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Application Of Treffinger Learning Model Towards Mathematical Creative Thinking Ability Of Junior High School Students

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ABSTRACT: *Mathematical creative thinking is one of the important abilities that students must have to be able to solve various problems, both mathematical problems and problems related to life. The reality in the field is that students still lack mathematical creative thinking skills because the learning that is carried out is less able to optimize the development of students' mathematical creative thinking processes. This study aims to determine students' mathematical creative thinking skills through treffinger learning and conventional learning. The approach used in this study is quantitative with a pretest-posttest design. The research sample consisted of 16 students in the experimental class and 18 students in the control class. Data were collected through a valid written test that can measure students' mathematical creative thinking skills. Data analysis used a mean difference test using the t-test (independent sample t-test). The results of the study showed that there was a difference in the mathematical creative thinking skills of students who were taught using the treffinger learning model and students who were taught using conventional learning, where the mathematical creative thinking skills of students who were taught using the treffinger model were better than students who received conventional learning. The positive impact obtained from the application of the Treffinger learning model is also inseparable from the teacher's ability to understand the characteristics and phases of the Treffinger learning model as well as the time and class management which is already very good.*

ABSTRAK: Berpikir kreatif matematis merupakan salah satu kemampuan penting yang harus dimiliki oleh siswa untuk dapat menyelesaikan berbagai permasalahan, baik permasalahan matematika maupun permasalahan yang terkait dalam kehidupan. Kenyataan di lapangan kemampuan berikir kreatif matematis masih kurang dimiliki siswa disebabkan pembelajaran yang dilaksanakan kurang dapat mengoptimalkan berkembangnya proses berpikir kreatif matematis siswa. Penelitian ini bertujuan untuk mengetahui kemampuan berpikir kreatif matematis siswa melalui pembelajaran treffinger dan pembelajaran konvensional. Pendekatan yang digunakan dalam penelitian ini adalah kuantitatif dengan desain pretest-posttest. Sampel penelitian terdiri dari 16 siswa kelas eksperimen dan 18 siswa kelas kontrol. Data dikumpulkan melalui tes tertulis yang telah valid yang dapat mengukur kemampuan berpikir

kreatif matematis siswa. Analisis data menggunakan uji perbedaan rata-rata dengan menggunakan uji-t (independent sample t-test). Hasil penelitian menunjukkan bahwa terdapat perbedaan kemampuan berpikir kreatif matematis siswa yang dibelajarkan dengan model pembelajaran treffinger dengan siswa yang dibelajarkan dengan pembelajaran konvensional, di mana kemampuan berpikir kreatif matematis siswa yang dibelajarkan dengan model treffinger lebih baik dari pada siswa yang memperoleh pembelajaran secara konvensional. Dampak positif yang didapatkan dari penerapan model pembelajaran treffinger juga tidak terlepas dari kemampuan guru dalam memahami karakteristik dan fase pada model pembelajaran treffinger serta manajemen waktu dan kelas yang sudah sangat baik.

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INTRODUCTION

The role of mathematics in everyday life has a very important value, where the presence of mathematics in everyday life is to facilitate various human activities, such as calculations, measurements, trade, and many other activities. By understanding mathematics, a person can improve their logical, analytical, and creative thinking skills to solve various everyday challenges. Mathematics is not only relevant in schools, but is also an integral part of almost every aspect of human life. Aulia, Duskri, and Yani (2023) also stated that mathematics is part of the teaching curriculum in schools which is an important component in the field of education, through learning mathematics students are trained to think critically, creatively, logically, systematically, and can solve problems in everyday life.

Along with the development of the times, mathematics is increasingly becoming an increasingly important need in various aspects of human life. Mathematics also has a strong relationship with various other fields of science, such as mathematics in economics, mathematics in physics, mathematics in chemistry, and so on. In addition, mathematics is also often considered a language, which is similar to verbal language, as a means of communication needed by every individual.

The purpose of learning mathematics is to prepare students to act critically, rationally, logically, and straightforwardly in facing an increasingly developing world. Cornelius (Lestari, Waluya, & Suyitno, 2015) stated that there are at least five reasons for the need to learn mathematics, because mathematics is 1) a means of thinking clearly and logically; 2) a means of solving everyday life problems; 3) a means of recognizing patterns of relationships and generalizations of experience; 4) a means of developing creativity, and 5) a means of increasing awareness of cultural developments.

Entering the era of globalization and the rapid development of technology today, students are faced with various problems. These problems are very diverse and often make it difficult for students to find solutions. Moreover, the current technological advances add to the complexity of the challenges they face. The lack of information received by students about

technological advances can result in difficulties in adapting to current technological developments. In addition, rapid technological advances often make students too dependent, which can reduce their level of creativity.

To overcome these problems, students need good skills to be able to solve the challenges they face effectively. One important skill is creative thinking. This ability will not develop by itself, where facilities or means are needed to hone it, and the field of education such as mathematics learning is one of the effective means to develop this creativity. Yani, Rosma, & Helmanda (2022) also stated that the ability to think logically, analytically, systematically, critically, creatively, and the ability to work together can be given to all students starting from elementary school through mathematics learning. Even students in finding new ideas or ideas that can be useful for the development of technology in the future are also greatly supported by mathematics.

Creative thinking skills in mathematics learning receive significant attention. This can be seen from the policy that integrates creative thinking skills into the curriculum. Based on Permendikbud number 22 of 2016, authentic mathematics learning emphasizes (1) focusing on the process and results in problem solving, and (2) aspects of reasoning to improve logical, critical, analytical, and creative thinking skills. Creative thinking skills are also integrated into other learning strategies and tools. Ibrahim, Khalil, and Prahmana (2024) also stated that creative thinking in solving mathematical problems plays an important role in determining the focal point of the problem, connecting its constituent elements, and facilitating the exploration of various solutions to problem solving.

However, students' mathematical creative thinking skills are still relatively low (Novi, 2016). The results of a study by Mawar, Nurcahyono, and Lukman (2023) also stated that students' mathematical creative thinking skills are still low in solving flat-sided spatial problems. This is caused by the mathematics learning process which tends to be monotonous and emphasizes the teacher's mindset too much, which results in students tending to be passive, only following what the teacher does without really understanding the concept. Furthermore, Wahyudin (Novi, 2016) also stated that the causes of students' low mathematical creative thinking skills in mathematics learning include the learning process which is not yet optimal. In addition, many teachers do not show the use of contexts that come from the real world, even though the context can generate students' knowledge and skills through real experiences (Afriansyah, 2014). As a result, students find it difficult to apply their knowledge in mathematics to real life.

Based on the above problems, it shows that students' mathematical creative thinking skills still need to be developed to be better, where teachers as learning facilitators should be able to design learning that can develop students' mathematical creative thinking skills. Teachers must also be able to ensure that students not only understand mathematical concepts, but are also able to apply them in everyday life, one of which is solving problems creatively and logically. One concrete step is to apply a learning model that can help develop students' creative thinking skills by using a creative-based learning model, namely the treffinger learning model.

The treffinger learning model has an important role in developing students' ability to think creatively and solve problems. This model also provides opportunities for students to explore their potential abilities, including creativity and problem-solving skills. Analisa and Muhid (2023) stated that the Treffinger learning model is one of many models in learning that has its own approach in producing creative thinking skills. In the treffinger learning model, there are several procedures in its learning activities, which include reviewing, understanding oneself and groups, optimizing creative thinking skills and attitudes, encouraging creative ideas, and developing real and complex problem-solving skills (Azzajjad, Halima, Rahayu, & Ahmar, 2023).

The treffinger learning model emphasizes the active involvement of students in the learning process, where students are faced with open problems that can be solved in various ways and have many correct answers. This situation encourages students to utilize their intellectual potential and experience in finding something new, thus training creative thinking skills (Hasanah, Sukardi, & Wadi, 2022).

The stages in the treffinger learning model include basic tools that contain a number of techniques that are considered basic in creative learning, namely real problems given to students according to their experience and knowledge so that students can be directly involved in meaningful learning with more than one answer choice to a problem. Furthermore, the practice stage with the process, namely providing students with the widest possible opportunities to implement the skills they have learned at the basic tools stage in practical situations and the problem-solving stage, where students apply the skills they have learned in the first two stages in facing challenges in real life. In the next stage, students apply their skills optimally in their lives (Ndiung, Sariyasa, Jehadus, & Apsari, 2021).

With all the stages in this Treffinger learning model, it is hoped that students' creative thinking skills and curiosity can develop. Several relevant studies have also been conducted by several previous researchers, namely the implementation of the Treffinger-based STEM (Science, Technology, Engineering, and Mathematics) approach to improve the creative thinking skills of junior high school students (Lestari & Hadi, 2022). The results of Pumalato's (2019) study also concluded that there was a significant positive effect of implementing the Treffinger model in improving creative thinking skills and solving mathematical problems.

The findings of the study above give meaning that creative thinking skills and mathematical problem solving skills can be optimized through a learning model based on creativity development and one of them is the Treffinger learning model. The novelty of this study is that it is more focused on improving and different mathematical creative thinking skills based on each indicator of creative thinking skills, namely fluency, flexible, original, and elaboration for the experimental class and control class after receiving learning with the Treffinger model and conventional learning. This study aims to determine students' mathematical creative thinking skills through the Treffinger learning model and conventional learning.

METHOD

The study used a quantitative approach with an experimental method that aims to determine whether there is an impact of the treatment given to the research subjects. Two classes were selected, namely the experimental class and the control class. In the experimental class, students were given a pretest to measure students' initial abilities in mathematical creative thinking, then the Treffinger learning model was applied during the learning process as an experimental treatment. After the learning process was completed, students were given a post-test to see changes in their mathematical creative thinking abilities. In the control class, students were also given a pretest, then followed the conventional learning process, and finally were given a post-test to see the developments achieved in their mathematical creative thinking abilities.

The Treffinger learning model applied to the experimental class includes the syntax (1) Basic Tools, (2) Practice with Process, and (3) Working with real Problems. While the conventional learning applied to the control class is the learning that is usually applied by teachers in mathematics learning in class VII MTsN Pidie Jaya, namely cooperative learning. The implementation of learning with the Treffinger and conventional learning models was carried out for three meetings each on the algebra material.

The sample of this study was selected using random sampling technique, where each member of the population has an equal chance of being selected as a sample. Random

sampling technique was used because all samples of this study have the same characteristics and abilities. The sample was selected based on the results of class randomization from all classes VII MTsN 2 Pidie Jaya, namely classes VIIA to VIIE and students of class VII-D were selected as the experimental class and students of class VII-A as the control class. The instruments used include learning instruments, namely the Lesson Implementation Plan (RPP) and Student Worksheets (LKS). While the data collection instruments consist of pretest and posttest. All research instruments were validated first before being used as research instruments, namely content and construct validation. Content validation was carried out on two experts, namely a mathematics education lecturer and a mathematics teacher at MTsN 2 Pidie Jaya. While construct validation was carried out through a limited trial on class VII students with valid validation results and a moderate level of reliability (0.57).

The research data were collected through tests (pretest and posttest) in the form of descriptions consisting of four questions with each question containing indicators of mathematical creative thinking skills, namely fluency, flexible, original, and elaboration. The collected data were then analyzed using a t-test whose stages are descriptive data processing, data normality test, data homogeneity test, and statistical hypothesis testing using an independent sample t-test.

RESULTS AND DISCUSSION

After the data was collected and analyzed against the N-gain value based on the pretest and posttest data on the mathematical creative thinking abilities of students in the control class and experimental class, the results were obtained as presented in the following table.

Table. 1 Comparison of Students' Mathematical Creative Thinking Ability in Experimental Class with Control Class

Statistics	Experiment	Criteria	Control	Criteria
Number of Students	16	-	18	-
N-Gain Value	16	High	12	High
	0	Medium	0	Medium
	0	Low	6	Low
Average	12,75	-	9,05	-
Variance	3,13	-	2,73	-
Standard Deviation	1,77	-	1,65	-

Based on table 1 above, it was obtained that the average mathematical creative thinking ability of students in the experimental class (12.75) was higher than that of the control class (9.05), although the effectiveness of the increase that occurred in both classes was almost the same. However, in the experimental class, the increase in the value of students' mathematical creative thinking ability in the high category was 16 students and in the medium and low categories 0 students, while in the control class the highest n-gain value was 12 students and the lowest was 6 and in the medium category 0 students.

To prove the statistical hypothesis using the t-test, the data is first subjected to prerequisite tests, namely the normality and homogeneity tests. The results of the data normality test on the pretest and posttest data on the mathematical creative thinking ability of students in the experimental and control classes are normally distributed. Furthermore, the data on the mathematical creative thinking ability of students in the experimental and control classes also have the same variance (homogeneous). Because the prerequisite tests have

been met, the t-test is continued to prove the statistical hypothesis in this study. The statistical hypotheses to be tested are:

H_0: The mathematical creative thinking ability of students who are taught using the Treffinger learning model is the same as that learned through conventional learning.
H_a: The mathematical creative thinking ability of students who are taught using the Treffinger learning model is better than those who are taught through conventional learning.

Based on the data above, the degrees of freedom are obtained, namely dk = 16 + 18 - 2 = 32 and the value of t (0.95) = 1.675, so that t_count > t (1-α) which is 6.345 > 1.675. As a result, based on the testing criteria, H0 is rejected or Ha is accepted, which means that the mathematical creative thinking ability of students who are taught using the Treffinger learning model is better than those who are taught through conventional learning. Based on these indications, the results obtained from each indicator of mathematical creative thinking ability for the experimental and control classes can also be seen as presented in the following table.

Table. 2 Percentage of Posttest Scores of Experimental and Control Class Students for Each Indicator Students' Mathematical Creative Thinking Ability

Posttest Experiment Class		
Creative Thinking Indicators	**Low**	**Good/Very Good**
Fluency	1,57%	98,43%
Flexible	28,13%	71,87%
Original	12,5%	87,5%
Elaboration	45,32%	54,68%
Posttest* Control *Class		
Creative Thinking Indicators	**Low**	**Good/Very Good**
Fluency	30,55%	69,44%
Flexible	44,45%	55,55%
Original	43,05%	56,94%
Elaboration	66,67%	33,33%

Based on Table 2, it can be seen that all indicators of students' mathematical creative thinking abilities in the experimental class are better than those in the control class for good/very good achievements. Meanwhile, the achievement of each indicator of mathematical creative thinking abilities in the low category also shows that the experimental class has a better percentage than the control class.

In addition, the positive impact obtained from the learning process using the Treffinger learning model is the increase in students' mathematical creative thinking skills in each indicator before and after the Treffinger learning model is applied. In the fluency indicator, the percentage of students in the low category decreased from 12.5% to 1.57%, while students in the good or very good category increased from 87.5% to 98.43%. For the flexible indicator, the percentage of students in the low category decreased from 59.38% to 28.13, while students in the good or very good category increased from 40.62% to 71.87%. Furthermore, for the original indicator, the percentage of students in the low category decreased from 45.32% to 12.5%, while students in the good or very good category increased from 40.62% to 87.5% and for the last indicator, namely elaboration, the percentage of students in the low category decreased from 84.38% to 12.5%, while students in the good or very good category increased from 15.62% to 87.5%.

In the implementation of learning during three meetings on algebra material, the learning process between the Treffinger model (experimental class) and conventional

learning (control class) showed better changes from each meeting. Where the activities of teachers and students in learning between the control class and the experimental class continued to improve for each meeting as expected. The recapitulation of teacher and student activities at each meeting is as presented in the following table.

Table 3. Teacher and Student Activities during Learning with the Treffinger Model and Conventional Learning

Meeting	Experiment Class	Control Class
	Teacher Activity	**Teacher Activity**
I	The teacher's activity at the first meeting was good and the learning was carried out based on the Treffinger learning model syntax. However, time management at the first meeting was not optimally controlled by the teacher, where the teacher had to provide a lot of direction to students in solving problems, because students were not used to learning with the Treffinger learning model. As a result, the first meeting learning was completed in 130 minutes, which should have been 120 minutes.	The teacher's activity at the first meeting was good and based on the time that had been determined and learning was carried out cooperatively and students were able to discuss like learning in previous materials. However, the teacher had difficulty in directing students to solve the problems given creatively, because students were not used to solving problems by thinking openly and contextually.
	Student Activities	**Student Activities**
	Student activities at the first meeting were not all effective, especially at the practice with process stage, where students were not yet accustomed to thinking openly and still needed a lot of time to solve problems creatively.	Student activities at the first meeting were still less effective, such as the lack of students in providing response activities to contextual problems and students still carrying out activities that were not related to learning.
	Teacher Activity	**Teacher Activity**
II	Teacher activity at the second meeting was better than the first meeting, where the learning time management was right and the teacher was able to facilitate students to learn optimally in every syntax of the Treffinger learning model. The teacher was also able to provoke and provide support in student group discussions to be able to think openly and flexibly in solving the mathematical problems given in the LKPD.	The teacher's activity at the second meeting was better than the first meeting, where the teacher had rearranged the students' discussion groups based on the observation results at the first meeting, so that there were no more students doing activities that were not related to learning. Furthermore, the teacher was also able to facilitate students in completing LKPD by thinking creatively, although there were still two groups that needed maximum assistance.
	Student Activities	**Student Activities**
	Student activities at the second meeting have shown more independence and have been able to adjust learning activities with the	Student activities at the second meeting have shown that the activities carried out during learning are related to learning, where

	Treffinger model. In completing LKPD, students have been able to discuss actively, especially in the syntax of working with real problems. In this syntax, students collect information together in groups through textbooks and algebra modules in solving the problems given.	students can work together in groups that have been rearranged by teachers who are different from the group members at the first meeting. However, there are two groups that require maximum guidance from teachers in thinking creatively in solving mathematical problems contained in LKPD
	Teacher Activities	**Teacher Activities**
III	In the third meeting, the teacher implemented learning with the Treffinger model well and effective time management and the teacher as a learning facilitator who is ready to accompany and provide direction to students if they experience obstacles, especially in solving mathematical problems by using creative thinking skills. Furthermore, in the working with real problem syntax, the teacher can encourage students to collect relevant information by conducting experiments to obtain explanations and solutions to the problems given.	Teacher activities at the third meeting have been carried out well and all learning activities are based on the specified time. Teachers can also position themselves as facilitators who are ready to accompany and provide direction to students if they experience obstacles, especially in solving mathematical problems using creative thinking skills. However, teachers are not systematic in the process of developing students' mathematical creative thinking skills, because learning is generally carried out cooperatively, where the focus is on group discussions in general.
	Student Activities	**Student Activities**
	Student activities at the third meeting were the same as student activities at the second meeting, where students were more independent and in completing LKPD students were able to discuss actively, especially in the syntax of working with real problems. In this syntax, students collect information together in groups through textbooks and algebra modules in solving the problems given. Furthermore, students can also communicate fluently in front of the class in presenting the results of group work and are very flexible in their thinking.	At the third meeting, student activities were good, especially in group discussions and presentations in front of the class, but students were not yet optimal in developing their mathematical creative thinking skills because learning was conventional without any special efforts in developing mathematical creative thinking skills as found in the Treffinger learning model.

Based on the recapitulation data in the table above, it shows that the success of the application of the Treffinger learning model in developing students' mathematical creative thinking skills is because in the first stage it uses open questions so that it will provoke students to think elaboratively, flexibly, originally and fluently. In the second stage, students

are invited to expand their thinking to participate in group activities and will be given more complicated questions than the first stage so that they will learn while working in groups, at this stage students have begun to be invited to think creatively.

While in the last stage the technique used is creative thinking technique, namely at this stage students will work on non-routine problems related to everyday life so that students are required to obtain solutions to these problems which will ultimately encourage students to think creatively. This is relevant to what was expressed by Huda (2013) that the treffinger learning model can improve creative thinking skills because it involves gradually convergent and divergent thinking skills in the problem-solving process, and has systematic development stages with various methods and techniques for each stage.

While conventional learning by implementing cooperative learning model does not have any special emphasis on developing students' mathematical creative thinking ability, although the LKPD given to both research classes is the same, each question contains indicators of mathematical creative thinking ability. Because in conventional learning the main focus is group discussion and working on LKPD as a discussion medium, so other support in learning for developing better students' mathematical creative thinking ability is less than optimal and systematic.

Similar research results were also obtained from research conducted by Zega, Lase, and Mendrofa (2022) which stated that there was a better influence of the application of the Treffinger learning model on students' mathematical creative thinking abilities than conventional learning models. The results of the study by Ginting and Sahdani (2024) also stated that the application of the Treffinger learning model can improve students' fluency, flexibility, originality, and elaboration as well as effective solutions in improving students' mathematical creative thinking abilities through an approach that integrates cognitive and affective aspects. In addition, the Treffinger learning model also provides opportunities for students to explore solutions in innovative ways which are very important in the context of 21st century education.

The overall score of students' mathematical creative thinking ability in the experimental group taught through the Treffinger learning model was also very different from the mathematical creative thinking ability of students in the control group taught through conventional learning. Where the average posttest result of the experimental class students' mathematical creative thinking ability was 12.75 and the average posttest of the control class was 9.05. The results of the hypothesis test also showed that the mathematical creative thinking ability of students who applied the Treffinger learning model was better than students who received conventional learning.

The most important factor possessed by the Treffinger learning model is that the model has a strong intersection with mathematical creative thinking skills, where the creative learning process uses a divergent thinking process (the process of thinking in various directions and producing many alternative solutions) and a convergent thinking process (the process of thinking critically and analytically in finding the single most appropriate answer). Asif, Qing, Hwang, and Shi (2019) also stated that the Treffinger learning model has three phases of creativity which show that creativity develops through awareness, risk taking, and commitment to results.

Due to the three phases of creativity and strong intersections owned by the Treffinger learning model, it has become a strong reason that the learning model can continue to be maintained and developed by educators in learning, especially in mathematics learning to develop and improve students' mathematical creative thinking skills. However, a good understanding by educators of the characteristics of the Treffinger learning model and classroom management when implementing it is also very important in learning

CONCLUSION AND SUGGESTIONS

Based on the results of data analysis and discussion, it can be concluded that there is a difference in the mathematical creative thinking ability of students who are taught using the Treffinger learning model and students who are taught using conventional learning, where the mathematical creative thinking ability of students who are taught using the Treffinger model is better than students who receive conventional learning.

The suggestions that can be conveyed based on the findings in this study are (a) for the success of the implementation of the Treffinger learning model, a good understanding of the educators regarding the characteristics and phases of the Treffinger learning model as well as class and time management is very necessary; and (b) in the implementation of the Treffinger learning model, it is also necessary to pay attention to the cognitive level of students so that it is easier to form discussion groups and adjust the given mathematical problems.

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