TEST INSTRUMENTS DEVELOPMENT OF MATHEMATICAL CREATIVE THINKING ABILITY IN QUADRILATERALS MATERIALS FOR THE SEVENTH GRADE STUDENTS

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Abstract

The ability to think creatively is one of the abilities students must possess in learning mathematics. Through this creative thinking ability allows students to solve problems with various solutions. An open-ended problem with the possibility of more than one solution is considered appropriate in measuring students' mathematical creative thinking abilities. Therefore, developed a test instrument that contains open-ended problems to measure students' mathematical creative thinking ability. This test was developed over a period of 6 months consisting of 5 items based on indicators of the ability to think creatively that is fluency, flexibility, originality and elaboration. The purpose of this study is to know (1) the validity of the item, (2) the difficulty index, (3) the discrimination, and (4) the instrument reliability so that these instruments are appropriate to be used to test students' mathematical cretive thinking ability. The population in this study is all students of class VII in State Junior High School 1 Tanjungsiang academic year 2016/2017, even semester. The sample was selected randomly as many as 37 students. Data collection in this research using test method. The result of the research is (1) all valid items with the validity level of 3 items of high question and 2 items are sufficient, (2) four items with the level of difficulty is moderate and one item with high difficult, (3) three items with discrimination is good, poor, sufficient, (4) sufficient category instrument reliability. Based on the results of the trial, it can be concluded that the instrument is worthy used to measure the mathematical creative thinking ability of junior high school seventh grade students. The types of problems used in these tests, indicators, scoring rubrics, and statistical analyzes have been described in this paper.

Keywords: Creative thinking, open-ended problems, validity, the level of difficulty, discrimination power and reliability.

1 INTRODUCTION

At this time, creativity is very important in order to bring about renewal in many areas of life. Creativity is the ability that humans have in generating new ideas that are different from others. Creative ideas that arise especially in the field of education is needed in improving the quality of education so that education in Indonesia can compete in the global arena. To get creative ideas, there is a need for regular exercise and start as early as possible. This can be done in the world of education, especially mathematics by improving the ability of mathematical creative thinking. In learning mathematics, teachers can pose problems that can

stimulate students' mathematical creative thinking ability. Problems that can stimulate students' mathematical creative thinking ability, it can be an open-ended problem, where the problem requires more than one answer or solution. Through the presentation of this open-ended problem, it is expected to bring up various variations of answers and completion strategies so that students' creativity can be honed. For that, it takes a test instrument to measure students' mathematical creative thinking ability. In this paper will be discussed about the development of a test tool to measure students' mathematical creative thinking ability.

1.1 The Ability of Mathematical Creative Thinking

Munandar (2009, p.7) reveals that divergent and creative thinking is exploring possible answers to a problem. While Aziz (2011, p.87) reveals that creativity is the ability to create and is one form of intelligence, namely creativity quotiont, which is basically owned by everyone. The source of creativity according to Rogers as quoted by Munandar (2009, p.18) is the tendency to self-actualize, realize the potential, the impulse to develop and mature, the tendency to express and activate all the capabilities of the organism.

Based on the description, basically everyone has the ability to think creatively that can be developed through a routine and regular exercise process. The ability of mathematical creative thinking is the ability of students in using the thinking process to generate a new idea, constructive, based on rational concepts that have been agreed to solve a mathematical problem. Mathematics education should be focused on the development of creative thinking where students are free to try their own original possible solutions (Kwon, 2006, p. 51).

In this study, the instrument of creative thinking is structured based on four characteristics as explained by Guilford (1973), namely fluency, flexibility, originality and elaboration. Fluency is based on students' ability to solve problems in accordance with what is required and the ability to translate the story into the math language and then able to pour many ideas in solving the problem. Flexibility is based on students' ability to generate different ideas, compile a variety of questions or look at a problem from a different point of view. Originality is based on problem solving ideas that are original ideas of students that are different from others and show their own language style in solving the problem. Elaboration involves the students' ability to develop a problem-solving idea in detail, based on agreed concepts.

1.2 Open-ended Problems

Students at junior high school are accustomed to routine questions that have only one definitive solution, Pehkonen (1995, p.3) calls this problem a closed problem. On the other hand, students are entitled to the freedom in determining solutions of answers that vary according to their own way to develop their mathematical creative thinking ability. In this paper, the problems tested focus on open-ended problems that have variations in responses and multiple resolution strategies. Through the presentation of this open-ended problem, it is possible for individuals to have unique ways of solving problems that are different from others, thus implicating the many variations of answers that arise from students. Based on Klavirs' research (2008) the disadvantage of open-ended problems is that teachers do not usually possess either the tools to evaluate the work of the different students or the tools to promote higher levels of problems solving. In this paper, student responses vary over open-ended issues analyzed and assessed based on the problem solving rubric set by the teacher. Each problem solving step has a weight score according to the difficulty level of each. Based on Kwon's research (2006) the open-ended problem given to the students positively influences the students' mathematical communication ability through the process of discussion about the difference of the solution among students and able to develop students' mathematical creative thinking through variations of answers that appear. Therefore, to develop the ability of mathematical creative thinking, open-ended problem is considered appropriate and suitable given to the students as the target of this research. This paper focuses on developing instruments for measuring mathematical creative thinking ability so that other aspects of mathematical ability are not analyzed.

2 TEST INSTRUMENTS OF MATHEMATICS CREATIVE THINKING ABILITY

Test instruments developed over a period of 6 months. In that period, conducted a literature study about mathematical creative thinking ability, its characteristics and indicators, then compiled the items based on indicators of mathematical creative thinking. The target of this research is the students of junior high school seventh grade with age range 12-14 years. The types of questions that are prepared and used in this instrument are non-routine. The form of the problem used is a form of non-routine description problem that is rarely given to junior high school students seventh grade. Bloom's taxonomic estimate of the questions in this instrument is C4 level (analysis) up to level C6 (evaluation). There are five items that are arranged based on the four characteristics of the mathematical creative thinking ability:

2.1 Fluency

The indicator of fluency in this test is that students can draw a variety of quadrilaterals with the area of known area.

Task:

Draw at least three different types of quadrilaterals whose area is 76 cm^2 with its size. Explain how to get the size of the quadrilaterals.

Table 1

Rubric of Scoring Students' Solution

Analysis of Students' Solution	Score
No answer	0
Be able to determine the various kinds of quadrilaterals and the formula to calculate the area	0-3
Be able to determine the size of the quadrilaterals whose area is 76 cm^2	0-5
Be able to draw various quadilateral whose area is 76 cm^2	0-2
Total score	0-10

2.2 Flexibility

The flexibility indicator in this test is that students can compile various questions on the data provided and solve them.

Task:

A rhombus, diagonals comparison is $d_1:d_2 = 1:2$. If the first diagonal length plus 2 cm and the second diagonal minus 4 cm then the rhombus becomes square. Write some questions then finish with the right answer.

Table 2

Rubric of Scoring Students' Solution

Analysis of Students' Solution	Score
No answer	0
Be able to write down various questions from known data	0-5
Be able to solve problems from various questions made by students	0-5
Total Score	0-10

2.3 Originality

The originality indicator in this test is that students can solve a problem related to the perimeter of quadrilaterals with their own way.

Task:
A parallelogram, the ratio of its side is 3:4. Draw a rectangle whose perimeter is three times the perimeter of parallelogram in your own way, complete with the solution.

Table 3

Rubric of Scoring Students' Solution

Analysis of Students' Solution	Score
No answer	0
Be able to determine the various possible sizes of parallelogram sides	0-5
Be able to calculate the perimeter of parallelogram from various possibilities of the sides of the parallelogram	0-2
Be able to draw a rectangle whose perimeter is three times the perimeter of the parallelogram	0-3
Total Score	0-10

2.4 Elaboration

The elaboration indicator in this test is to develop a way to solve problems related to the perimeter and the area of a quadrilaterals.

Task 1:

Area of a rectangle is 144 cm^2. Draw a quadrilateral whose perimeter is half of the perimeter of the rectangle in your own way.

Table 4

Rubric of Scoring Students' Solution

Analysis of Students' Solution	Score
No answer	0
Be able to formulate the area of the rectangular area then determine the range of possible lengths and widths	0-5
Be able to calculate rectangular perimeter of various possible lengths and widths	0-2
Be able to draw a quadrilateral whose perimeter is half of the perimeter of the rectangle	0-3
Total Score	0-10

Task 2:

The perimeter of a square is 40 cm. Draw other quadrilaterals whose area is half the area of the square, then determine the size of the quadrilateral that you drawn.

Table 5

Rubric of Scoring Students' Solution

Analysis of Students' Solution	Score
No answer	0
Be able to formulate the perimeter of a square then determine the size of the sides	0-3
Be able to calculate the area of the square	0-2
Be able to draw a quadrilaterals whose area is half of the area of the square	0-5
Total Score	0-10

3 METHODOLOGY

This research was conducted by conducting instrument test about the mathematical creative thinking ability toward junior high school students with a sample of 37 students from all population of seventh grade students at SMP Negeri 1 Tanjungsiang academic year 2016/2017 even semester with age range between 12 to 14 years. The question instrument consists of 5 items with a 90 minute completion time allocation. Analysis of student's solution is done to know the feasibility of this test instrument to measure students' mathematical creative thinking ability, that is by testing the validity of item, difficulty index, discrimination, and reliability. This is in accordance with Kim's research results (2003, p.167) that for verification of the feasibility of the test and each item is performed by testing the validity, reliability, discrimination, and level of difficulty.

3.1 Validity

3.1.1 Content Validity

A measuring device is named to have content validity when the measuring instrument has a suitability between the grain of the measuring instrument and the indicator of the achievement of the established goal (Soemarmo, 2017). The validity of the content can be weighed by the relevant experts through the suitability of the measuring instrument grid with the measuring tool grille, in this study the validity of the content of the test instrument of mathematical creative thinking ability has been assessed directly by the lecturer of mathematics in the field of Evaluation of Mathematics Learning. Some input from the validator among others: (1) the sentence structure of the question should be able to make the students do in a way that is not raw and creative, (2) the questions are arranged must be clear and does not contain double meaning, (3) the type of question should be contextual, (4) indicators adjusted to the goals to be achieved. Based on the validator assessment, the test instrument has been prepared by meeting the criteria: (1) the preparation of sentence questions can stimulate students to think creatively, (2) the preparation of sentences must be clear and does not contain double meaning, (3) the preparation of contextual-type questions, (4) the preparation of indicators adjusted to the goals to be achieved. The test instrument of mathematical creative thinking ability has fulfilled the validity of the content because the material in the tested instrument is the quadrilateral material has been taught in the class which is the test sample, so the material on the instrument is really representative of the given learning material. In other words, students have received material about quadrilateral before the test of the mathematical creative thinking ability held.

3.1.2 Face Validity

The face validity is the suitability of the difficulty level of the mathematics test with the level of the student class that is the subject (Soemarmo, 2017). The validity of the face can be weighed by the relevant school-level mathematics teachers who have experienced, in this case the validity of the face weighed by the mathematics teacher of seventh grade at the school where the test run of the instrument. Input from the teacher is on the wording in each question must be adjusted to the ability of students so that students are able to understand the purpose of the question. The test instrument of mathematical creative thinking ability has fulfilled the face validity because the composition of the questions on each item seems good to be understood by the students of junior high school seventh grade.

3.1.3 Construct Validity

The validity of the item about the test instrument of mathematical creative thinking ability is calculated by using product moment correlation formula with crude numbers (Arikunto, 2012: p. 87).

3.2 Level of Difficulty

The level of difficulty of each item is analyzed by comparing the average score with the maximum score set. If the level of difficulty is worth more than 0.7 then the item of question has an easy criterion. If the level of difficulty is between 0.3 - 0.7 then the problem item has a moderate criterion. If the level of difficulty is less than 0.3 then the problem item has a difficult criterion.

3.3 Discrimination

Before analyzing the discrimination, students were grouped into 27% of the upper group and 27% of the lower group based on the scores obtained. After that, discrimination is calculated by the difference of upper and lower group scores compared to the maximum score set. Discrimination power is worth between 0-1, with criterion 0 is ugly means the item is not able to distinguish the upper and lower groups, while the index discrimination 1 is very good means the item is able to distinguish the upper and lower groups.

3.4 Reliability

Test instrument reliability is calculated using alpha formula, with correlation coefficient value between 0-1. Correlation coefficient value 0 means very low while 1 means the reliability is very high.

4 RESULTS

Based on the validity test item, the results obtained are the following:

Table 6

Validity Value

		Item Number				
		1	2	3	4	5
Validity Value	R_{xy}	0,71	0,57	0,75	0,87	0,46
Criteria		High	Sufficient	High	Very high	Sufficient

All the items have validity values with sufficient criteria, high and very high so that the instrument can be said exactly measure what to be measured, in this case is to measure students' mathematical creative thinking ability.

The results of the calculation of the difficulty level of each item:

Table 7

The Level of Difficulty

		Item Number				
		1	2	3	4	5
The Level of Difficulty		0,48	0,41	0,18	0,56	0,68
Criteria		Moderate	Moderate	Difficult	Moderate	Moderate

The analysis of the difficulty level shows that of the five items, four of which have a moderate level of difficulty whereas only one is difficult.

Results of calculations on the discrimination of each item:

Table 8

The Discrimination

	Item Number				
	1	2	3	4	5
The Discrimination	0,68	0,41	0,13	0,84	0,40
Criteria	Good	Good	Poor	Very good	Moderate

Based on the above table, item number 3 has bad discrimination which means that the item is less able to distinguish the students in high group and low group students. Good item to measure the ability of mathematical creative thinking should have the criterion of the discrimination that is enough, good, and excellent. For that, it needs a little improvement on item number 3 so it is feasible to be a good item criterion in measuring the ability to think creatively on indicators of originality.

Based on the calculation, the instrument reliability value is 0.59 with sufficient criteria. This means that the instrument of this problem has the provision in testing the ability of mathematical creative thinking from time to time. The test instrument is feasible to measure the ability of a mathematically creative thinker because it has sufficient reliability value.

5 CONCLUSIONS

Here is a summary of the calculation results of the validity value, the difficulty level, discrimination and reliability test of the instrument of mathematical creative thinking ability seventh grade students:

Table 9

Recapitulation of the results of the analysis

Item Number	Validity	Level of Difficulty	Discrimination	Reliability	Decision
1	0,710 (high)	0,48 (moderate)	0,68 (good)	0,59 (sufficient)	Used
2	0,568 (sufficient)	0,41 (moderate)	0,41 (good)		Used
3	0,745 (high)	0,18 (difficult)	0,13 (poor)		Used
4	0,867 (very high)	0,56 (moderate)	0,84 (very good)		Used
5	0,459 (sufficient)	0,68 (moderate)	0, 40 (sufficient)		Used

Good item to measure the ability of mathematical creative thinking is based on the criteria and indicators of mathematical creative thinking, contains problems that have many solutions and many strategies of completion, and meet the criteria of validity, the level of difficulty, discrimination and reliability enough as a measuring instrument.

In item number one with the indicator of fluency, its validity is included in the high criterion, the level of difficulty is moderate, the discrimination power is good, and the reliability of the test instrument is sufficient, so item number one is worthy to be used as the test instrument of mathematical creative thinking ability. This item is able to measure the fluency of the mathematical creative thinking ability, based on the ability of students in solving problems in accordance with what is requested and the ability to translate the story into the mathematical language and then able to pour many ideas in solving the problem.

In item number two with flexibility indicator, its validity is included in sufficient criteria, meaning that the item is enough to measure the flexibility indicator of the mathematical creative thinking ability based on the students' ability in compiling various questions on the data provided and able to solve it well. Based on the level of difficulty and the discrimination obtained, then item number two deserves to be used as a test instrument of mathematical creative thinking ability.

In item number three with the indicator of originality, the validity value is high so that this item precisely measures the originality of the student in solving the problem by his or her own ability and is different from the others. The level of difficulty is included in the difficult criteria, and the discrimination is poor which means the item less be able to distinguish high group students with low group students. For that reason, there needs to be a slight improvement in the item to test the originality of this mathematical creative ability so that the value of the discrimination power can rise which implies the ability of the problem item in differentiating high group students with low group. In conclusion, item about number three is feasible to be used after the improvement of the problem as a test instrument of mathematical creative thinking ability to measure the authenticity indicator based on the students ability in solving a problem related the perimeter of quadrilaterals in each way and different from the others.

In point four and five with an elaboration indicator of mathematical creative thinking ability, the results of the validity values analysis, the level of difficulty and discrimination indicate that these items are each worthy of use to measure the elaboration of the mathematical creative ability based on the remaining ability in developing a way to solve problems related to the perimeter and the area of quadrilaterals.

With the results of calculations that have been obtained and analysis that has been done, it can be concluded that the five items have met the criteria of a good question. So the instrument is feasible to be used in testing the mathematical creative thinking ability of junior high school students seventh grade.

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