



Mathematical Creative Thinking Ability Based on Intellectual Intelligence and Cognitive Style in SSCS Learning with Open-Ended Problems

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Abstract

The study aims to describe the mathematical creative thinking ability reviewed from intellectual intelligence and cognitive style in SSCS learning with open-ended problems. This research is a type of mix method research with sequential explanatory design. The population of this research is a class VII student of State Junior High School 3 Semarang academic year 2018/2019. Sampling method used in this study was random sampling technique. The study subject was selected with the purposive sampling technique based on the results of the intellectuality intelligence and the field independent (FI) cognitive style or the field dependent (FD). The results showed that the group of upper normal intelligence students category with the cognitive style of FI reaches the four indicators of mathematical creative thinking ability so that they are included in Level 4 (very creative), the group of upper normal intelligence students category with the cognitive style of FD can achieve three indicators of mathematical creative thinking ability and included in Level 3 (creative), the group of normal students category with the cognitive style of FI can achieve two indicators of mathematical creative thinking ability which then is included in Level 2 (quite creative), and the group of normal students category with the cognitive style of FD is only able to achieve a single indicator of mathematical creative thinking ability so that it is included in Level 1 (less creative).

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INTRODUCTION

Creative thinking ability is one of the Higher Order Thinking Skills (HOTS), which is a high thinking level skill where the thought process is not merely memorizing and relaying the known information (aminah, 2019). Creative thinking ability is an ability to generate new ideas or new ways to do things in generating a product (Martin, 2019). Some aspects of creative thinking are very important for students, through creative thinking students can come up with new ideas from themselves.

Learning activity requires students to have the ability to think and act creatively according to the demands of competence. Hopefully, students can come up with new creative ideas to formulate, interpret, and solve problems. According to Santrock (2009), Creative people can solve new problems quickly, but also learn how to resolve similar problems automatically, so that they can solve other problems that require insight and creativity.

In this research, there are four indicators of mathematical creative thinking ability, it is fluency, flexibility, originality, and elaboration. Meanwhile, the level of creative thinking ability consists of four levels, 4th Level (very creative), 3rd Level (creative), 2nd Level (quite creative), and 1st level (less creative).

Based on the results of the preliminary study conducted by the researchers, it is shown that the mathematical creative thinking ability of grade VII of State Junior High School 3 Semarang is still low. It is shown from the first test results of mathematical creative thinking ability. Students who have an average below the BKA are 37 students from 64 students. In addition, based on the interview with VII grader mathematics teachers in State Junior High School 3 Semarang, the students haven't been able to show the mathematical creative thinking ability.

One of the factors that caused low mathematical creative thinking ability is that the learning process does not require students to take an active role in classroom learning activities. The used lesson doesn't support students to cultivate the mathematical creative thinking ability. Therefore, an effort is needed to provide creative and innovative learning that focused on students and involve students actively in an ongoing class.

One of the efforts that teachers can do to enhance students' mathematical creative thinking ability are with Search, Solve, Create, Share (SSCS) learning model. According to Pizzini (1992), The SSCS learning model consists of four phases, there are search phase to identify problems, the solve phase to plan the problem solving, the create phase to write down the obtained problem solving, and the share phase to socialize the problem solving. Pizzini (Djumadi & Santoso, 2014) states that the SSCS has an advantage in stimulating students to use their ability to process data of their learning process so that students can practice critical and creative thinking skills in the problem-solving process and make students more active in the learning process. Based on these, SSCS learning encourages students to think critically, creatively, independently, and provides students with opportunities to practice and develop skills in resolving problems.

Besides SSCS learning, an open-ended problem learning can also grown-up the mathematical creative thinking ability. According to Shimada (1997), an open-ended problem has more than one method to solve problems. Openness aspects in open-ended can be classified as 1) the openness settlement process, 2) the openness final result, and 3) the openness of advanced development (Mahmudi, 2008).

Intelligence is one of the educational main problems. According to Suharnan (2005), intellectual intelligence or IQ has an important role in some aspects of human life such as career achievement, job performance, academic achievement, creativity, and health quality. This is in accordance with Misbach's opinion (2008) that someone who has high enough intellectual intelligence (IQ) usually can also be seen that the person has the mathematical ability, ability to visualize space, ability to recognize, connect, and assemble words. It is also supported by the Threshold theory (Hayes, 1989) that someone will be very successful in creative activities if it has IQ above the average or above 120. Based on the upper statements, intellectual intelligence is one of the factors that affect students' mathematical creative thinking ability.

Besides the differences in intellectual intelligence of each student, there are different ways and processes of creative thinking to solve mathematics problems, it is called a cognitive style. Cognitive style is a special way of learning, the way of receiving and processing information, attitudes towards information, and habits

related to the learning environment (Uno, 2010). According to Mulyono (Argiyanto, 2019), cognitive style is a consistent way of capturing the stimulus and information, how to remember, think, and solve problems, respond to a task, or respond to various types of environmental situations. The cognitive styles of this research are field independent (FI) where someone tends to be impersonal-oriented, prioritize internal motivation, more affected by internal reinforcement, think analytically, prioritize analytical skills, and loves science, and field dependent (FD) where someone tends to be socially oriented, prioritize external motivation, more affected by external reinforcement, think globally, prioritize social and humanities skills, and love social and humanitarian.

Based on the description, This research aims to (1) test the mathematical creative thinking ability of students who achieve the guidance on the SSCS model with open-ended problems, (2) test students' mathematical creative thinking ability on the SSCS model with an open-ended problem that higher than the mathematical creative thinking ability of the students on the PBL model, (3) describe the creative thinking ability of students that reviewed from intellectual intelligence and cognitive style.

METHOD

This research is a type of mix method research with sequential explanatory type. That is sequential combination from quantitative to qualitative. It began by doing quantitative research with collecting and analyzing the obtained quantitative data results, then compiling the results to describe in more detail and strengthen the results of quantitative research on qualitative research (Creswell, 2015). The research conducted in state junior high school 3 Semarang. The population of this research is all students of grade VII state junior high school 3 Semarang academic year of 2018/2019. Sampling uses random sampling technique so that two samples were obtained randomly, i.e. a sample of experimental class given GEFT tests, SSCS learning with open-ended problems, and a test of mathematical creative thinking ability, a sample of control class with problem based learning and a test of mathematical creative thinking ability.

Retrieval of research subject uses purposive sampling technique which means subject retrieval technique is considered (Sugiyono, 2018). Research subjects based on the results of categorizing IQ scores and cognitive styles. Selected research subjects as many as 8 students, consists of 2 students of upper normal intellectual intelligence category with a field independent cognitive style, 2 students of upper normal intellectual intelligence category with a field dependent cognitive style, 2 students of normal category with a field independent cognitive style, and 2 students of normal intellectual intelligence category with a field dependent cognitive style.

Data on mathematical creative thinking capabilities are obtained from the mathematical creative thinking ability test, interview, and documentation. Cognitive-style data is obtained from the GEFT test. The intellectual intelligence data is obtained from the IQ test results that have been done before in collaboration with the psychology institutions and schools and researchers obtained from the conceling teachers state junior high school 3 Semarang.

RESULTS AND DISCUSSION

Based on the tests that have been done, it shows that the data obtained from the population with normal distribution using the test Kolmogorov-Smirnov with a value of $\text{sig} = 0.200$ is normal. The results of the creative thinking abilities test on both homogeneous variances using the Levene test with a value of $\text{sig} = 0.628$. The average test of creative thinking capability was obtained an average value of 79.94 and with One Sample T-Test $\text{sig} = 0.000$ analysis which meant the mathematical creative thinking ability of students in the SSCS class with the open-ended problem more than the actual submission limit, 72. The test of the mathematical creative thinking capability in the SSCS class with an open-ended problem obtained $z_{\text{count}} = 2,041$ and $z_{\text{table}} = 1,64$, it is clear that $z_{\text{count}} > z_{\text{table}}$ then students who get an SSCS learning with an open-ended problem that earns a value more than 72 are more than 75%. The results of calculating the average similarity test show that the average outcome of a test of mathematical creative thinking ability is on the class that uses SSCS learning with an open-ended problem is more than an average mathematical creative thinking

ability test students using PBL learning. It is indicated with the calculation result obtained by $t_{\text{count}} 2,892$ and $t_{\text{table}} 1,696$, so $t_{\text{count}} > t_{\text{table}}$.

Mathematical Creative Thinking Ability Reviewed From Intellectual Intelligence And Cognitive Style

Analysis of mathematical creative thinking ability is focused on eight elected students based on the results of intellectual Intelligence Test (IQ) and cognitive style test results. The eight elected students can be seen in the following table 1.

Table 1. Research Subject Classification

Subject	IQ Type	Cognitive Style
S-25	Upper Normal	Field Independent
S-31	Upper Normal	Field Independent
S-29	Upper Normal	Field Dependent
S-2	Upper Normal	Field Dependent
S-3	Normal	Field Independent
S-8	Normal	Field Independent
S-9	Normal	Field Dependent
S-19	Normal	Field Dependent

Students in the upper normal intelligence and normal intelligence categories with field independent cognitive styles are groups of students who have been active during the study. Students with upper normal intelligence are able to respond to question and answer activities, they also actively responding to the lesson. Lin and Shiver argued that individuals who have a field independent cognitive style tend to actively participate in learning. In addition Morgan (Kheirzarden & Kassaian, 2011) states that individuals who belong to the cognitive style of field independent tend to be able to create structures based on their own thought patterns.

Students in the upper normal intelligence category and normal intelligence with dependent field - style cognitive shows a delay in understanding unstructured problems, therefore it requires more time to explain in detail. In Wooldridge's opinion (2006) students with field dependent cognitive styles have dependant on their environmental structure, the learning process that relies on experience, has a short and volatile attention, chooses a learning situation that fits the feelings and experiences that they have, socially oriented and less achievement oriented, and less competition.

The test results of the mathematical creative thinking ability of the subject students reviewed from intellectual intelligence and cognitive style are analyzed by noticing the indicators of mathematical creative thinking skills that correspond to this research, i.e. fluency, flexibility, originality, and elaboration. Each indicator is outlined in the achievement of the students' mathematical creative thinking ability in the specified category.

Fluency indicators are the ability of students to provide answers or problems that are appropriate in problem solving. In this indicator, students in the upper normal intelligence category and normal intelligence categories with field independent and field dependent Cognitive styles are able to understand the problem well. In addition, students also resolve the problem correctly and appropriately and conclude the problem correctly.

Indicators of flexibility, students must be able to use a variety of strategies or ways to solve mathematical problems. In this indicator, students in the upper normal and normal intelligence categories in the field independent cognitive style are able to solve the problem with two different alternatives correctly and appropriately. In addition to the normal intelligence category over the field dependent Cognitive style, students are also able to look for and write down two different ways of resolving problem solving strategies correctly and appropriately. While in the category of normal intelligence with the field dependent cognitive style, only one problem can be solved correctly using two different ways. But in the rest of the matter, students can only accomplish one way right. Students in this category try to find another alternative solution, but there is an error in writing the formula and lack of understanding the problem well and detail.

Originality indicators are thee ability of students to solve mathematical problems by using their own language, in a new and unique way that is unusual, or different from other means. Students solve questions by creating ideas as a result of their own thought and find the solution of mathematical problems in their own way. In this indicator, students in the group of upper normal and normal intelligence categories with an independent field cognitive style are able to use their own way based on their understanding. They also use their own language to solve mathematical problems. As for the group of students in the upper normal and

normal intelligence categories with the field dependent cognitive style, students have not been able to solve the problem in their own way. So it is not maximal in describing a variety of flat builds according to problems in the question.

The elaboration indicator requires students to expand their answers to existing problems. In addition, students also extend the idea that is owned and able to elaborate answers in detail. In this indicator, students in the upper normal intelligence categories with field independent and field dependent cognitive styles have been able to reach an elaboration indicatorability of mathematical creative thinking. Students are able to detail the answers well and correctly, and able to expand the ideas or problems that are in question. Students are not fixated with what they have known so that they can resolve and conclude the problem appropriately. While the students in the group of normal intelligence categories with field independent and field dependent cognitive styles do not reach the elaboration indicator in the ability of mathematical creative thinking. Students are struggling to understand the problem and detailing the answer correctly so that students are unable to solve the problem.

The group of students in the upper normal intelligence categories with field independent cognitive style is capable of reaching all four indicators of mathematical creative thinking ability. This means that in this category students are able to solve the open-ended mathematics problem on mathematical creative thinking ability. This group of students is included in the 4th level of mathematical creative thinking ability (very creative). In accordance with Ningrum's research (2016) that students with field independent cognitive styles meet all aspects of mathematical creative thinking with the highest number of scores. In addition, the research conducted by Rahmawati (2013) shows that students in the upper normal intellectual intelligence with 110-119 IQ scores are able to reach all indicators of mathematical creative thinking ability in the application question. It is also supported by open-ended problems learning that corresponds to Suryadinata's research (2015) that with topen-ended problems students are trained to convey their ideas and get used to solving a problem in several ways so that it is not fixated in one answer only, so students can define different answers in a way that corresponds to the concept that has been studied.

The group of students in the upper normal intellectual intelligence categories with field dependent cognitive style reaches three indicators of mathematical creative thinking ability. It means that they have not reached one of the indicators, i.e. originality indicator. It is in accordance with Witkin (1977) that the research subjects with field dependent cognitive styles will find difficulty in facing problems that require information out of context, so they will find it difficult to solve problems using open-ended questions that only give little information on the question. Based on the results conducted to Hendriani's research (2017) that field dependent subjects can sometimes create problem-solving plans, but often cannot solve the problem correctly. Other than that Alvani's research results (2016) stated that field dependent students creativity includes fluency which is shown from the ability to provide three different answers, flexibility is indicated by the existence of a different way or solution idea, and the novelty that shown by all the given answers is the answer to the first question it has done. Therefore, based on the description the group of students in the upper normal intelligence category with field dependent cognitive styles is included in the 3rd level of mathematical creative thinking ability (creative).

The group of students in the normal intellectual intelligence category with field independent cognitive style showed that students have not reached the elaboration indicator, this is accordance with the research conducted by Anggareni, Dwiwana, & Swasono (2016) shows that subjects with 100 - 109 IQ score can demonstrate fluency and flexibility aspects in asking mathematics problems, but not yet being able to show the novelty aspect. A group of students in the normal intelligence categories with field independent cognitive style is included in the 2nd level of mathematical creative thinking ability (creative enough).

The group of students in the normal intellectual intelligence categories with field dependent cognitive style indicates two indicators of mathematical creative thinking ability, i.e. fluency and flexibility indicators. Elaboration and originality indicators have not been achieved. The group of students in the normal intelligence categories with field dependent cognitive style is included in the 1st level of mathematical creative thinking ability (less creative).

CONCLUSION

The conclusion of this research is that students' mathematical creative thinking ability achieves completeness. The group of students in the upper normal intellectual intelligence with field independent cognitive style is included in the very creative level of mathematical creative thinking ability levels. The group of students in the upper normal intellectual intelligence with field dependent cognitive style is included in the creative level. The group of students in the normal intellectual intelligence with field independent cognitive style is included in the creative enough level. The group of students in the normal intellectual intelligence with the field dependent cognitive style is included in the less creative level.

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