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Open Ended Approach for Students' Mathematical Creative Thinking Ability

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Abstract

The purpose of this study was to determine the effect of open ended approach on students' mathematical creative thinking ability. This research is based on the importance of mathematical creative thinking skills to solve mathematical problems in a more flexible and innovative way, which in turn can develop students' abilities in various aspects of life, both in academic and non-academic fields. This type of research is a quasi-experiment and uses a quantitative approach with a Posttest Only Control Design. The study population included all VIII grade students, using cluster random sampling technique, two classes were obtained, namely class VIII-7 as the experimental class and class VIII-10 as the control class. Data were collected through observation sheets and tests of students' mathematical creative thinking skills. Data analysis was conducted using descriptive and inferential methods. The results of descriptive analysis showed that the average mathematical creative thinking ability of students taught with an open ended approach was 70.89 higher than that of students taught with a scientific approach of 62.57. The results of inferential analysis with Independent Sample T-Test showed sig value. 0,038 < 0,05. The conclusion of this study is that the open ended approach has an influence on students' mathematical creative thinking skills.

Keywords: mathematical creative thinking**;** open ended approach; scientific approach.

INTRODUCTION

Building a learning environment that inspires students to actively explore and realize their full potential is the purpose of education. Education is a purposeful and organized effort. The main purpose of education is to support students' moral development, intelligence development, character development, spiritual growth, and acquisition of skills necessary for society, country, and self (Yusuf, 2018). Learning can be considered a teaching and learning activity because in it there are aspects of teaching and learning (Susanto, 2016).

Math is taught at every level of education. Many aspects of daily life require mathematics, which also serves as a basis for understanding other fields. Math is more than just a bunch of equations and numbers, it is also the result of analysis and reasoning that connects concepts from human experience with concepts that are suitable for others to understand and use. The process of linking mathematics learning with the context of students' lives in mathematics material becomes easier for them to understand. In addition, learners can apply math subjects to everyday problems. Learners learn mathematics through a series of structured activities that can give them experience and help them master the material being taught (Zulyadaini, 2017). One of the goals of national education is to form students into individuals who are pious, noble, healthy, intelligent, creative, independent, and responsible and democratic citizens, including improving creative thinking skills. According to (Nurlaela & Ismayati, 2015), creativity is the ability to use all of one's abilities to solve environmental challenges in new ways.

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Rapid developments in technology and information are closely related to human creative abilities. In facing future challenges, creative thinking is key for learners. (Fakhriyani, 2016) revealed that creativity refers to a person's ability to achieve extraordinary achievements by creating new innovations, modifying existing concepts, finding unique solutions to difficult problems, generating original ideas that have never existed before, and seeing various possibilities that were previously unthinkable.

Creative thinking is a person's ability to analyze information that has never been encountered before and combine ideas or concepts to solve problems (Moma, 2015). Finding unique solutions to math problems helps students develop their creative thinking skills. This gives students many opportunities to realize their potential in areas such as pursuing their interests, perfecting skills, and finding satisfaction in their work to achieve success.

Creative thinking skills in Indonesia are still low, with Indonesia ranked 115 out of 139 countries according to The Global Creativity Index 2015 (Dewi et al., 2019). This is due to the lack of training from teachers to develop these skills. This finding is further reinforced by the tendency of students to rely more on memorization than concept understanding, due to language teaching methods that tend to be similar to those in books (Hidayat & Widjajanti, 2018). Mathematical creative thinking skills include the ability to find new solutions and variations quickly and flexibly to open-ended mathematical problems while still maintaining their correctness. It involves the ability to propose new ideas when facing math problems (Amidi & Zahid, 2017).

Interviews conducted by researchers with an VIII grade mathematics teacher revealed that students' creative thinking skills were still relatively low. (Safaria & Sangila, 2018) stated that students are still lacking in creative thinking skills to work on story problems of flat building material, with no students reaching the high category, 14.3% in the medium category, and 85.7% in the low category. Based on the test results that researchers obtained by giving open ended questions to five students about the indicators of creative thinking ability, namely fluency, flexibility, originality, and elaboration, it was concluded that in terms of creative thinking indicators, students' ability to think creatively was still lacking, as shown by the answers they gave. Students showed fluency by being able to provide one correct answer, but had difficulty in solving the problem clearly. In terms of flexibility, students have not been able to provide varied and accurate answers. Regarding originality, students could not solve the problem correctly, and in elaboration, they lacked detail in explaining the answers and were still confused in expressing ideas, so the answers given were incomplete.

In solving open ended problems, students do not try to find or use new strategies to solve the problem at hand. Worse still, most students rely on memorization rather than a strong understanding of concepts. As a result, if they cannot remember a formula well or if there is no information to support the formula, they will have difficulty solving the problem. In one problem, there may be several solution methods, or even many solutions that can be used. However, in reality students often focus on only one way of solving. Therefore, students still lack creativity in solving a problem.

It is very important for educators to formulate clear and open-ended problems in order to stimulate students' creative thinking, broaden their perspectives, and motivate them to explore different ways of solving problems. (Foong, 2000) states that the application of open problems in the curriculum of some countries aims to improve students' ability to think and solve problems. One of the learning approaches that presents open-ended problems is the open ended approach (Dewi & Juandi, 2023).

In the open ended approach, students are expected to be more effective in explaining mathematical concepts and situations, as well as being more active and creative in communicating material. Open ended questions encourage students to actively discuss (Kadarisma, 2018). (Mustika & Ningtiyas, 2023), explained that the open ended approach

emphasizes the importance of understanding concepts so that students are able to solve problems with various strategies. Students are also supported in this learning by being divided into small groups, which supports interaction and discussion in a conducive atmosphere. The goal is to make it easier for students to learn and understand the material. (Tesi, Lambertus, & Mukhsar, 2018) explained, the Open-Ended (OE) approach is a teaching method that focuses on giving problems without definite answers to students. In this approach, students are encouraged to actively participate, express their ideas freely, and apply their mathematical knowledge thoroughly. Despite their limited abilities, students will find solutions in the way they want. The open ended approach also increases students' intrinsic motivation to provide reasons or explanations in solving the given problems. Students develop strong collaboration skills when completing teacher-given tasks and gain a lot of experience in problem solving through this approach. (Gultom, 2017) explains that the open ended approach is a strategy that encourages students to solve problems in a creative way and appreciate various methods of solving. This approach gives students the opportunity to face problems that can be solved in more than one way. Becker and Shimada (Munroe, 2015) also added that in open ended learning, problems have three levels of openness: open process, open end result, and open development method. These problems serve as the main tool in the learning process and are often non-routine problems, encourage students to think creatively, and do not always have clear answers. Students are expected to respond well to open ended problem situations, and three types of problems that can be used in this context include finding connections, grouping and measuring. One alternative strategy that can be applied by educators to achieve learning objectives is the open ended learning approach. With this approach, students are usually faced with open-ended problems that they must solve, giving them the opportunity to apply creative ideas and innovate in finding solutions. The open ended approach creates an environment where learners can face problems with various approaches and creative ideas (Situmorang, 2022).

This study aims to determine the effect of open ended approach on students' mathematical creative thinking ability. This research differs from previous studies in several ways. The focus of this study is more focused on analyzing students' mathematical creative thinking skills with open ended and scientific approaches, while previous studies more generally discuss the effect of open ended on various materials and levels of education. In addition, this study used an experimental design with two groups (experimental and control), while previous studies often only compared open ended with conventional learning.

METHODS

This research is included in the quasi-experimental type of research, namely the experimental class, the class that received the open ended approach treatment and the control class, the class with the scientific approach treatment. The population in this study consisted of all VIII grade students at SMP Negeri 9 Kendari, which were divided into eleven classes, namely from class VIII-1 to class VIII-11. Of these, two classes were selected using the cluster random sampling method, namely class VIII-7 as the experimental group and class VIII-10 as the control group.

In this study, students' creative thinking skills were evaluated through observation and mathematical creative thinking skills test. The aim was to ensure students were engaged in productive learning activities with the open ended approach. For this reason, observation sheets were used at each meeting. The researcher designed, developed, and compiled a mathematical creative thinking ability test consisting of four questions in the form of descriptions. These findings provided information on students' engagement and activities. The learning activity criteria are listed in the following table.

Table 1. Interpretation of Learning Practicability

Percentage	Category
$75\% \leq x \leq 100\%$	Very good
$50\% \leq x < 75\%$	Good
$25\% \leq x < 50\%$	Simply
$0\% \leq x < 25\%$	Very Less

(Arikunto, 2021)

Data on students' mathematical creative thinking skills were obtained from the posttest results, where students' scores were converted into scores in the range 0-64 according to the criteria listed in table 2.

Table 2. Criteria for the Level of Students' Mathematical Creative Thinking Ability

Percentage	Category
$0 - 12$	Very Uncreative
$13 - 25$	Not Creative
$26 - 38$	Creative Enough
$39 - 51$	Creative
$52 - 64$	Very Creative

(Widiastuti & Putri, 2018**)**

The percentage value of creative thinking ability is interpreted as follows:

Table 3. Interpretation of Students' Creative Thinking Level

Percentage	Category
$80 \leq x \leq 100$	Very good
$60 \leq x < 80$	Good
$40 \leq x < 60$	Simply
$20 \leq x < 40$	Less
$0 \leq x < 20$	Very Less

(Riduwan, 2013)

The statistical hypothesis used in this study is as follows; $H_0 : \mu_1 = \mu_2$ opponent $H_1 : \mu_1 > \mu_2$. With description, μ_1 = Average mathematical creative thinking ability of students taught with open ended approach; μ_2 = Average mathematical creative thinking ability of students taught with a scientific approach; H_0 = The average mathematical creative thinking ability of students taught with an open ended approach is equal to the average mathematical creative thinking ability of students taught with a scientific approach; H_1 = The average mathematical creative thinking ability of students taught with an open ended approach is higher than the average mathematical creative thinking ability of students taught with a scientific approach

Criteria of Influence: 1) The average value of mathematical creative thinking ability of students taught using open ended approach is higher than students taught with scientific approach. 2) The test results$-t$ ($t - test$) test results show that there is a significant difference between students' mathematical creative thinking ability in the experimental class taught using the open ended approach and the control class taught using the scientific approach. So there is an effect of open ended approach on students' mathematical creative thinking ability.

RESULTS AND DISCUSSION

Descriptive analysis of the posttest results showed the mathematical creative thinking ability of students in class VIII-7 (experimental class) and VIII-10 (control class) of SMP Negeri 9 Kendari, with the following data.

Table 4. Results of Analysis of Students' Mathematical Creative Thinking Ability.

Descriptive Statistic	Experiment Class	Control Class
N	37	35
Mean	70,89	62,57
Std. Deviation	19,317	19,838
Variance	373,155	393,546
Minimum	25	25
Maksimum	100	100

The posttest results showed that the experimental class taught with the open ended approach had a higher level of mathematical creativity compared to the control class taught using the scientific approach. The distribution of posttest scores for students' mathematical creative thinking ability in both groups can be seen in Table 5.

Table 5. Distribution of Student Mathematical Creative Thinking Ability Test Results

Category	Open Ended Approach		Scientific Approach	
	Percentage (%)	Frequency	Percentage (%)	Frequency
Very Uncreative	0	0,00	0	0
Not Creative	3	8,11	4	11,43
Creative Enough	9	24,32	11	31,43
Creative	12	32,43	9	25,71
Very Creative	13	35,14	11	31,43
Total	37	100	35	100

A data distribution diagram showing students' ability to think creatively can be made based on the information contained in table 5 as shown in the figure below.

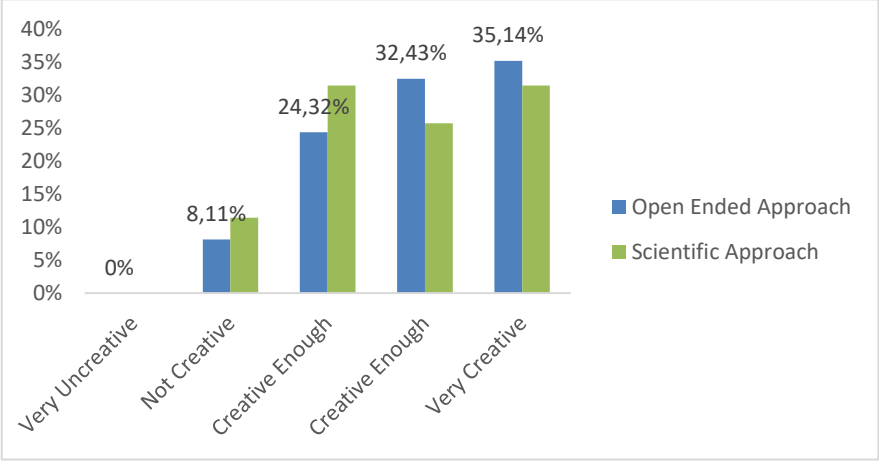

Figure 1. Data Distribution Diagram of Mathematical Creative Thinking Ability

From the analysis of the posttest results of students' mathematical creative thinking skills using the Kolmogorov-Smirnov test, the following results were obtained:

Table 6. One-Simple Kolmogorov-Smirnov Test Normality Test Results

Data	Experiment Class	Control Class
Asymp. Sig. (2-tailed)	0,362	0,519

The table 6 shows that the Kolmogorov-Smirnov normality analysis for creative thinking skills in the experimental class and control class respectively obtained a sig value. 0.362 and 0.519, which are greater than 0.05. This indicates that the data related to creative thinking ability is normally distributed.

Table 7. Lavene Statistic Homogeneity Test Results

Sig.	Decision
0,098	Accept H_0

Both data on creative thinking ability are homogeneous, as shown by the homogeneity of variance table, where sig. = 0,098 > 0,05. Thus, parametric statistical analysis can be used for the data analysis technique used to observe the effect of open ended approach on creative thinking ability; in this case, t-test is used to see the effect.

Table 8. Independent Sample T-Test Analysis Results

t hitung	$\frac{Sig.}{(2-Tailed)/2}$	Decision
1,803	0,038	Reject H_0

The results of Independent Sample T-Test showed sig value = 0.038 <0.05, which means the average mathematical creative thinking ability of students taught with open ended approach is higher than students taught with scientific approach. This indicates that the open ended approach has a positive influence on students' mathematical creative thinking skills.

Data on how the teacher managed the class as well as the students who participated in the learning process in the experimental class were collected for six meetings. Based on the observation sheet, the teacher admitted that the implementation of the open ended approach was a challenge. As a result, some steps in the learning process could not be completed by the teacher. Since students were not familiar with this approach, teachers faced time constraints and challenges at the beginning of the implementation. Students' inability to solve problems and teachers' limitation to visit each group to provide help and guidance caused teachers to often find problems that students could not solve properly. As a solution, the teacher will explain the problem-solving process on the blackboard if students have difficulty in solving the problem.

The first meeting in the experimental class the teacher motivated the students about the importance of the topic to be taught today, reminded them about the learning materials, and kept the class focused and comfortable. After that, the teacher outlines the learning objectives and steps and reminds students about the open ended learning approach that will be used. In the core activities, the teacher divided students into several heterogeneous groups and gave a general explanation of the material to be discussed. Next, the teacher asked stimulating questions and distributed LKPDs designed to help students understand the material better. The LKPD contains open-ended problems that are discussed in groups and presented in front of the class. During the discussion, the teacher helps students understand the problem and offers assistance as needed. After the group finishes working on the LKPD, they present the results

of their discussion in front of the class, while other students provide responses and the teacher supervises and guides the process.

In the closing activity, the teacher will evaluate the material that has been learned, and together with students will draw conclusions. The teacher also gives assignments or homework to students and reminds the material that will be discussed at the next meeting. From the second to the last meeting, the teacher continues to improve the teaching method and manage time well. The students' activity level in learning with the open ended approach increased as the six meetings progressed, although at the first meeting they were less enthusiastic and had difficulty adapting to the method. Some students felt shy, hesitant, and less active in working together in teams, and had difficulty explaining the reasons for choosing the way to solve the problem. (Kadir et al., 2022) stated that students' mathematical creative thinking skills were moderate, with results that were not maximized. However, research by (Wanelly & Fauzan, 2020) and (Handayani, 2018) showed that the open ended approach can improve students' creative thinking and mathematical communication skills better than conventional learning. These findings suggest that despite initial challenges, the open ended approach has the potential to improve students' overall mathematical creative thinking ability.

Students who were initially less active became more enthusiastic in subsequent meetings after the difficulties encountered could be overcome gradually. It can be seen from the student activity observation sheet that shows an increase in student activeness at each meeting. Although there are still obstacles, with the teacher's instructions and assistance, students begin to understand well the open-ended problems. Students are accustomed to working on open-ended problems in order to stimulate students' creative thinking to be able to express their ideas more easily, use various methods flexibly, show ideas that are different from others, develop and detail the ideas presented. In addition, they are also more courageous to explain the results of their work or give responses. In the first to last meeting, students' activeness and spirit of responsibility in the group were better than before, and students were used to doing open-ended evaluation tasks.

This study analyzed the mathematical creative thinking ability of students in two groups of classes, namely the experimental class using the open ended approach and the control class using the scientific approach. The results showed that students in the experimental class had better creative thinking skills than the control class. In the experimental class, most students fell into the creative and very creative categories, while in the control class, the distribution of students was more evenly distributed in the moderately creative, creative, and very creative categories, but with a smaller number of students in the very creative category. This finding is supported by research conducted by (Dewi & Juandi, 2023), as well as (Situmorang, 2022) who also found a positive effect of open ended approach on students' mathematical creative thinking ability.

Statistical tests showed that the data on students' creative thinking skills were normally distributed and the variance between groups was homogeneous. The Independent Sample T-Test results showed a significant difference between the two groups, which concluded that the open-ended approach had a positive effect on students' mathematical creative thinking skills.

CONCLUSION

Students who participated in learning with the open ended approach showed better mathematical creative thinking skills compared to students who used the scientific approach. Most of the students in the experimental class with the open ended approach showed creative to very creative abilities, while in the control class, the distribution of students was more evenly distributed across different categories of creativity. These findings suggest that the open ended approach has a positive effect on students' mathematical creative thinking skills.

This approach can be an effective strategy for teachers to stimulate and improve students' creative thinking skills in mathematics learning.

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