Analysis of mathematical creative thinking test instruments on open-ended problems with ethnomatematic nuances

D N Munafehi*, Mulyono, M Z Zahid, E A Syaharani, R Fariz
Department of Mathematic, Faculty of Mathematics and Natural Science, Universitas Negeri Semarang, Indonesia

*Corresponding author: detalia@mail.unnes.ac.id

Abstract. The purpose of this study was to analyze the mathematical creative thinking ability test instrument in open-ended problems with ethnomathematical nuances. The aspects that must be possessed in a mathematical creative thinking ability test instrument consist of: fluency, flexibility, originality, and elaboration. These four aspects are contained in open-ended questions. Open-ended questions are questions that can be worked on with several answers or various settlement strategies. Ethnomathematics applied to open-ended questions is batik. Batik that has various styles should be able to explore the mathematical creative thinking ability. The method used to collect data on mathematical creative thinking ability is the essay test method which consists of 5 items. The data analysis technique used is qualitative and quantitative data analysis. Qualitative analysis was carried out by examining the validity of the content. Meanwhile, the quantitative analysis was carried out by using the classical test theory approach which the calculations were assisted by the Microsoft Excell program.

1. Introduction
The development of technology in the digital era is currently growing faster. Technology becomes a means that functions to provide comfort and convenience for humans. Technology, especially in the field of education, is very important, even in the current conditions that require students to carry out learning activities at long distance. Through technological advances, learning activities can still run even though the students are in their respective homes. However, this technological development must also be balanced with the readiness of the teachers in dealing with student behavior. Teachers who cannot directly supervise students when they take tests so it creates flexibility for students to be dishonest.

Teachers are expected to be able to develop a test instrument that can prevent students from cheating during tests. Open-ended problems are one of the solutions to these problems because open-ended problems require students to find several different solutions or settlement strategies. This is in line with Munroe [1] stated that open-ended problems are designed in such a way that there may be more than one correct answer or there may be more than one way to arrive at an answer. Open-ended learning according to Priatna [2] provided opportunities for students to find solutions, solve problems in several ways. Therefore, students through open-ended questions are expected to be able to explore their own abilities in solving problems without depending on other people.

In improving students’ mathematical performance in open problems, Bahar & Maker [3] stated that educators must focus on developing creativity. Developing mathematical creative thinking ability as one of the higher-order thinking ability is the goal of learning mathematics. Students who are familiar with
open-ended questions will find it easier to develop mathematical creative thinking ability. This is in line with [4-6], who stated that open-ended questions can encourage students to improve their creative thinking ability.

According to Munahefi, et al [7] that students are encouraged to be actively involved in learning so that they can foster mathematical creative thinking ability. One way to foster student activity in solving math problems is to provide interesting problems for students. According to Abdullah [8], Ethnomatematics makes mathematics easier to learn, because students feel familiar with the daily habits of society. Ethnomatematics, namely using a cultural approach through learning mathematics. Culture is implemented by students in everyday life so that students can understand mathematics as something that is always considered abstract. This is in line with [9] culture becomes a method for students to transform their observations into creative forms and principles about the field of science.

This study applies batik as a geometric material. Students understand the two-dimensional figure depicted on the batik motif. This is expected to improve students' mathematical creative thinking ability. Ethnomatematics can develop mathematical creative thinking ability [10-11]. Therefore, the preparation of a mathematical creative thinking test instrument should include ethno-mathematical nuances so that the aspects of mathematical creative thinking can be actually applied by students.

2. Research Methods
The purpose of this research is to analyze mathematical creative thinking instruments in open-ended problems with ethno-mathematical nuances. The data used in this study are qualitative data in the form of content validity test sheets and review sheet questions and quantitative data in the form of student answers. The subjects used in this study were students of the Mathematics Education study program.

| aspects of mathematical creative thinking | Category Score |
|------------------------------------------|----------------|
|                                         | low            |
|                                         | middle         |
|                                         | high           |

| Originality | If there are 5% or more students who answer correctly with same solution. |
| Flexibility | If students can’t solve problems with any problem solving strategy |
| Elaboration | If students cannot explain problem solving in detail and coherently and do not use appropriate mathematical concepts, representations, terms, or notations |
| Fluency     | Students can only determine one correct answer. |

Table 1. The scoring rubric of the mathematical creative thinking test

The ability to think mathematically creative according to [12] is the ability to solve mathematical problems based on aspects of fluency, flexibility, elaboration, and originality. Therefore the aspects of mathematical creative thinking used in this study consist of: fluency, flexibility, elaboration, and...
originality. The test method used to collect data on mathematical creative thinking ability is an essay test. The scoring rubric of the mathematical creative thinking test is shown in table 1.

3. Results and Discussion

The mathematical creative thinking test instrument with open-ended problems with ethno-mathematical nuances in this study consists of five description questions. Each question measures one aspect of mathematical creative thinking ability.

1. Look at the following batik design pictures! Mention the name of the flat shape on each of the batik designs!

2. Mention the properties of the shape in your answer to problem number 1!

3. Make a Venn diagram of the relationship between the shapes based on the properties of the shapes you mentioned in problem 2!

Figure 1. Open-ended question to measure aspects of fluency and elaboration

Figure 1 questions number 1 and 2 shows the test instrument to measure mathematical creative thinking ability in the aspect of fluency. Students are expected to be able to mention the various shapes and characteristics of the shapes in the batik motif. The test results show that the number of shapes that can be mentioned by students is different. There are students who can only mention 1 flat shape in each batik motif, but there are also students who can name more than four flat shapes in each batik motif correctly. The more students say the answer correctly, the higher the score will be and vice versa. According to Steffens [13], fluency is the most basic form of creative achievement. Zainudin & Subali [14] stated that the highest score in the aspect of fluency will be achieved if students can say the correct answer exceeds the minimum set. Fluency according to Sriraman & Haavold [15], namely denotes the number of solutions.

Figure 1, question number 3 is a mathematical creative thinking test instrument to measure elaboration aspects. Students are expected to be able to compile a Venn diagram based on the properties of a two-dimensional figure. Therefore students must be able to detail the similarities and differences in the properties of each shape mentioned by the students in questions 1 and 2. The student then presents the results of identifying the relationship between the properties of the plane on the Venn diagram. Students will get high scores if they can present the relationship of all the shapes in the form of a Venn diagram correctly. Elaboration based on Ayllón et al [16] as an aspect of mathematical creative thinking to measure idea development. Sriraman & Haavold stated that elaboration is ability to produce detailed steps so that they make a plan work.
Figure 2. Open ended questions to measure aspects of flexibility

Figure 2 shows an open-ended problem with ethnomathematical nuances to measure the flexibility aspect. This designed open-ended problem can be worked on with various settlement strategies. Students can determine the ratio of the area between the shapes with several problem solving steps. Flexibility according to [15,17], namely using a variety of problem-solving strategies. Therefore, The flexibility the number of different categories of ideas and different strategies to solve problem.

5. Make a sketch of a batik design that contains the following statement!
   - There are shapes with the number of diagonals 9.
   - There are shapes that has a pair of parallel sides.
   - There are shapes in which the diagonals divide the angles equally and diagonals are perpendicular to each other.
   - There are shapes that diagonals intersect perpendicularly.
   - There are shapes containing sides that are congruent to each other.

If the area size for drawing a batik design sketch is 20 cm x 20 cm, determine the size of the shape in the sketch then calculate blank area!

Figure 3. Open ended questions to measure aspects of Originality

Figure 3 shows an open-ended problem with ethnomathematical nuances to measure aspects of originality. Students draw batik designs by displaying the conditions given. Students will get high scores if the batik designs made are original, unique, and in accordance with the provisions of the questions. Unique means that the batik design is made different from the others but still has to pay attention to the terms and conditions that apply. Originality according to Schoevers, [18] is the originality of the results of each answer. The original answer is indicated by the uniqueness of the resulting answer. This is in line with [15] denotes the relative unusualness of the solution.

The test instrument has shown all aspects of mathematical creative thinking but it is necessary to test the validity and reliability to demonstrate its validity. Table 1 shows the results of the validation test of the mathematical creative thinking test instrument for 38 students.
Table 2. Validation Test Results of Mathematical Creative Thinking Test Instruments

| Problem Number | 1    | 2    | 3    | 4    | 5    |
|----------------|------|------|------|------|------|
| R table        | 0.320| 0.320| 0.320| 0.320| 0.320|
| R count        | 0.805| 0.828| 0.476| 0.710| 0.648|
| Criteria       | valid| valid| valid| valid| valid|

Table 2 shows that the five questions on the mathematical creative thinking test are valid. While the reliability test obtained r count 0.917 higher than r table 0.320 so that the mathematical creative thinking test instrument is reliable. The value of r count indicates that this test instrument is classified as high reliability.

Ditasona [9] stated that some types of problems may not potential to measure mathematical creative thinking ability. Open ended problem is which kinds of problems have the potential to develop students’ creative thinking ability [20-22]. Therefore, the mathematical creative thinking test instrument developed in this study is an open-ended question with ethno-mathematical nuances. The ethnomatematic element in this test instrument is by utilizing batik as Indonesia’s cultural heritage. Modification of flat shapes into batik designs in addition to preserving culture can also foster student creativity. Hence [23] stated that ethnomatemaitka can foster a positive attitude towards mathematics.

4. Conclusion

The mathematical creative thinking test instrument consists of open-ended questions with ethnomatic nuances that measure aspects of fluency, flexibility, originality, and elaboration. Each question on this instrument measures one aspect of mathematical creative thinking. The ethno-mathematical element in this instrument is demonstrated by the use of batik as a means of presenting open-ended questions. The results of the validation test show that all of the mathematical creative thinking test questions are valid. The test instrument was also declared reliable with the result of r count was 0.917, so this indicated that this test instrument was classified as high reliability.

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