Mathematics creative thinking ability based on student's cognitive style by using Knisley learning models

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Mathematics creative thinking ability based on student's cognitive style by using Knisley learning models

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Abstract. The aim of this study was to find out the ievements of students' creative thinking ability with Knisley's learning model compared to the Direct Instruction model. This research is mixed methods. The results showed: (1) the mathematical creative thinking ability of students with Knisley's learning model achieving classical completeness; (2) the proportion of students' mathematical creative thinking abilities with Knisley's learning model is better than the Direct Instruction model; (3) the mathematical creative thinking ability of students with Knisley's mathematics learning model is better than the Direct Instruction mathematics learning model (4) student groups impulsive cognitive style achieve indicators: fluency; or fluency and novelty; student groups reflective cognitive style achieve indicators: fluency and flexibility; or fluency, flexibility and novelty; student groups fast-accurate achieve indicators: fluency, flexibility, and novelty; or fluency, and flexibility; and student groups slow–inaccurate achieve indicators: fluency, or nothing.

1. Introduction

Mathematics has an important role in human life and underlies the development of modern technology. Understanding mathematics is needed so students can process, organize, and use information to survive in changing, uncertain, and competitive times [1, 2, 3]. One of the competency standards of graduates of senior high school students in the dimensions of skills is having creative thinking and acting skills.

Creative thinking is a mental activity used to build a new idea [4]. To identify and analyze the level of mathematical creativity in problem solving and submission of problems in general three aspects of mathematical creativity are used which are the three main components in "The Torrance Test of Creative Thinking (TTCT)" namely flexibility, fluency, and novelty [5, 6].

Each student has a different level of creativity or ability to think creatively. But the ability of students in the aspect of creative thinking in the world of education in Indonesia is still rarely considered. There was a gap between reality and expected ideal abilities [7]. The teaching situation in Indonesia more emphasis on memorization and looks for one correct answer to the problem given. According to [8, 9], students only imitate and record how to solve problems that have been done by the teacher.

The low ability of students in the aspect of creative thinking also occurs in Islamic Senior High School Wonogiri students. Based on the results of observations in Islamic Senior High School Wonogiri, the minimum completeness criterion (KKM) actual mathematical creative thinking ability of students of class X Islamic Senior High School Wonogiri is still low, namely 61.5. In addition, mathematics learning so far generally uses the conventional method of teacher-centered learning.

One of the factors that influence students 'problem solving abilities is the characteristics of students' thinking in the cognitive field [10]. According to [11], that "strategic problem solving general such as these are further influenced by cognitive style". If students have different cognitive styles, the problem solving steps are different. Cognitive style influences the differences in their creative thinking [12]. To improve students' mathematical creative thinking skills, there needs to be a learning approach and a learning model that allows students to make observations and explorations so they can build their own knowledge. However, the problem faced in mathematics learning is the lack of active students and students tend to feel bored during the learning process.

Students' creative thinking ability can be developed through learning that can train students to explore all the capabilities that exist within themselves, one of them is by applying learning with Knisley's Model. Knisley's model is a learning model that consists of four stages, namely learning when the teacher acts as a narrator, the teacher as a guide and motivator, the teacher as the resource person, and the teacher as the trainer.

Based on the background described above, the purpose of this study are: 1) to find out whether the mathematical creative thinking ability of class X students through the application of the Knisley mathematical learning model fulfill the classical completeness, 2) to find out whether the proportion of completeness of mathematical creative thinking abilities of students who apply Knisley's mathematics learning model is better than the completeness proportion of mathematical creative thinking abilities of students applying Direct Instruction mathematics learning models, 3) To find out whether the average mathematical creative thinking ability students who apply Knisley's mathematics learning model are better than the average mathematical creative thinking ability of students who apply Direct Instruction mathematics learning model, 4) To describe mathematical creative thinking abilities of class X students based on students' cognitive styles in mathematics learning with Knisley's Model.

2. Methods

The method used in this study is mixed methods. The model used is a squential explanatory model, which is a research method that combines qualitative and quantitative research methods by mixing the two methods out of balance [13, 14].

Data collection methods used in this study are scale, written test, interview and documentation. The population in this study was 10th grade students of Islamic Senior High School Wonogiri in the academic year of 2018/2019. The sample in this study were 2 classes from class X Science 3 as many as 26 students as the control class and class X Science 2 as many as 26 students as the experimental class. The experimental class received treatment for learning mathematics with Knisley model. While the control class used the Direct Instruction model.

In quantitative research, the sample was selected using a cluster random sampling technique. Quantitative methods are used to determine the achievement of completeness of mathematics creative thinking abilities in the experimental class and the control class. In qualitative research, purposive sampling is used, namely the technique of taking subjects with certain considerations. Qualitative methods are used to describe students' creative thinking abilities in terms of cognitive style in impulsive, reflective, fast-accurate, and slow-inaccurate.

The research was conducted at Islamic Senior High School Wonogiri. The subjects used as data sources were experimental group students consisting of 2 students with impulsive type, 2 students with reflective type, 2 students with fast-accurate type, and 2 students with slow-inaccurate type based on the results of the cognitive style quitionaire and strengthened by interviews with the consideration of being able to communicate well and considerations from the tenth grade mathematics subject teachers of Islamic Senior High School Wonogiri. Qualitative data analysis includes analysis of interview data. Data analysis in qualitative research includes data reduction, data presentation, and conclusion drawing. Analysis of students' creative thinking abilities in this study is based on the results of the creative thinking ability test and also the results of interviews in which there are indicators creative thinking abilities which include the ability of fluency, flexibility, dan novelty. The results of the interview

analysis will be used as a triangulation to identify students' creative thinking abilities in terms of the cognitive style in selected students [15, 16].

3. Results and discussion

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

Table 1. Data Characteristics of Student Thinking Style

Impulsive	Reflective	Fast-Accurate	Slow-Inaccurate
AIF	ASR	ANK	AMFi
AMFa	EAS		INI
ANA	ETR	AFS	KDO
AA	RB	GBT	NAS
HAP	RKS	Kr	SWK
IARP	RA	RRS	
MIBA	SAJ		
MGA	AKA		

From the data characteristics of cognitive style obtained, 8 students were selected as research subjects, consisting of 2 subjects for each characteristic of their cognitive style. The subjects of the study were interviewed before learning and tests of mathematical creative thinking abilities were done.

Learning activities using Knisley model in the research class were carried out four times. The time allocation for each meeting was 2 x 45 minutes. The description of the learning process with the Knisley model 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 Knisley learning model in each meeting is presented in the following Table 2.

Table 2. Implementation of Teacher Activities

Meeting	Total Score	Achievement
Meeting 1	78	78%
Meeting 2	75	75%
Meeting 3	81	81%
Meeting 4	83	83%

Based on Table 2 it can be seen that the percentage of implementation of teacher activities has more been more than 70% at each meeting. At the first meeting the percentage of teacher activity was 78%, the second meeting was 75%, the third meeting was 81%, and the fourth meeting was 83%.

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
Knisley Model	26	77,88	10,19	100	56,25
Direct Instruction Model	26	70,19	13,38	93,75	50

Proportional test was done with Ms. Excel program. Based on the calculation, the value of z_{score} = 2,49 and z_{table} = 1.64. Because $z_{score} > z_{table}$, H_0 was rejected and H_1 was accepted. It can be concluded that the percentage of classical completeness in mathematical creativity thinking ability test on Knisley model gained minimum criterion with value ≥ 75, and reached classical completeness.

Furthermore, the average difference test was done by t test. the value of t_{score} = 2,33 and t_{table} = 2,01 were obtained. Because $t_{score} > t_{table}$, it can be concluded that the mean of the mathematical creativity thinking ability test of experimental group students who obtained Knisley model was more than the mean data of the mathematical creativity thinking ability test scores of the control class students who received the Direct Instruction model. There were two different test proportions of the experimental and control group to test mathematical creativity thinking ability test results.The value of z_{score} = 2,31 and z_{table} = 1.64. Since $z_{score} > z_{table}$, it can be concluded that the proportion of thorough students in the class using the Knisley model was greater than the proportion of students who completed the study in the classroom using the Direct Instruction model [17, 18].

The description of mathematical creative thinking ability in terms of the cognitive style of class X students in Knisley learning model, can be determined by analyzing the results of mathematical creative thinking ability tests and interviews with the research subjects. The subjects of this study were 8 students, consisting of 2 students each characteristic of cognitive style. The list of research subjects is presented in Table 4.

Table 4. List of Research Subjects

Characteristic of cognitive style	Research Subjects	Subject Code
Impulsive	AIF, HAP	I1, I2
Reflective	EAS, SAS	R1, R2
Fast-Accurate	ANK, AFS	C1, C2
Slow-Inaccurate	INI,NAS	L1, L2

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' Conitive Style

No	Student's Cogtitive Style	Level of Students Creative Thinking Ability
1.	Impulsive I1	Level 1 (Less Creative)
2.	Impulsive I2	Level 3 (Creative)
3.	Reflective R1	Level 3 (Creative)
4.	Reflectifve R2	Level 4 (Very Creative)
5.	Fast-Accurate C1	Level 4 (Very Creative)
6.	Fast-Accurate C2	Level 3 (Creative)
7.	Slow- Not Accurate L1	Level 0 (Not Creative)
8.	Slow- NotAccurate L2	Level 1 (Less Creative)

Students with the cognitive style of impulsive could fulfill the first indicator of mathematical creative thinking, namely fluency. The two subject was able to fulfill the indicators fluency. On the second indicator of mathematical creative thinking ability, namely flexibility, the two subjects less fulfilled the second indicator. Then on the third indicator of mathematical creative thinking ability was novelty, one of the them simply fulfilled the indicator of novelty, while one of other was less fulfilled the indicator of novelty.

Students with the cognitive style of reflective could fulfill the first indicator of mathematical creative thinking, namely fluency. The two subject was able to fulfill the indicators fluency. On the second indicator of mathematical creative thinking ability, namely flexibility, one of the them simply fulfilled the indicator of flexibility, while one of other was less fulfilled the indicator of flexibility. Then on the third indicator of mathematical creative thinking ability was novelty, the two subjects simply fulfilled the third indicator.

Students with the cognitive style of fast-accurate could fulfill the first indicator of mathematical creative thinking, namely fluency. The two subject was able to fulfill the indicators fluency. On the second indicator of mathematical creative thinking ability, namely flexibility, the two subjects also simply fulfilled the second indicator. Then on the third indicator of mathematical creative thinking ability was novelty, one of the them simply fulfilled the indicator of novelty, while one of other was less fulfilled the indicator of novelty.

Students with the cognitive style of slow-inaccurate, one of the them simply fulfilled the indicator of fluency, while one of other was less fulfilled the indicator of fluency. On the second indicator of mathematical creative thinking ability, namely flexibility, the two subjects less fulfilled the second indicator. Then on the third indicator of mathematical creative thinking ability was novelty the two subjetcs less fulfill the third indicator of mathematical creative thinking of novelty.

4. Conclusion

Based on the result of the research, it can be concluded that (1) the average score of students' mathematical creative thinking ability in the Knisley model on the material occurrence of an opportunity achieved completeness lesson in a classical manner that was more than equal to 75 % of the number of students, (2) the mean value of the students creative thinking ability tests in the class using the Knisley model was more than the average of the students' creative thinking ability test scores in the class which used Direct Instruction model, and (3) the complete proportion of students studying in a classroom that received the Knisley model was more than the proportion of students who completed the learning in the classroom using Direct Instruction model. Students' creative thinking ability based on impulsive cognitive style is at level 1 (less creative) that is fulfilling fluency indicators. However, there are students with impulsive cognitive style who have the ability to think creatively in level 3 (creative), namely fulfilling indicators of fluency and novelty. Students' creative thinking ability based on reflective cognitive style is at level 3 (creative), that is fulfilling indicators of fluency, and novelty, and at level 4 (very creative), that is fulfilling indicators of fluency, flexibility, and novelty. Students' creative thinking ability based on fast-accurate cognitive style is at level 3 (creative) that is fulfilling indicators of fluency, and novelty, as well as at level 4 (very creative) that is fulfilling indicators of fluency, flexibility, and novelty. Students' creative thinking ability based on slow-inaccurate cognitive style is at level 1 (less creative) that is fulfilling fluency indicators, and at level 0 (not creative) that is not fulfilling indicators of fluency, flexibility, and novelty.

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