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The mathematical creative thinking ability viewed from learning interest in eleventh grade of vocational high school by using treffinger model assisted by problem card

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Abstract

This study aimed to find out (1) whether the students' mathematical creative thinking ability with Treffinger learning model assisted by problem cards could achieve classical completeness or not, (2) whether the average of students' mathematical creative thinking ability with Treffinger learning model assisted by problem card can reach the Minimum Mastery Learning Criteria or *KKM*, (3) whether students' mathematical creative thinking ability with Treffinger's learning model assisted by problem cards was better than students' with PBL learning model, and (4) the analysis of students' mathematical creative thinking ability in terms of students' learning interests. This research was a mixed method research. The population of this research was XI grade students of State Vocational High School 2 Rembang. The subjects of this research were selected by using random sampling techniqu. Then, XI grade of shipping engineering class B as class experiment class XI A as PBL learning class. The data collection covered method tests, questionnaires, observations, and interviews. Afterwards, the result showed that that: (1) the mathematical creative thinking ability of students in Treffinger learning assisted by problem cards achieved the classical completeness, (2) the students' mathematical creative thinking ability in Treffinger learning assisted by problem card achieved the Minimum Mastery Learning Criteria, (3) the students' creative thinking ability with Treffinger learning model assisted by problem card was better than students with PBL learning model, and (4) the students' mathematical creative thinking with high interest in learning was better than students' with the low learning interest.

1. Introduction

Mathematics is one of the subjects given at various levels of the school, starting from the elementary to the upper level. In Permendikbud Number 21 of 2016 the provision of this subject aims to equip students' competencies to demonstrate a logical, critical, analytical, creative, meticulous and thorough attitude, responsible, responsive, and not easily giving up in solving problems, having curiosity, learning enthusiasm continuous, self-confidence, and interest in mathematics.

Mathematics has an essential role in various aspects of life. Many problems and activities in life must be solved by using mathematical sciences such as counting, measuring, etc. By the time, the role of mathematics today is increasingly important since the amount of information conveyed by people in mathematical languages such as tables, graphs, diagrams, equations and others. Mathematics is used in various scientific disciplines. It becomes a basic science in all disciplines, thus mathematics is very necessary to advance the human thinking power that is very functional in human life.

The development of creative thinking skills needs to be done due to this ability is one of the desired abilities in the world of work (Career Center, Maine Department of Labor USA, 2004). The creative thinking ability to think also determines the superiority of a nation. The competitive power of a nation is determined by the creativity of its human resources. Therefore,

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mathematics learning needs to be designed in such a way that it has the potential to develop students' creative thinking abilities.

Nowadays, the development of mathematical creative thinking skills has become one of the important learning focuses which have been developed in mathematics learning. Potur (2009) states that creative thinking is cognitive, original, and problem solving processes. In mathematics learning the creativity of students is needed espec ially in solving questions that involve students for mathematical creative thinking, where students are expected to be able to express new ideas that are creative in analyzing and solving problems (Kemdikbud, 2013). Therefore mathematical creative thinking in mathematics learning is needed to solve complex problems. By developing mathematical creative thinking ability, students will be able to solve mathematical problems with various alternative ways. In addition, students can also apply it to solve complex mathematical problems in the real world with various alternative solutions.

According to De Bono as quoted by Barak & Doppelt (2000), there are 4 levels of development of creative thinking skills, namely awareness of thinking, observation of thinking, thinking strategies and reflection thinking. Furthermore, Silver (1997) states that mathematical creative thinking indicators consist of indicators of fluency, flexibility, and novelty. According to Siswono (2007) in mathematical creative thinking, someone will go through the stages of synthesizing ideas, building ideas, planning the application of ideas, and applying these ideas to produce something or new products. The product in question is students' creativity. Along with that, Anwar et al (2012) state that mathematical creative thinking is a new way to see things that are characterized by four components, namely fluency, flexibility, originality, and elaboration.

The success of mathematics learning achievements is influenced by several factors which are divided into external factors and internal factors. External factors are factors from outside students, including family environment, community, and supporting facilities. Internal factors, namely factors from within the student itself, for example intelligence, talent, interest, creativity, and physical condition (Pramadita, 2013).

The condition of high and low interest in student learning will be very influential in the learning process. Student interest has a function to arouse learning spirit as for interest has a function as a motivating force. It is a force that encourages students to learn. Willingness of students who have a high interest in learning will always try to search carefully and become enthusiasm to explore and develop basic potential (talent), so as to stimulate confidence and vice versa. Thus students can understand and follow the learning process provided by the teacher.

In addition, the learning process carried out by the teacher also influences students in understanding the learning provided. The results of observations in eleventh grade of State Vocational High School 2 Rembang, the learning process was still using Problem Based Learning (PBL) model in accordance with the direction of the curriculum applied in Rembang N 2 Vocational School namely 2013 Curriculum.

The results of interview with mathematics teachers of State Vovational High School 2 Rembang, the ability of mathematical creative thinking and students' interest in learning were still largely low which in the end it caused students' learning outcomes under the Minimum Mastery Learning Criteria or *KKM.*. Mathematics teacher of eleventh grade of State Vovational High School 2 Rembang has tried to improve students' mathematics creative thinking ability, by performing group discussion, providing additional practice questions in the form of story questions and so on, but in general, the aspects of mathematics learning objectives were still low, especially in students' mathematical creative thinking ability. This can be seen from the following symptoms. (1) If they were given a different question from the example, then there would be more than 50% of students who cannot do it; (2) If the teacher gave an assignment, many students answered incorrectly because they were confused about which formula or method to use; (3) when they were given the problem of developing a formula or using a formula that requires little change, students could not answer the problem; (4) about 50% of students cannot explain the results of their work according to the problems from which the learning material has been learned. This is reinforced by the value of the daily test results of mathematics subjects in the material before the matrix material. Based on the results of the daily test, it was obtained an average of 68.09 and classical completeness of 69.23% with a maximum value of 85 and Minimum Completion Criteria 70. So that the teachers need to design a varied learning, involve students in

order to be more active in learning, and create student to have high learning interest. As the result, students will be able to develop their mathematical creative thinking ability.

Learning mathematics by using creative learning Treffinger model can improve students' creative mathematical thinking ability because it trains students to express their ideas creatively which eventually students will be able to find the most effective way to solve a problem. In addition, this model also involves affective aspects in problem solving that make students understand the situation and conditions of a problem.

Problems that will be given to students as learning material are problems that have been arranged in the form of problem cards. Therefore the Treffinger learning model that will be used in this study is called the Treffinger learning model assisted by problem cards. Based on the problems that have been described, this study aims to determine: (1) whether the students' mathematical creative thinking abilities with Treffinger learning models assisted by problem cards can achieve classical completeness, (2) whether the average of students' mathematical creative thinking abilities by using Treffinger learning model assisted by problem cars can reach the Minimum Mastery Learning Criteria, (3) whether the mathematical creative thinking ability of students with Treffinger learning models assisted by problem cards is better than students' with PBL learning models, and (4) the results of analysis of students' creative mathematical thinking ability in terms of student learning interest.

2. Methods

The research method used in this study was a combination method of Sequential Explanatory Design models. This model is a mixed method that applies quantitative data collection and analysis in the first stage followed by the collection and analysis of qualitative data in the second stage which is built on the initial quantitative results (Creswell, 2013: 316). The population in this study was the eleventh grade students of State Vovational High School 2 Rembang. The determination of the sample in this study was done by using Simple Random Sampling.

This study was True Experimental Design in the form of Posttest-Only Design Control. According to Sugiyono (2015), there were two groups, each of which was chosen randomly. The first group to be treated is called the experimental group and the non-treated group is called the control group. The description of research design is as follows.

Table 1. The Research Design

Class	Treatment	*Post-test*
Experiment	X_1	Y_1
Control	X_2	Y_2

Information:

X_1 : the application of the Creative Problem Solving learning model.

X_2 : the application of the Discovery Learning learning model.

Y_1 : testing the results of critical thinking ability of the Treffinger learning class.

Y_2 : testing the results of critical thinking skills of the PBL learning class.

Quantitative data analysis was divided into two: initial data analysis and final data analysis. The initial data was taken from students' daily mathematical replication data in the previous material to find out whether the two classes came from the same initial conditions . In the initial data analysis, the analysis was carried out by using the normality test, homogeneity test, and two similarity test averages. While the analysis of the final data was taken from the results of tests of students' mathematical negative thinking skills. In the analysis of final data analysis using normality test, homogeneity, and hypothesis testing. Where to test hypotheses using the proportion of one party test, the average of one party test, the difference in two averages test, and the difference in two proportions test. For the analysis of qualitative data was by using three main steps: data reduction, data presentation, and conclusion.

Methods of data collection in this study covered the creative mathematical thinking ability test, student interest questionnaire, observation, and interviews. The creative mathematical thinking test method used to obtain data on the results of test of creative mathematical thinking skill students in matrix material. The questionnaire method was used to obtain data on the results of student learning interest in mathematics learning. The observation method was used to get data about student activities during the learning process took a place. The interview method was used to determine students' creative matheatical

thinking ability from each students' learning interest category.

3. Results & Discussions

In the research, the initial data analysis was conducted to find out whether the class samples used came from the same class conditions or not. The preliminary analysis showed that students' daily mathematical replication data in the previous material in the Treffinger learning class and PBL learning class came from a population with normal distribution, had the same variance (homogeneous), and there was no difference in the mean between the Treffinger learning class and the PBL learning class. Based on the results of the analysis of the initial data, the study sample used, yes, the Treffinger learning class and the PBL learning class felt l from the same class condition. Then the research was conducted in class four meetings with the details of three meetings for learning activities and one meeting to test mathematical creative thinking ability. The main material for learning in this research was matrix.

The test results in the Treffinger learning class showed that of the 26 students who took the test of mathematical creative thinking skills, there were 24 students who achieved grades more than or equal to Minimum Mastery Learning Criteria. The average test results of the critical thinking skills of the Treffinger learning class students were 76,0996. While the results of tests on class control that of the 27 students who took the tests the ability of creative thinking mathematically, there were 20 students who achieved grades more than or equal to the Minimum Mastery Learning Criteria. The average test results of students' critical thinking ability in the PBL learning class were 70,2126.

Based on the results of mathematical creative thinking ability test, the final data analysis was performed to test the hypothesis. The final data analysis shows the data from the results of the mathematical creative thinking ability of students in the Treffinger learning class and the PBL learning class originating from populations that were normally distributed and had the same (homogeneous) variance. Based on the result of the analysis, the test data using parametric statistic test.

Next is a hypothesis test. Proportion test of one party used to know whether the mathematical creative thinking abilities of students at Treffinger aided learning problems reached classical completeness card. Based on the test result of the proportion of one party, namely the right party obtained a value $z_{hit} = 2{,}0389$. With $\alpha = 0{,}05$ earned value $z_{tabel} = 1{,}64$. Clear value $z_{hitun} > z_{tabel}$, then H_0 was rejected. So students mathematical creative thinking ability in Treffinger learning assisted by problem cards achieved the classical completeness.

If the average of one party was used to find out the students mathematical creative thinking abilities in Treffinger learning assisted by problem cards reach Minimum Completion Criteria. Based on the results of the average test of one party, namely the right party obtained a value $t_{hi} = 3{,}3386$. With $\alpha = 0{,}05$ and $\alpha = 0{,}05$ earned value $t_{tabel} = 1{,}71$. Clear value $t_{hitung} > t_{tabel}$, then H_0 rejected. So students mathematical creative thinking ability in Treffinger learning assisted by problem cards reached the Minimum Mastery Learning Criteria.

The difference of two averages test was used to determine whether the average student's ability to think creatively. The mathematical learning problems Treffinger assisted in the Treffinger learning class card more than the average mathematical ability of students' creative thinking in PBL learning class. Based on the test results of the difference in the two averages, that is, the right was obtained by the value $t_{hitung} = 1{,}6897$. With $\alpha = 0{,}05$ and $dk = 51$, earned value $t_{tabel} = 1{,}6745$. Clear value $t_{hitun} > t_{tabel}$, so H_0 was rejected. So the average of students' mathematical creative thinking ability in Treffinger learning assisted by problem cards class was more than the average mathematical creative thinking ability of students in learning in the PBL learning class.

If the difference in two proportions was used to determine whether the proportion of students completing learning in the classroom using the Treffinger model assisted by problem cards was more than the proportion of students who completed the learning in the PBL learning class. Based on the test results of the difference in two proportions, that is one right is obtained by value $z_{hitung} = 1{,}7674$. With $\alpha = 0{,}05$ earned value $z_{tabel} = 1{,}64$. Clear value $z_{hitu} > z_{tabel}$, then H_0 was rejected. So the proportion of students completing learning in the classroom using

the Treffinger model assisted by problem cards was more than the proportion of students who completed learning in the PBL learning class.

From the results of the two tests, the average mathematical creative thinking ability of students in Treffinger learning assisted by problem cards class was more than the average mathematical creative thinking ability of students in PBL learning class and the proportion of students who completed learning in the class using the Treffinger model assisted by problem cards is more than the proportion of students who complete learning in the class using PBL models, then hypothesis 3 was also proven that students 'mathematical creative thinking skills in Treffinger learning assisted by problem cards class was better than students' creative mathematical thinking skills in learning in the PBL learning class.

From the description above, it means that the application of the Treffinger learning model assisted by problem cards can be used to develop students' creative mathematical thinking skills in learning. By implementing the Treffinger learning model assisted by problem cards in the classroom, learning will be more fun, creative mathematically, and meaningful. In addition, the Treffinger learning model assisted by problem cards not only memorizes formulas in learning, but students are required to be accustomed to active mathematical creative thinking in developing their ideas when solving mathematical problems.

The results of this study are in accordance with Rohaeti's study (2013) which showed that the improvement of creative thinking skills of students who obtained mathematics learning with the Treffinger model was higher than those of students who obtained conventional learning. Based on the results of Rohaeti's study (2013) it was concluded that increased students' mathematical creative thinking ability who obtain mathematics learning with the Treffinger learning model are higher than students who obtain conventional learning, students give a positive attitude towards the application of the Treffinger learning model to learning Mathematics. In addition, this study is also in accordance with Triwibowo's (2017) study which states that the Treffinger learning model can improve students' creative mathematical thinking skills.

Interest in learning in the study were classified into three categories, namely low learning interest, medium in learning interest and high learning in interest. The determination of student learning interest categories was done by using student learning interest scale. The results of grouping students based on learning interest categories were as follows. In the low learning interest category, there were four students. In the moderate learning interest category, there were sixteen students. Whereas in the high learning interset category, there were six students.

The research objectives of student learning interest showed that there were three categories of interest in learning in the Treffinger learning class, namely interest in learning low, interest in learning moderate, and interest in learning high. The selection of research subjects was done by selecting two students in each interest group to learn for analysis of mathematical creative thinking skills. So that the research subjects were six students. The selection of research subjects was based on the teacher's consideration, observations of the researcher on student activity, and the results of students' creative thinking ability in each category of learning interest. The selected research subjects can be seen in the following table.

The selected research subjects can be seen in the following table.

Table 2. The Subject Research

Student learning interest		
Low	Moderate	High
E-03	E-17	E-06
E-15	E-20	E-22

Based on table at above, it can be seen that no interest in learning each category, there were two research subjects were interviewed. Where research subjects in the learning interest category low was subject E-03 and subject E-15. Research subjects in the learning interest category moderate was subject E-17 and subject E-20. While the research subjects in the interest in learning categories high was subject E-06 and subject E-22. The results of categorizing interest in learning it was obtained from the results of filling the learning interest scale. The ability of mathematical creative thinking in this study was the ability to think creatively mathematically in working on problems with indicators of mathematical creative thinking, namely fluency, flexibility, oroginality and elaboration.

3.1. Analysis of mathematical creative thinking skills of students is reviewed from interest to learn low

Based on the analysis of the results of the work tests of mathematical creative thinking skills and the results of interviews with subjects of low learning interest, namely the E-03 subject and E-15 subject obtained the following results. E-03 subjects and E-15 subjects were only able to reach one indicator of mathematical creative thinking, namely the fluency indicator. Because E-03 subjects and E-15 subjects were less capable of indicators of flexibility, they were able to work on the problem but could not mention other methods or different ways than they used. In addition E-03 and E-25 were also not able to achieve indicators of authenticity and elaboration indicators. The subjects felt confused and did not understand the problem so students with low learning interest were less able to develop their creativity and cannot work on the questions given. Then it can be concluded that the research subjects with low interest in learning were less able to solve mathematical creative thinking skills problems quite well. The research subjects with low interest in learning were only able to solve mathematical creative thinking ability in mathematical creative thinking indicators, namely fluency indicator.

3.2. Analysis of mathematical creative thinking ability of students in terms of interest in learning is moderate

Based on the analysis of the results of the work of mathematical creative thinking ability tests and the results of interviews with subjects of moderate learning interest, namely the subject of E-17 and E-20 subjects obtained the following results. E-17 subjects and E-20 subjects with moderate learning interest categories were quite able to reach mathematical creative thinking indicators, namely fluency, flexibility, authenticity and elaboration indicators. Of the four indicators, students with moderate learning interest were able to reach two indicators of mathematical creative thinking, namely indicators of fluency and flexibility, while indicators of authenticity and elaboration, there were some inappropriate results because students with interest in learning were less thorough and less creative in completing problem, even though some can do it. Then it can be concluded that the research subjects with interest in learning were quite able to solve the problems of mathematical creative thinking skills well. Research subjects with interest in learning were quite capable of solving mathematical creative thinking skills problems in accordance with mathematical creative thinking indicators, namely fluency and flexibility.

3.3. Analysis of mathematical creative thinking ability of students in terms of interest in learning is high

Based on the analysis of the results of work tests of mathematical creative thinking ability and the results of interviews with subjects of high learning interest, namely the subject of E-06 and E-22 subject obtained the following results. The subject of E-06 and the subject of E-22 with high learning interest categories were able to reach all indicators of mathematical creative thinking, namely fluency, flexibility, authenticity, and elaboration indicator. Then it can be concluded that the research subjects with low interest in learning were able to solve mathematical creative thinking skills. The research subjects with a high interest in learning were able to solve mathematical creative thinking ability in accordance with mathematical creative thinking indicators, namely fluency, flexibility, authenticity, and elaboration indicator.

Based on the description above, the mathematical creative thinking ability of students with high learning interest was better than moderate and low mathematical creative thinking ability since most students with a high interest in learning were able to work on mathematical creative thinking ability well in accordance with mathematical creative thinking indicator, while mathematical creative thinking ability of students with moderate learning interest was better than low learning interest students since most students with moderate interest in learning were able to work on the problem of mathematical creative thinking ability quite well, while in students with low learning interest were less able to do the problem of mathematical creative thinking skills well.

The results of this study are in accordance with the Siagian study (2012) which suggests that students' high interest in learning will also be high learning achievement. Lestari (2013) adds that students with high learning interest have better learning achievement than students with moderate or low learning interest. Mustaqim, et al (2013), students with high interest have better learning achievement than students with moderate learning interest, and students with a learning interest are having better learning achievement than students with low interest in learning. Kpolovie (2014) also

suggests that the increasing interest in learning in schools can contribute to improving academic abilities. This means that the higher the interest in learning, the higher academic ability.

4. Conclusion

Based on the results of this study concluded that: (1) the capacity of creative thinking in the students' mathematical learning problems Treffinger aided achieve calssical completeness card, (2) the capacity of creative thinking in the students' mathematical learning problem Treffinger aided reached Minimum Completion Criteria, (3) the average mathematical creative thinking ability of students in Treffinger learning assisted by problem cards in the Treffinger learning class is more than the average mathematical creative thinking ability of students in the PBL learning class, and the proportion of students' creative mathematical thinking ability in Treffinger learning assisted by problem cards in the Treffinger learning class is more than proportion students' mathematical creative thinking skills in learning in the PBL learning class, and (4) the ability of mathematical creative thinking from research subjects with high learning interest is better than mathematical creative thinking abilities of subjects with moderate or low learning interest. While the mathematical creative thinking ability of the research subjects with moderate learning interest is better than the mathematical creative thinking ability of the subjects with low interest in learning.

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