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International Conference on Mathematics and Science Education 2019 (ICMScE 2019) Journal of Physics: Conference Series 1521 (2020) 032030 IOP Publishing doi:10.1088/1742-6596/1521/3/032030 1 Enhancement of mathematical creative thinking ability through open-ended approach based on metacognitive N Nurkaeti1*, Turmudi2, Karso2, V Pratiwi1, S Aryanto1, and Y Gumala1 1Program Studi Pendidikan Guru Sekolah Dasar, Fakultas Ilmu Pendidikan, Universitas Bhayangkara Jakarta Raya, Jl. Perjuangan No.81, Bekasi 17121, Indonesia 2Departemen Pendidikan Matematika, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No.

229, Bandung 40154, Indonesia *Corresponding author's email: nunuy.nurkaeti@dsn.ubharajaya.ac.id Abstract. This study aims to describe enhancement of mathematical creative thinking abilities in fifth grade elementary school student through open-ended approach based on metacognitive, open-ended, and direct instruction. The method of this study was quasi experiment with pretest posttest design.

Enhancement of mathematical creative thinking ability students that learning with open-ended approach based on metacognitive better than students that learning with open - ended and direct instruction. It was caused, in the open-ended approach based on metacognitive students encourage to think divergent. So they could find various alternative solution to solve the problem.

In the other hand, using metacognitive strategy in the open -ended approach could make student to think conscious and deeply about how to solve the problem. Therefore students could know their known and made meaningful learning. 1. Introduction Mathematical creative thinking ability is an ability the person to find ideas that unique and different especially in problem solving.

Creative thinking ability is one of the 21 st that elementary school students must have. [1] 21st century skills include critical thinking, creative thinking, communication, innovation, and collaboration. Moreover, creative thinking ability is one of competency standards of basic education.

It is a proof of the importance of creative thinking ability to be extend in elementary school. Creative thinking abiliy should be extend in elementary school, so that the student could to facing the world change and encourage the optimalization student potential [2][3]. The importance of mathematical creative ability is invers ely proportional to conditions.

The result study of mathematical creative thinking patterns of elementary students show that the students high level amounted to 20%, medium level 33,33% and low level 46,67% [4]. The study illustrates that the pattern of mathematical creative thinking abilities of elementary students is still relatively low. Viewed from the aspects of creative thinking ability, aspects of flexibility, fluency, originality, and elaborative students who are in the low category are still need guidance, even though students in the high and medium categories are already good [5].

Those problem caused by lack of elaborated learning process and environment that practice the students to think creatively, so that it is necessary to develop creative thinking ability through mathematical learning. The elaboration of mathematical learning could be done through learning approaches or learning methods. This could be used as an alternative to develop mathematical creative thinking ability. Mathematical creative thinking ability are classified as divergent thinking.

In the open-ended approach, International Conference on Mathematics and Science Education 2019 (ICMScE 2019) Journal of Physics: Conference Series 1521 (2020) 032030 IOP Publishing doi:10.1088/1742-6596/1521/3/032030 2 students should to think divergently, so that the students are expected to be able to develop their thinking ability to think creatively through giving open problems [6][7][8]. To develop mathematical creative thinking ability could be done through open-ended approach and open-ended approach based on metacognitive.

Mathematical creative thinking ability could be develop with using metacognitive question, journal, and mind mapping in the open-ended approach based on metacognitive [9]. Open-ended approach combined with metacognitive strategy are expected not only helping the student to solve the problem, but also the student could to think consciously and show their reason behind their solving problem.

This is in line with [10] using metacognitive strategy in mathematical learning could help the student to find solving problem. Mathematical creative thinking ability could be develop through open -ended approach and open- ended approach based on metacognitive. However, which learning conditions can provide better effectiveness in enhancing mathematical creative thinking ability.

Therefore in this study aims to discuss the enhancement of mathematical creative thinking ability through open-ended approach based on metacognitive, open-ended, and direct instruction. 2. Method The method of this study is quasi experiment with pretest posttest d esign with three sample groups. The three sample groups were grade V students of elementary school in Majalengka Subdistrict with 64 students.

Three sample groups were given different learning treatments. The study was carried out by giving a pretest before treatment. Learning in the experimental class 1 used open-ended approach based on metacognitive, in the experimental class 2 using open ended approach, and control class using direct instruction.

Open-ended approach based on metacognitive is done with the stages of understand the problem (including giving problem solving questions, metacognitive questions, and mind map), solving the problem for individual work (including giving metacognitive questions and journals), solving the problem for group wor k (including giving metacognitive questions and journals, presentastion o f results, and discuss (including the use of metacognitive question and mind map) [9].

The stages of open-ended approach refer to the stages of the open-ended that are proposed by Koseki and Hashimoto. It which are like the stages of open-ended approach based on metacognitive, but there is no use of metacognitive question, journal, and mind map [9]. Direct instruction is carried out with the teacher's explaining about material and the teacher giving exercise.

During learning processes is carried out observation of teacher and student activities. The last was done posttest for each class and the questionnaire was applied. The test instrument used is test question about mathematical creat ive thinking ability, while the non- test instruments used is questionnaires and observation form. Data analysis was performed to see the differences enhancement mathematical creative thinking ability by conducting prerequisite analysis tests, normality tests, homogeneity tests, and average differences for normalized N-Gain values. 3.

Result and Discussion The different of enhancement mathematical creative thinking

ability be observed based on statistics tes of N-Gain data from student that learning with open-ended based on metacognitive, open-ended, and direct instruction. The descriptive statistics from N-Gain at the three classes showed on the Table 1. Tabel 1. Descriptive Statistics of N-Gain Class N-Gain Minimum N-Gain Maximum Mean Open Ended Based on Metacognitive 0.20 1.00 0.558 Open-Ended 0.00 1.00 0.510 Direct Instruction 0.00 0.67 0.266 International Conference on Mathematics and Science Education 2019 (ICMScE 2019) Journal of Physics: Conference Series 1521 (2020) 032030 IOP Publishing doi:10.1088/1742-6596/1521/3/032030 3 Based on test of normality and homogenity for N-Gain are known that the results for each class are normality and homogenity.

As a result the difference test that will be carried out is by using the parametric test (One Way Anova). The mean difference test is done by testing the statistical hypothesis. The result of the test are showed on Table 2 that obtained Sig. 0,000 < 0,05. It means that there is a rejection of H0, so that there are differences enhancing of mathematical creative thinking ability the students who study with open-ended based on metacognitive, open-ended, and direct instruction. Tabel 2.

One Way Anova Test of Mathematical Creative Thinking Ability Sum of Squares df Mean Square F Sig. Between Groups 1.645 2 .823 21.642 .000 Within Groups 2.319 61 .038 Total 3.964 63 Table 3 show the mean of gain between classes that learning with open-ended based on metacognitive, open-ended, and direct instruction.The results of the Tukey HSD test showed that class learning with open-ended based on metacognotive had the highest mean of 0.5825, meanwhile mean of class with open-ended approach and class with direct intructional in sequence are 0.5770 and 0.2381.

Those mean difference shows that the enhancement of mathematical creative thinking ability of students who learn with open-ended based on metacognitive better than enhancement of mathematical creative thinking ability students who learn with open-ended and direct instruction. Tabel 3. Tes Post-Hoc (Tukey HSD) Mathematical Creative Thinking Ability Class N Subset for alpha = 0.05 1 2 Tukey HSDa Direct Intructional 21 .2381 Open-Ended 23 .5770 Open-Ended Based on Metacognitive 20 .5825 Sig. 1.000 .995 The increasing of mathematical creative thinking ability students that learn with open-ended based on metacognitive is caused by using metacognitive strategy and using open-ended problem.

This is in line with the research conducted that increasing the creative thinking ability of students learning using Search, Solve, Create, and Share (SSCS) learning combined with metacog nitive strategies is better than students who just learning with SSCS and

traditional approach [11]. This shows that the use of metacognitive strategies helps students to think creatively and solve the problems consciously.

Metacognitive strategy in the open-ended based on metacognitive encourage students to think creatively while solving open-ended problem and to think consciously, so that they can develop their known. [12] Metacognitive strategy helping the student to develop their knowledge and encourage the student to know their way of thinking on solving the problem.

Moreover, metacognitive strategy helping the students focus to understanding information and problem, so that the student could get solving the problem [13]. Using journal, mind map, and metacognitive question on the metacognitive strategy guide students to plan various alternatives solving problem and evaluate their thinking activities, so that they could find the most effective solution.

In addition, it is could to make students express the reasons behind their decisions of problem solving they have taken. [10] Metacognitive question are used stimulate the students to ask yourself. The asking activity yourself is one of activity to think reflective. It is encourage the student conciusly to think divergently about solving mathematical problem.

As it is known that thinking divergently is characteristic of creative thinking. International Conference on Mathematics and Science Education 2019 (ICMScE 2019) Journal of Physics: Conference Series 1521 (2020) 032030 IOP Publishing doi:10.1088/1742-6596/1521/3/032030 4 Using open-ended problem in the learning is one of factor to enhancing mathematical creative thinking ability.

[14] The problem that used in the open-ended approach encourage student to think creatively.This is indicated by an enhancing of mathematical creative thinking ability that students who learn with open-ended approach is better than students who learn with direct instruction. Although not better than students who learn with open-ended approach based on metacognitive.

This is in line with the results of study that there is an influence and improvement of mathematical creative thinking ability student is better by using an open-ended approach [15][16][17]. The answers of solving problem students that learn with open-ended approach focus on structural problem solving without involving the reasons behind decision making of solving problem that have taken.[18] In solving open-ended problems students have difficulty in expressing reasons, where students are more focused on solving problems structurally.

Unlike the case for students who learn by using open-ended approach based on metacognitive, they are stimulated to think consciously. So that they are able to express their reasons for making decisions on their solution that they have taken, through using of metacognitive strategies. Mathematical creative thinking ability of students who learn using the direct instruction is very low.

This is caused by there is no opportunities for students to practice thinking divergently both through the open-ended problems and metacognitive strategies. The solution that their given focus on one solution answer, because students are not accustomed to providing various of alternative answers. The inability of students to provide various alternative solution show the lack of developmen mathematical creative thinking ability students. 4.

Coclusion Enhancement of mathematical creative thinking ability students who learn using open-ended approach based on metacognitive is better than students who learn with open-ended approach and direct instruction. Metacognitive strategies that include mind map, journal, and metacognitive question encourage students to think conscious and divergent in solving open-ended problem.

Mind maps, journal, and metacognitive question lead the students to plan and find various alternative solving problem, evaluate their solving problem, and choose the best solving problem. So that the student could know what their known and made meaningful learning. 5. References [1] Wijaya EY, Sudjimat DA, Nyoto A, Malang UN 2016 Transformasi pendidikan abad 21 sebagai tuntutan pengembangan sumber daya manusia di era global.

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