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Mathematical creative thinking ability based on students' characteristics of thinking style through selective problem solving learning model with ethnomatematics nuanced

Zaenuri [a,*], Putri Ambar Nastiti [a], Suhito [a]

[a] *Universitas Negeri Semarang, Gedung D7 Lt. 1, Kampus Sekaran Gunungpati, Semarang 50229*

** E-mail address: putriambarnastiti@gmail.com*

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Abstract

This study aimed to determine the effectiveness of the Selective Problem Solving (SPS) model with ethnomatematics nuances on students' mathematical creative thinking abilities and describe mathematical creative thinking abilities based on students' characteristics of thinking style by applying Selective Problem Solving model with ethnomatematics nuances. The study population were VII grade students one of Junior High School in Magelang in the academic year of 2017/2018. The study sample were students of class VII B with Selective Problem Solving learning model with ethnomatematics nuances and students of class VII G with Problem Based Learning (PBL) model. They were chosen through cluster random sampling technique. Quantitative data were analyzed using normality, homogeneity, proportion test, independent sample t-test, and paired sample t-test. Qualitative data were analyzed using data validation, data transcript, reduction, data presentation, and conclusions. The results showed that students 'mathematical creative thinking ability in Selective Problem Solving learning model with ethnomatematics nuances has not yet reached classical completeness, students' mathematical creative thinking ability in Selective Problem Solving learning model with ethnomatematics nuances was better than students' mathematical creative thinking ability in Problem Based Learning (PBL) model, there were differences of students interest on local culture before and after learning in Selective Problem Solving learning model with ethnomatematics nuances, sequential concrete thinking type, namely subjects fulfilled the indicator of fluency and the indicator of flexibility and were enough in fulfilling the indicator of novelty, sequential abstract thinking type showed that subjects fulfilled the indicator of fluency and less fulfilled the indicator of flexibility and novelty, random abstract thinking type revealed that subjects less fulfilled the indicator of fluency and not fulfill the indicator of flexibility and novelty, and random concrete thinking type showed that subjects less fulfilled the indicator of fluency and flexibility and did not fulfill the indicator of novelty.

1. Introduction

Education is a conscious effort carried out by a person or group of people in order to develop their potential through the learning process. One way to develop students' abilities and skills is through mathematics learning. According to Hudojo (2003), mathematics is a tool that can develop ways of thinking. In line with this, Suherman (2003) states that the purpose of mathematics learning is to establish a critical and creative thinking pattern. Mathematics learning is expected to equip students with the ability to think logically, analytically, systematically, critically, and creatively and be able to work together.

The ability of mathematical creative thinking is needed by students to solve complex problems. Meanwhile, to improve students' creative thinking ability, students need to master problem solving approach. Creative thinking has a close relationship with problem solving. Students who have the ability to think creatively cannot only

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solve unusual problems but also be able to think of various alternatives to problem solving. Creative thinking leads to ways of thinking, solving problems, and realizing an idea. According to Khoiri et al. (2013), the higher students' creative thinking ability, the higher the problem solving ability, on the contrary the lower students' creative thinking ability, the lower their problem solving ability.

According to the survey done by TIMSS (Trends in the International Mathematics and Science Study) in 2015, Indonesia was in 45th position out of 50 countries in the field of mathematics with a score of 397 and ranked 45th from 48 countries in the field of science with a score of 397. Whereas, according to the PISA results on in 2015 Indonesia was ranked 8th from the bottom with 386 points in mathematics and 403 in science. From the results survey , it can be concluded that Indonesia still lags behind the field of education, especially mathematics from other countries. The TIMSS and PISA (Programme for International Student Assesment) evaluation results showed that students' abilities in mathematics are still low.

Based on the results of interviews with one of the junior high school mathematics teachers in Magelang, it was known that the problem solving abilities of class VII students were still not optimal. This caused by other underlying abilities such as reasoning ability, communication ability, creative thinking ability, and so on. Students are not familiar to solve non-routine problem. Moreover, it is because students' problem solving abilities are not optimal and students are not yet accustomed to solving the non-routine problems, then the students' creative thinking abilities also not optimal.

The ability to think creatively has been developed as a factor in the success of mathematics learning. Munandar (2012) states that creative thinking ability is an ability that reflects aspects of fluency, flexibility, originality, and the ability to elaborate on an idea (elaboration). Meanwhile, according to Silver (1997), there are three main components considered in the ability to think creatively, covering fluency, flexibility and novelty.

In connection with mathematical creative thinking ability, the role of the teacher is very important in creating students to have good mathematical creative thinking ability. It is because, by mastering this ability, students will obtain satisfying learning outcomes and the mathematics learning objectives set can be achieved. One of the roles of teachers in mathematics learning is to help and assist students in the process of solving problems that are non-routine. According to Dick & Carey, as quoted by Lestanti (2016), a teacher should be able to recognize and know the characteristics of students because understanding the characteristics of students will greatly influence the success of student learning.

Students have different ways of thinking from one to another one. The way students think influences the success of students in solving mathematical problems with their own means and abilities. According to Gregorc in De Porter & Hernacki (2003), the characteristics of a person's thinking are divided into four types, namely sequential concrete (SK), sequential abstract (SA), random concrete (AK), and random abstract (AA).

According to Djamarah in Riana et al. (2017) to overcome the problem of low students' learning outcomes, teachers must be good at choosing what content to teach and how the learning process must be managed and carried out in school. Mathematical learning must be designed as attractive as possible so that it can stimulate and encourage the thinking process of students in using their mind consciously to solve a problem.

The learning process in the classroom, especially the mathematics learning process, does not take advantage of the environment, especially cultural values. In the learning process, local cultures and traditions are lacking so today students do not know and appreciate the culture that grows around them. Related to the low awareness of the local culture, an effort is needed to increase cultural awareness. One effort that can be done is to apply things related to culture into learning, namely learning cultural nuances. Cultural nuances of learning are strategies for creating a learning environment and designing learning experiences by integrating culture as part of the learning process. One form of culture-based learning is ethnomatematics.

Based on Wahyuni et al. (2013), ethnomatematics is one form of learning approach that links local cultural wisdom in mathematics learning. Rubio (2016) says that ethnomatematics learning is a learning application that adapts to mathematical concepts in daily activities. Sirate (2012) revealed that, the application of ethnomatematics is as a means to motivate, stimulate students to overcome saturation and difficulties in learning mathematics. One approach that can provide opportunities for students to improve problem solving ability is contextual learning and culture-based learning. Sunandar et al. (2018) says that in order to build a good understanding, ethnomatematics nuances of are needed to some objects so that it can be observed directly by students. Yosopranata et al. (2018) says that the application of the learning model with ethnomatematics nuances can create a pleasant atmosphere and eliminate the saturation of students during learning so as to foster their interest in learning mathematics.

The creative thinking ability can be improved through learning that aims to train students' problem solving and creative thinking ability. According to Purnomo et al. (2015) the creative thinking ability needs to be encouraged through mathematics learning. One possible method to encourage students' creative thinking ability in mathematics is through problem solving. One interesting learning model that can train students' problem solving and creative thinking ability is Selective Problem Solving learning.

The Selective Problem Solving learning model is one of the problem-based learning models. According to Sak (2011), the purpose of the Selective Problem Solving learning model is to develop creative thinking abilities and problem solving abilities using analogous, profound, and selective thinking to enrich individual knowledge so that it can be transferred to different problem situations. This learning model has six steps, namely defining the problem, identifying the problem, solving the problem, constructing the problem, solving the problem, and reflecting.

Through Selective Problem Solving (SPS) learning model, it is expected to improve students' creative thinking ability in mathematics learning. Therefore, in this study learning model selected was Selective Problem Solving with ethnomatematics nuances.

Based on the background of the problems described above, the formulation of the problem to be examined in this study was how was the effectiveness of Selective Problem Solving (SPS) learning model with ethnomatematics nuances towards students' creative mathematical thinking ability and how were students' creative thinking abilities viewed from the characteristics of students' thinking in mathematics learning using the Selective Problem Solving (SPS) learning model with ethnomatematics nuances.

The purpose of this study was to determine the effectiveness of Selective Problem Solving (SPS) learning model with ethnomatematics nuances towards students' creative mathematical thinking ability and to determine the students' creative thinking abilities in each type of characteristic of thinking in mathematics using Selective Problem Solving (SPS) learning models with ethnomatematics nuances.

2. Methods

The method used in this study was mixed method with sequential explanatory design. The study population were VII grade students at one of the junior high schools in the city of Magelang. The research sample were students of VII B with Selective Problem Solving learning model with ethnomatematics nuances and students of VII G with Problem Based Learning model taken through cluster random sampling technique. The selection of samples in qualitative research was done using purposive sampling technique, and resulted 12 subjects, consisting of 3 subjects on each of the characteristics of thinking style to be analyzed in terms of mathematical creative thinking abilities.

The data in this study were obtained through tests of mathematical creative thinking ability, questionnaires characteristic of students' thinking style, love culture questionnaires, and observation sheets. The data collection method used were a test for quantitative data and interviews for qualitative data. The test used to determine the mathematical creative thinking ability of students was mathematical creative thinking ability test. Interviews were used to determine the credibility of the data. The results of the mathematical creative thinking ability test were triangulated with the results of interviews on 12 research subjects. Quantitative data were analyzed using normality, homogeneity, proportion test, independent sample t-test, and paired sample t-test. Qualitative data were analyzed using data validation, data transcript, data reduction, data presentation, and conclusions.

3. Results & Discussions

This section explains the results of quantitative and qualitative research. Before learning mathematics with the Selective Problem Solving model with ethnomatematics nuances, students were given questionnaires characteristic of thinking style. Data on characteristics of thinking style were obtained from the results of classifying the characteristics of students' thinking style according to the questionnaire that has been given. Data on the characteristics of student thinking style are presented in Table 1.

Table 1. Data Characteristics of Student Thinking Style

Sequential Concrete	Sequential Abstract	Random Abstract	Random Concrete
E-05	E-08	E-01	E-20
E-07	E-13	E-02	E-21
E-10	E-18	E-04	E-25
E-14	E-19	E-06	
E-22	E-27	E-09	
E-23		E-11	
		E-12	
		E-15	
		E-16	
		E-24	
		E-26	
		E-28	
		E-29	

From the data characteristics of thinking style obtained, 12 students were selected as research subjects, consisting of 3 subjects for each characteristic of their thinking style. The subjects of the study were interviewed after learning and tests of mathematical creative thinking abilities were done.

Learning activities using Selective Problem Solving (SPS) with ethnomatematics nuances in the research class were carried out four times. The time allocation for each meeting was 2 x 40 minutes. The description of the learning process with the Selective Problem Solving model with ethnomatematics nuances that have been implemented can be seen in teacher activity observation sheet which has been filled by observers during the learning process. In general, the implementation of teacher activities in mathematics learning using Selective Problem Solving (SPS) learning model with ethnomatematics nuances in each meeting is presented in the following figure.

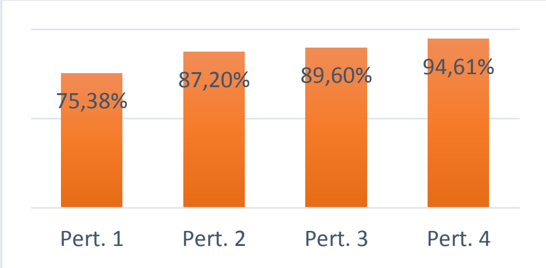

Figure 1. Implementation of Teacher Activities

Based on Figure 1 it can be seen that the percentage of implementation of teacher activities has increased at each meeting. At the 1st meeting the percentage of teacher activity was 75.38%, the second meeting was 87.20%, the third meeting was 89.60%, and the fourth meeting was 94.61%. Besides being able to be seen from the observations of teacher activities at each meeting, the description of the learning process with the Selective Problem Solving model with ethnomatematics nuances that have been carried out can also be seen on the observation sheet of student activities that have been filled by observers during learning. In general, the implementation of student activities in mathematics learning using Selective Problem Solving learning model with ethnomatematics nuances at each meeting is presented in the following figure.

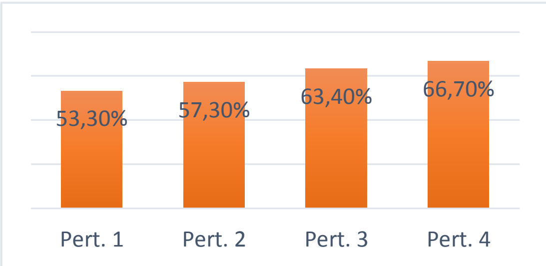

Figure 2. Implementation of Student Activities

Based on Figure 2, it can be seen that students' activity has increased at each meeting, although the increase was not too significant. At the 1st meeting the percentage of student activity was 53.30%, the second meeting was 57.30%, the third meeting was 63.40%, and the fourth meeting was 66.70%. Beside being seen from the results of evaluating the implementation of teacher and student activities, the description of mathematics learning using the Selective Problem Solving model with ethnomatematics nuances can also be seen from the results of student knowledge assessment at each meeting through quizzes. The quiz results obtained by each student at meeting 1, meeting 2, meeting 3, and meeting 4 can be seen in Figure 3 below.

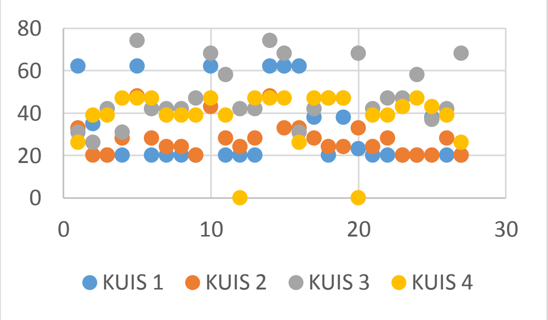

Figure 3. Quiz Results for Each Student at Meetings 1, 2, 3, and 4

Mathematical learning using the Selective Problem Solving model with ethnomathematics nuances was realized through learning involving cultural elements around the student's residence. In classroom learning, the teacher displayed images of culture to students related to learning material. This was intended to make students easier to remember and understand the material taught. Here are some pictures of cultures, especially places in the Magelang, which can be related to square and rectangular material.

Figure 4. The Tomb of Kyai Semar

Figure 5. Umbul Temple Bath

Figure 4 is a picture of the Tomb of Kyai Semar where the tomb gate is square, so it can be linked to square material. Meanwhile, Figure 5, namely of Umbul Temple Bath in Magelang, the bathing pool is rectangular, so it can be associated with rectangular material.

Students of class with Selective Problem Solving model with ethnomathematics nuances were given a questionnaire of cultural love attitudes twice, namely at the beginning of the meeting before students were given learning using the Selective Problem Solving model with ethnomathematics and at the end of the meeting after students were given learning using the Selective Problem Solving model with ethnomathematics. The recap of the results of students interest on local culture questionnaire is presented in Table 2.

Table 2. Results of Students Interest on Local Culture Questionnaire

Questionnaire	n	$\bar{x}$	s	Max	Min
Before	30	69,41	5,94	78	53
After	30	71,65	4,92	81	63

After learning in 4 meetings, students were given a test to measure their mathematical creative thinking abilities. The results of the test of mathematical creative thinking ability are presented in Table 3.

Table 3. Results of Mathematical Creative Thinking Ability

Class	n	$\bar{x}$	s	Max	Min
Class with SPS learning model with etnomathematics nuances	29	55.59	10.92	77	36
Class with PBL learning model	30	48.64	14.08	74	18

To determine the effectiveness of mathematics learning using Selective Problem Solving model with ethnomatematics nuances on students' mathematical creative thinking ability, the data were analyzed by the results of mathematical creative thinking ability tests and the results of the questionnaire scores on local culture.

Based on the calculation, the researchers obtained value $z_{count} = -7{,}183$. Obviously $z_{count} = -7{,}183 < z_{table} = 1{,}645$, so H_0 was accepted. This meant that the proportion of students who have achieved mastery learning outcomes was less than 0.75 of all students in research or learning classes, and was said to be incomplete. This happened because there were some obstacles in classroom learning, especially in conditioning students. Students tended to be more active in asking questions and asking for direction so that class conditions became less conducive. Moreover, the reference used in this study were criteria of minimal completeness from schools, where the criteria of minimal completeness were obtained from the measurement of various student abilities in all mathematics material in class VII, causing students who complete thed test in mathematical creative thinking ability to be less than expected. If what was measured is mathematical creative thinking ability, it would be better to use criteria of minimal completeness that was lower than criteria of minimal completeness originating from school.

Based on calculations using SPSS 16.0, the value of Sig in the Independent Sample t-Test table = 0.042. Obviously the value Sig = 0.042 <0.05 so H_0 was rejected. This meant that the average mathematical creative thinking ability of students in Selective Problem Solving learning model with ethnomatematics nuances was more than the average of mathematical creative thinking ability of students in Problem Based Learning model. This is in accordance with the opinion of Ogunkunle & George (2015) which states that ethnomatematics learning improves students' creative thinking abilities. According to Fajriyah (2018), ethnomatematics creates a learning environment with motivation and more fun. Motivating and more enjoyable learning will make students interested in learning mathematics which is expected to improve students' creative mathematical thinking ability.

Based on the results of calculations in the Paired Samples Test table, the value t = -2,391 and the significant value sig = 0,024 where the value of sig = 0,024 <0,05, so H_0 was rejected. This showed that there were differences of students interest on local culture between before and after learning with the Selective Problem Solving learning model with ethnomatematics nuances. This is in accordance with the opinion of Bahri et al. (2018) that there are differences in the average score of of students interest on local culture questionnaire before and after learning.

Based on the description above, it was known that the second, and third, indicators have been fulfilled, but the first indicator has not been fulfilled. It can be concluded that learning mathematics with the Selective Problem Solving learning model with ethnomatematics nuances was not effective for students' mathematical creative thinking abilities.

To determine the description of mathematical creative thinking ability in terms of the characteristics of thinking of class VII students in Selective Problem Solving learning model, the ethnomatematics nuances were carried out by analyzing the results of mathematical creative thinking ability tests and interviews with the research subjects.

The subjects of this study were 12 students, consisting of 3 students each characteristic of thinking style. The list of research subjects is presented in Table 4.

Table 4. List of Research Subjects

Characteristics of Thinking Style	Research Subjects
Sequential Concrete	E-05, E-10, E-14
Sequential Abstract	E-08, E-13, E-19
Random Abstract	E-09, E-16, E-26
Random Concrete	E-20, E-21, E-25

The results of the test's ability to think creatively were analyzed with regard to indicators of the ability of creative thinking mathematically, including fluency which was generated a lot of different ideas to give the correct answer, flexibility that produced a wide range of ideas with a different approach, and novelty that was reazlied by giving unusual answers or giving a way of solving problems in a completely new and unusual way or commonly done by students at the level of knowledge. The results of the interviews were also analyzed based on indicators of mathematical creative thinking ability, namely how the subject got ideas in solving problems, how the subject explained the steps in solving the problem, and how the level of difficulty of the problem was presented according to each subject.

After analyzing the data from the results of the mathematical creative thinking ability test, based on the results of the questionnaire characteristic of students’ thinking and the results of the interviews, the following data were obtained.

Table 5. Results of Analysis of Mathematical Creative Thinking Ability Based on Students’ Characteristics of Thinking Style

Subject Code	Characterictics of Thinking Style	Achieving Indicators of Mathematical Creative Thinking Ability		
		Fluency	*Flexibility*	*Novelty*
E-05	SK	M	CM	KM
E-08	SA	KM	TM	TM
E-09	AA	TM	TM	TM
E-10	SK	M	CM	KM

E-13	SA	M	KM	KM
E-14	SK	M	CM	CM
E-16	AA	KM	TM	TM
E-19	SA	M	KM	KM
E-20	AK	KM	KM	KM
E-21	AK	TM	TM	TM
E-25	AK	KM	KM	TM
E-26	AA	KM	KM	TM

Information:
SK : Sequential Concrete
SA : Sequential Abstract
AA : Random Abstract
AK : Random Concrete
M : Fulfill
CM : Enough Fulfill
KM : Less Fulfill
TM : Not Fulfill

Students with the characteristic types of sequential concrete thinking could fulfill the first indicator of mathematical creative thinking, namely fluency. The third subject was able to fulfill the indicators fluency. On the second indicator of mathematical creative thinking ability, namely flexibility, the three subjects simply fulfilled the second indicator. Then on the third indicator of mathematical creative thinking ability was novelty, one of the three subjects simply fulfilled the indicator of novelty, while two of them were less fulfilled the indicator of novelty. Students with characteristic types of sequential concrete thinking could write down what was known and asked correctly and completely. This is in accordance with the opinion from De Porter and Hernacki (2003) which states that sequential concrete thinkers hold on to reality and process information in an orderly, linear, sequential manner. Students with this type of thinking were also able to solve problems with the right mathematical concepts. This is consistent with the opinion that sequential concrete type thinkers are easy to remember facts, information, and formulas.

Students with characteristic types of sequential abstract thinking were able to fulfill the first indicator of mathematical creative thinking ability, namely fluency. Two of the three subjects were able to fulfill the indicator of fluency, while one subject less fulfilled the indikator of fluency. The second indicator of mathematical creative thinking ability was flexibility, two of the three subjects less fulfilled the indicator of flexibility, while one subject did not fulfill the flexibility indicator. Then, on the third indicator of mathematical creative thinking ability, namely novelty, two of the three subjects less fulfilled the indicator of novelty, while one subject did not fulfill the indicator of novelty. Students with characteristic types of sequential abstract thinking could write what was known and asked correctly, complete and concise. This is in accordance with the opinion from De Porter and Hernacki (2003) which states that sequential abstract thinkers easily find important things such as key points and details. Students with this type of thinking are also less able to solve problems with the right mathematical concepts. Students tend to be wrong in substituting the formula. This is in accordance with the opinion that states that sequential abstract type thinkers tend to ignore reality, so that difficulties in solving problems related to everyday life.

Students with characteristic types of random abstract thinking less fulfilled the first indicator of mathematical creative thinking ability, namely fluency. Two of the three subjects less fulfilled the indicator fluency, whereas one subject did not fulfill the indicator fluency. On the second indicator, namely mathematical creative thinking ability flexibility, one of three subjects less fulfilled the indicator flexibility, while two subjects did not fulfill the flexibility indicator. Then, on the third indicator of mathematical creative thinking ability, novelty, the three subjects did not fulfill the indicator novelty. Students with characteristic types of random abstract thinking could write what was known and asked correctly and tended to be more concise. This is in accordance with the opinion from De Porter and Hernacki (2003) which states that random abstract thinkers are able to absorb information correctly but tend to be slow. Students with this type of thinking also have not been able to solve problems with the right mathematical concepts. Students with this type of thinking tend to be wrong in substituting formulas. This is in accordance with the opinion which states that abstract random type thinkers often use different ways of doing things, so sometimes it is not appropriate to use or substitute formulas.

Students with characteristic types of random concrete thinking less fulfilled the first indicator of mathematical creative thinking ability, namely fluency. Two of the three subjects less fulfilled the indicator of fluency, whereas one subject did not fulfill the indicator fluency. On the second indikator of the mathematical creative thinking ability, namely flexibility, two of the three subjects less fulfilled the indicator of flexibility, while one subject did not fulfill the flexibility indicator. Then, on the third indicator of mathematical creative thinking ability, namely novelty, two of the three subjects less fulfilled the indicator of novelty, while one subject did not fulfill the indicator of novelty. Students with characteristic types of random concrete thinking could write down what was known and asked correctly. This is in accordance with the opinion from De Porter and Hernacki (2003) which states that random concrete thinkers are process oriented rather than results. Students with this type of thinking are also less able to solve problems with the right mathematical concepts and tend not to solve the final item. This is in accordance with the opinion which states that random concrete type thinkers are not too concerned about time when they are in an interesting situation.

4. Conclusion

Based on the results of research and discussion on mathematical creative thinking ability based on the characteristics of students' thinking style in mathematics learning using the Selective Problem Solving model with ethnomatematics nuances, conclusions were drawn (1) mathematics learning with the Selective Problem Solving model with ethnomatematics nuances is not effective for students' mathematical creative thinking abilities, (2) students with the type of sequential concrete tend to be able to fulfill the indicators of creative thinking first fluency, as well as the second indicators that is flexibility, but for the third indicator, namely novelty students with concrete sequential types tend to be less fulfill, (3) students with a sequential abstract types tend to be able to fulfill the creative thinking of the first indicators that fluency, but for the second indicator, namely flexibility students with an abstract sequential types tend to be less fulfill, as well as a third indicator, namely novelty, (4) students with random abstract types tend to be less able to fulfill the creative thinking of the first indicators that is fluency, while the second indicator is flexibility, students tend to not be able to fulfill, as well as the third indicators, namely novelty. Students with the type of random abstract tend to be unable to fulfill the indicators, (5) students with random concrete types tend to less fulfill the first and second indicators, namely fluency and flexibility, while for the third indicator, novelty students with random concrete types tend to not be able to fulfill. Based from the four descriptions of mathematical creative thinking ability in this study, it is known that the sequential concrete type has mathematical creative thinking ability that are better than the other characteristics of thinking style.

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