that math questions have only one solution.

Based on the experience of the pre study, when given a problem which allows many answers (open ended problem) students tend to hesitate to answer and not confident with their own answers. The creative thinking ability test results show that most students are still not able to answer the questions. The result of the test of creative thinking ability also showed the same thing i.e. less than 10 students who get the score above the value of the minimum mathematics score that assigned by school and the average value of a class of less than 60. From the pre results of this research indicate that students trained to answer questions that have many possible answers and this means the ability of mathematical creative thinking of students in schools is still low. Based on the results of preliminary research also shows that the process of learning mathematics in school the teacher is still a center of learning and teachers rarely the teacher gives the students the opportunity to play an active role in learning and students are also rarely given the open ended problems then needs analysis before answering. Learning methods used by teacher are also still less varied. Teachers usually use the method of monotonous as just using the lecture method. Using media or tools are also rarely used in mathematics learning in that school.

Educate not only give or transfer the science then the learning process becomes a learning system that tend to focus on rote-memorization. As a result, learners are not very proficient in applying the theories of science and also weak in conduction a scientific study that is contextual. In the present era that demands active learners are very important in the learning process of the teacher not as the only source of learning and the methods used by teachers in delivering the lessons do not use the approach that is teacher-centered. The process of learning centered on the teacher just makes the process of learning into something boring and less develop the ability of learners.

One approach to learning is student-centered learning approach Model Eliciting Activities (MEAs). Lesh and Doerr said that Model Eliciting Activities (MEAs) are derived from a model and modelling perspective on problem solving in mathematics, science, and engineering education and provide students with a future-oriented approach to learning [3]. Model Eliciting Activities (MEAs) is an approach to developing students’ ability in building a model, therefore any lesson that stage favor cooperation within the Group of students build mathematical models to solve a problem. The syntax of the Model Eliciting Activities (MEAs) approach in this research is modified from the syntax of Model Eliciting Activities (MEAs) from Chamberlin and NG Kit Ee Dawn can be seen as follows: 1) Students are divided into several groups, each group consists of 3-4 students; 2) Each group is given the Materials that have been drawn up based on the principles of learning approach Model Eliciting Activities (MEAs) and demanding work using the approach to Model Eliciting Activities (MEAs); 3) Students solve the problem given by way of a discussion within the Group (group discussion). While the teachers toured the classroom leads students in correcting the mistakes he had made; 4) Representatives of students from several groups (groups with different answers) presented the results of her work in front of the class. During the presentation progresses, each group is given a sheet of reflection to assess the results presentation of the other groups. Reflection sheet includes 3 assessments, namely: 4.1) Representation - how good are the models created to solve the problem?; 4.2) Validity – could you guys give advice to
4.3) Application of model – could that have been made are used in other math concepts?

5) Students or other groups are given the opportunity to respond to the results of his friend's presentation (class discussion). In this case the teacher becomes a facilitator in the course of the discussion and give questions about the work of students [4,5].

Based on the syntax indicates that students are given the opportunity to discuss with their friends and then need to express their opinion, ideas or the answer to the problem that teacher give. After that, with the teacher discuss the material again to obtain a summary. The syntax that Model Eliciting Activities (MEAs) has, give a lot of opportunities for students to develop their creative mathematical thinking ability in groups or their self. By using the concept of Model Eliciting Activities (MEAs) made to study mathematics in a more meaningful way because the students are trying to understand the material by their own way and then communicating back by giving the feedback.

Munandar formulating creative thinking ability as reflecting the fluency, flexibility, originality in thought and the ability to develop and detail of an idea (elaboration). The behavior of the student are the tarits of creativity that is associated with the ability to think someone with the ability to think creatively. The more creative a person the traits are getting owned. In this study, students are not required to create something completely new but judging from the way of thinking of the students to find something different from the usual. The ability of creative thinking in this study, is limited by the fluency, flexibility, and originality. The indicators are: 1) fluency: the students are able to provide many answers; 2) flexibility: the students are able to provide alternative answers from the information obtained; 3) originality: students are able to provide unique ways based on what they think [6].

Several previous studies which are relevant to use of the Model Eliciting Activities (MEAs) already done, the application of learning Model Eliciting Activities (MEAs) can improve student mastery of math concepts on the material of the triangle in grade 7. The other research, state that Model Eliciting Activities (MEAs) are also great for increasing the learning outcomes of mathematics on grade 5 in SDN 1 Baturiti [7,8].

Based on the explanation, the issues to be discussed are the analysis indicators of students' creative mathematical thinking ability that showed during the implementation of Model Eliciting Activities (MEAs) and also to see if Model Eliciting Activities (MEAs) can be one of the learning approach that can be used to increase students' creative mathematical thinking ability. The purpose of this study was to analyze the indicators of creative mathematical thinking ability of students in topic square of grade 7 on one junior high school at Tangerang city that appeared during the implementation of Model Eliciting Activities (MEAs) and to find that Model Eliciting Activities (MEAs) can increase students' creative mathematical thinking ability.

2. Methods

This research uses quasi-experiment with the post-test experimental class design with descriptive analysis of qualitative. In this research, the subject is one class in grade VII in one junior high school at Tangerang City. The independent variable in this study is Model Eliciting Activities (MEAs) and the dependent variable is the students' creative mathematical thinking ability. Primary data in this research is students' post-test results that made based on creative mathematical thinking ability indicators that have been determined beforehand. The instrument in this research is post-test of creative mathematical thinking ability that given at the end of the implementation of Model Eliciting Activities (MEAs). Posttest results were analyzed by determining the suitability of the students' answers to the indicators of the ability of creative mathematical thinking that expected. From the data will be seen the students' average post-test results to be compared with mathematics minimum score that determined by the school to see the Model Eliciting Activities (MEAs) in improving students' creative mathematical thinking ability.

3. Results and Discussion

Based on the results of the research that conducted in grade 7 on one junior high school at Tangerang City in the material square with creative mathematical thinking indicators used in the post-test are: (1)
fluency: students are able to provide many answers; (2) flexibility: students are able to provide alternative answers from the information obtained; (3) originality: students are able to provide unique answers based on what they think. Researcher found that there are differences in students' ways of answering the question even the treatment and the instrument used is the same.

In this research, creative thinking ability test instrument consists of 8 problems. The indicator of fluency consists of 3 problems, the indicator of flexibility consists of 3 problems, and indicators of originality consist of 2 problems. In this article, one problem contains 1 indicator. For problem number one, the indicator is fluency, the problem is “Specify the area of the space below using at least 2 different ways!”

![Problem number 1](image)

**Figure 1.** Problem number 1

For the question about the indicator of fluency found that there are differences in students’ ways of answering the question even the treatment and the instrument used is same. There are some differences in students’ ways of answer this part, as shown below:

![Student’s answer for problem number 1](image)

**Figure 2.** (a) and (b) Student’s answer for problem number 1

Seen from two pictures above, how the student answered (a) or (b) is almost the same and can be said both students were able to think well. It can be seen from the large number of quadrilaterals formed...
from a given problem. The less quadrilateral described the smooth process of thinking students. Students (a) responded by adding 3 forms a square on the outside of the square while the students (b) answer by dividing the square into 5 forms a square. Of the 25 students answer with vary. The difference in the way to the answer is caused by different levels of student creativity despite getting the same learning process. Based on the answers to almost any answer correct posttest, there are some students who are less than perfect answer because of the inappropriate calculation process.

For problem number 2 the indicator used is flexibility, the problem is “From the two-dimensional figure below, draw the new shape of quadrilateral as many as you can than can fit the shape!”

![Figure 3. Problem number 2](image)

For the question about the indicator of flexibility found that there are differences in students’ ways of answering the question even the treatment and the instrument used is same. There are some differences in students’ ways of answering this part, as shown below.

![Figure 4. (a) and (b) Students’ answer for the problem 2](image)
The picture is an example of an answer from the associated students’ indicator of flexibility. Most of the students answered correctly and in accordance with the expectations of researcher, but the difference in the way to the answer visible in each student. Student (a) answered with pictures that match the properties owned 6 rectangles and without a lot of repetition of the quadrilateral. The students (b) able to answer, but it is a lot of repetition of quadrilateral. In the answer of student (b) there is still a triangular shape in the settlement while the question only asked a square form only. This is also clearly visible differences how to determine an alternative answer to the question. The difference of how to answer is caused by the level of creativity and a different understanding each student acquire the same learning though.

For problem 3, the indicator of originality, the problem is “In a picture, there is a quadrilateral and the other two-dimensional figure. The area of quadrilateral is 5:8 one of the other two-dimensional figure. Draw the specified image!”

The way students answer shown in picture below.

![Figure 5](image)

**Figure 5.** (a) dan (b) figure of Students answer for problem no. 3

Only a few students could answer the teacher's expectations accordingly. Example answer as shown (a) and (b) which is the correct answer and unique. The only difference there is in the process of answering. Students (a) respond by giving a description of how to obtain the answers while the student (b) have the answers that are more unique and not taught by researchers but less on writing the process of obtaining the answer. Researchers had confirmed to the students (b) about how to find pictures like these images. Student (b) divide a square into a small shape parallelogram. Of the 25 students, a lot of students who are less familiar with the problem number 3 and this is the subject of the correction for the researchers.

If compared with the minimum mathematics score that assigned by school is 72, it means that still lots of students who scored below standard because of the 25 students there were only 8 people who score above 72 and earned an average of 62.5 class with the maximum score 90.63 and score a minimum of 25. Based on this, to see the influence of Model Eliciting Activities (MEAs) can affect or increase
the ability of mathematical creative thinking of students, researcher compared with the results of the preliminary research conducted by researcher.

On preliminary before the applied Model Eliciting Activities (MEAs), almost all the students are not familiar with the open ended problem that demands a lot of alternatives to answer and the average score is still under 60. Once applied Model Eliciting Activities (MEAs), although on the posttest as many as 17 students get score below the standard of minimum completeness but which needs to be appreciated is the attitude of the students who are getting trained and confident with their own answers. The low score of the posttest is also influenced by the lack of precise answer to each of the students but overall the process of teaching and learning with Model Eliciting Activities (MEAs) which requires students to dare to express their opinion in the form of a model is indicated with an attitude of confidence and getting used to the open ended problem. This shows that the ability of mathematical creative thinking of students is higher than their initial ability before they are taught with Model Eliciting Activities (MEAs).

4. Conclusion
Based on the research results obtained, the researchers concludes that: (1) Analysis of students’ creative mathematical thinking ability based on indicators that appear after the implementation of Model Eliciting Activities (MEAs) approach can be sorted from most understandable indicator to the most difficult indicator for of students is as follows : fluency, flexibility, and originality. (2) Model Eliciting Activities (MEAs) approach can increase students’ creative mathematical thinking ability although it needs a lot of improvement and perfection.

Advice that researcher can be given to the mathematics teachers is can use the Model Eliciting Activities (MEAs) approach with more open ended problem as a variation in mathematics teaching-learning process and enhance this approach to be optimally used in improving students’ creative mathematical thinking ability, to further researchers to continue with another research that use the Model Eliciting Activities (MEAs) approach to other problems and issues with high subjects and also subject that need high precision.

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