Promoting middle school students’ mathematical creative thinking ability using scientific approach

A Istiqomah¹, K S Perbowo² and S E Purwanto³

¹ Department of Mathematics Education, Universitas Muhammadiyah Prof. DR. HAMKA, Jl. Tanah Merdeka, Jakarta Timur, Jakarta, Indonesia

E-mail: krisna_satrio@uhamka.ac.id

Abstract. This research aims to identify the strength of scientific approach in order to develop mathematical creative thinking in junior high school. Descriptive qualitative method is used in this research. 34 students in 7th grade are chosen using purposive sampling. For collecting data, this research uses test, observation, and interview. The test consists of 6 items which have been tested for their validity and reliability and used in pre-test and post-test. The pre-test shows that students average score in mathematical creative thinking is 43 (low), while in post-test it is 69 (middle). The N-gain in mathematical creative thinking point is 0.461, which is classified in the middle grade. Furthermore, the N-gain for each indicator, they score 0.438 for fluency; 0.568 for flexibility; and 0.382 for novelty. The N-gain for those indicators falls under middle grade. The research shows that scientific approach develops more flexibility, and, on the other hand, it develops less novelty.

1. Introduction
Mathematics is a course that students have been learning since elementary school aiming at providing students with logical, analytical, systematic, critical and creative thinking ability. As stated earlier, one of the mathematical thinking abilities is creative thinking. Creative thinking is a form of thinking to find new answers, methods, or ways in response to a problem in order to solve it [1][2]. Students’ mathematical creative thinking ability is a habit which can be trained. Creativity will develop under the right circumstance, yet it will deteriorate when no support is given by those around. Schools can help students develop their problem-solving skills and develop their creativity at the same time [3][4].

Generally speaking, the teaching and learning at schools focus more on developing analytical ability. The teaching and learning emphasize more on memorization and finding the answers to the questions provided. The focus on and attention to the effort of improving creative thinking ability in mathematics have infrequently or never been developed [5]. Based on the research conducted by Fardah [6] out of the 30 students she studies only 7 are found to have high creative thinking ability. The result is not greatly different from Septainingrum’s [7] research which finds that those students with high mathematical ability are not in any creative thinking ability level.

The indicators of creative thinking ability according to Torrance are Fluency, Flexibility, Originality and Elaboration [2]. Silver also adds that in order to assess one’s creative thinking three key components in creativity in using TTCT need to be used, i.e. Fluency, Flexibility, and Novelty [8].

The Indonesian government in their effort of improving its education quality has amended their curriculum into Curriculum 2013. Curriculum 2013 refers to the process of teaching and learning
which is executed with scientific approach. Scientific approach is a way or mechanism of teaching and learning to facilitate students in order for them to obtain knowledge or skill using a procedure which is based on a scientific method [9]. Scientific approach is designed to provide students with creative thinking ability. The teaching and learning processes in scientific approach are characterized by 5M activities, namely mengamati (observing), menanya (questioning), mengumpulkan informasi (collecting information), mengolah informasi (processing information), and mengkomunikasikan (communicating). The 5M activity will influence student’s creative thinking mindset, where students are given a chance to observe the existing phenomena, to question, to reason, and, finally to communicate the results they have obtained. In addition, innovation is expected to surface through creative thinking ability to find various answers to a problem. Through these steps of scientific approach, it can then be determined students’ mathematical creative thinking ability in scientific approach which is limited by such indicators as fluency, flexibility, and novelty. The fluency aspect includes students’ ability in solving problems correctly and accurately. The flexibility aspect includes the ability to employ various problem-solving strategies. Finally, the novelty aspect includes students’ ability to use new strategies.

Based on the description above, this research aims to analyze student’s mathematical creative thinking ability in scientific approach, so that the strengths and weaknesses of scientific approach in building mathematical creative thinking ability can be found.

2. Method
This research is conducted in Junior High School 49 Jakarta, at Jalan Raya Bogor Km. 20 Kramat Jati, Jakarta Timur 13510. It uses descriptive qualitative method, intending to describe students’ mathematical creative thinking ability in the scientific approach. The sample is taken using Purposive Sampling [10]. The research sample is class VII–F amounting to 34 students. The data are collected using tests, observation, and interview. The students’ mathematical creative thinking ability test contains 6 subjective questions on triangle section the validity and reliability of which have been confirmed based on fluency, flexibility, and novelty indicators.

The observation aims at finding out students’ mathematical creative thinking ability which is built during the teaching and learning process using the scientific approach as written down in a field record. The interview technique used here is unstructured interview aided with interview guideline. In this research, the researchers use the indicators and sub-indicators as adapted from Olson and Willian [11] as presented in Table 1.

| No. | Indicator | Sub Indicator                                                                 |
|-----|-----------|-------------------------------------------------------------------------------|
| 1.  | Fluency   | a. Stir/produce thoughts in large number.                                      |
|     |           | b. Determine problem-solving steps completely and correctly.                  |
|     |           | c. Predict answers fluently and quickly to a problem.                         |
|     |           | a. Provide varied answers/ideas.                                              |
| 2.  | Flexibility | b. Be able to see a problem from different points of view.                  |
|     |           | c. Finding many alternatives or different ways of solving a problem.          |
|     |           | a. Provide new and unique expressions responsiveness.                        |
| 3.  | Novelty   | b. Possess uncommon ways of solving problems.                                |
|     |           | c. Determine his/her own ways of solving problems.                           |

3. Results and Discussion
This research aims at analyzing students’ mathematical creative thinking ability in scientific approach. Pre- and post-tests are used to figure out students’ mathematical creative thinking ability before and after the teaching and learning using scientific approach. Based on the pre-test results, the mean score
is 43 (low) and their post-test score is 69 (medium). The fluency, flexibility, and novelty indicators during pre-test have such mean scores as 50 (low), 53 (low), and 26 (low) respectively, and the post-test results indicate that the fluency, flexibility, and novelty indicators have the following mean scores respectively 72 (medium), 80 (high), and 55 (low). Below is the table on student distribution in each of students’ mathematical creative thinking ability indicators.

**Table 2. Student Distribution in Students’ Mathematical Creative Thinking Ability Indicators**

| Indicator  | Category | Pre-Test | Post-Test |
|------------|----------|----------|-----------|
| Fluency    | High     | 2        | 16        |
|            | Medium   | 11       | 5         |
|            | Low      | 21       | 13        |
| Flexibility| High     | 6        | 20        |
|            | Medium   | 4        | 6         |
|            | Low      | 24       | 8         |
| Novelty    | High     | 0        | 3         |
|            | Medium   | 0        | 1         |
|            | Low      | 34       | 30        |

After the pre-test is administered, the researchers also perform some observation by attending the teaching and learning using scientific approach. Based on the observation results, it is found that the scientific teaching and learning process in building students’ mathematical creative thinking ability does not fully involve students actively. This can be seen from the fact that during the teaching and learning process, those students sitting in the rear rows seem ignorant to the materials being delivered, and no student asks any question nor expresses their ideas even when they are working on the questions. The 5M activities are implemented quite well, except for 2 activities of collecting information and communicating the results, hence student’s ability in expressing new and unique ideas remain unobserved.

Just as the observation results, the interview conducted by the researchers in relation to the teaching and learning process using scientific approach performed by teachers in building mathematical creative thinking ability finds that it is less optimal. The less attention that teachers give to students’ preparedness to receive the materials to be tougher is seen from the interview where students fail to explain the results observed from the teaching and learning process on the materials being delivered. In addition, when interviewed students say they are shy to ask questions during the teaching and
learning process, yet they will ask when teachers go close to them. Students also say that they only work on the questions coming from package textbooks and they suffice themselves with just one answer. Later on, students’ works are directly submitted and discussion (communication) is rarely held in the classroom.

To find out the improvement of Pre- and Post-Test scores of students’ mathematical creative thinking ability, the N-gain formula according to Hake [12] is used.

$$\langle g \rangle = \frac{< S_f > - < S_i >}{100 - < S_i >}$$

The results of N-gain calculation is presented in table 3 below.

### Table 3. Results of N-Gain Calculation

| Indicator | Mean n-gain | Category |
|-----------|-------------|----------|
| Fluency   | 0.438       | Medium   |
| Flexibility | 0.568   | Medium   |
| Novelty   | 0.382       | Medium   |

Based on the results of mean N-gain, it is found that students’ mathematical creative thinking ability is 0.461 at medium category improvement. From the results of mean N-gain of each indicator, it is found that scientific approach can build students’ mathematical creative thinking ability at the medium category. The sequence of strengths of scientific approach in building mathematical creative thinking ability is flexibility, fluency, and novelty.

4. Conclusion

The mean score of Pre-Test is 43 (low). And from the observation of teacher and student activities during teaching and learning using scientific approach, it can be concluded that 5M activities are implemented quite well, except for 2 activities of collecting information and communicating the results. The teaching and learning of mathematics using scientific approach fairly improve students’ mathematical creative thinking ability as can be seen from the Post-Test results at a mean score of 69 (category medium). The students’ improved mathematical creative thinking ability using scientific approach is also seen from the results of N-gain calculation at a medium improvement category at 0.461. From the results of N-gain calculation, it is also found that the strength of scientific approach in building mathematical creative thinking ability lies with flexibility indicator. However, scientific approach still fails to build the novelty indicator. Therefore, the teaching and learning using scientific approach should be performed optimally and by actively involving students in order for it to be able to improve students’ mathematical creative thinking ability.

5. References

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