International Journal of Multicultural and Multireligious Understanding

http://ijmmu.com
editor@ijmmu.com
ISSN 2364-5369
Volume 12, Issue 4
April, 2025
Pages: 28-39

The Effect of Mathematics Learning with an Open-ended Approach Assisted by the Geogebra Application on the Mathematical Creative Thinking Ability of Junior High School Students

M. Syarif Hikmatuloh; Syukrul Hamdi; Elly Arliani

Department of Mathematics Education, Yogyakarta State University, Indonesia

http://dx.doi.org/10.18415/ijmmu.v12i4.6668

Abstract

The purpose of this study is to describe the influence of the open-ended approach assisted by geogebra application in improving students' creative thinking skills. The type of research used is experimental research with a research design, namely one group pretest-posttest design. The results showed that there was a significant influence of the application of the open-ended approach assisted by the geogebra application on students' mathematical creative thinking skills with a pretest percentage of 16.7% and a posttest percentage of 64.3% which showed an increase based on the treatment given. This is suspected because in the implementation of an open-ended approach, the geogebra application is able to build new knowledge from relevant previous learning experiences through the process of investigating, explaining and collaborating to find problem solving.

Keywords: *Creative Thinking; Open-Ended Approach; Geogebra Application*

1. Introduction

Mathematics is an illmu that has an important role in the field of education. Mathematical science is inseparable from the many formulas that must be memorized and understood by students. However, the limitations of students' memory make them only memorize formulas that are considered meaningful. Therefore, students cannot rely only on existing memory, but must improve their thinking skills (Ahmadi et al., 2013). One of the thinking skills that must be improved is the ability to think creatively. Mathematics as one of the lessons that helps to develop creative thinking skills. With high creative thinking skills, of course, it will stimulate students to solve math problems not only in one way but also find another way where the results obtained can be ascertained to be valid. So students must be able to think creatively which is very helpful in solving math problems.

The relationship with creativity is increasing among educators and researchers. This is due to the fact that the 21st century with its increasingly advanced technology has caused many fundamental differences in the way of human life. As a consequence, creative people are required to respond to these uncertain differences (Piirto, 2014). Creative products in every aspect of life are expected to provide solutions to every problem that arises due to these differences. Thus, creativity has become one of the

important learning skills in this 21st century. In the Indonesian context, creativity has also become the focus of learning that has been applied in all subjects, including mathematics. It was stated in the 2006 curriculum that mathematics learning should provide students with logical, critical, analytical, and creative thinking skills (Departemen Pendidikan Nasional, 2006). Furthermore, in the 2013 curriculum document, creative thinking is also stated in mathematics learning (Kementerian Pendidikan dan Kebudayaan, 2013). In the independent curriculum, it also implements what is called a profile to strengthen the profile of Pancasila students. The Pancasila student profile consists of six dimensions, one of which is the creative dimension. The creative dimension means that students are able to modify and produce something original, meaningful, useful, and impactful, where the key elements of creativity consist of producing original ideas and producing original works and actions and having flexibility to think in finding alternative solutions to problems (Badan Standar Kurikulum Dan Asesmen Pendidikan Kementerian Pendidikan Kebudayaan Riset, 2024). Because its complexity shows how important the creative abilities that students must have.

Standard definitions of creativity tend to focus on the conception of creativity as something 'new and valuable' or 'new and precise' (Pope, 2005). The viewpoint about creative thinking Runco, (2007) should be in the ideas given to solve problems. Creative thinking can be interpreted as the ability to get something new. In this study, creative thinking means that students are able to find various ways or possible answers in solving mathematical problems. The possibilities that occur can be in the form of students thinking using one way of many answers, many ways of one answer or many ways of many answers. Silver, (1997) mentioned that there are three indicators of creative thinking ability, namely fluency, flexibility and novelty. (1) Fluency is the ability of students to make diverse and correct answers in solving problems. (2) Flexibility, which is the ability of students to solve problems in a variety of different ways. (3) Novelty is the ability of students to make various different (new) answers in solving problems. Novelty refers to the answers submitted by students of less than 10% (Prayitno et al., 2023). Learning must involve students more actively in the problem-solving process. Teaching creative thinking can help the younger generation to develop the ability to do difficult jobs and overcome increasingly complex local and global challenges.

2. Statements of the Problem

Research reveals that in mathematics learning, teachers and students are still difficult in developing the ability to think creatively (Al-Abed, 2023, Hardiyanti, 2025). Teachers rarely give questions that train students to develop creative thinking skills because they only see the results without the process that students go through. Many students still find it difficult to learn mathematics. In this case, there are many changes in the world of education where students are encouraged to find out from various sources or study materials and not to be informed. Learning that used to be teacher-centered is now a student-centered learning approach. This is in accordance with the demands of future learning where students can develop their mindset openly according to their respective abilities. Therefore, a learning approach is needed to develop this mindset, one of which is *the open-ended* approach.

The open-ended approach Shimada & Becker, (1997) is based on giving more flexibility to students to gain more knowledge, discovery experience, recognize and solve problems because this approach helps students in solving a problem with different methods and more than one solution. Thus students will be more creative in finding solutions to problems. The types of questions used in learning with an open-ended approach are non-routine questions and open-ended problems (Rachmawati et al., 2023). The open problems are grouped into three types, including: (1) solving problems in various ways, (2) solving problems that have varied answers, (3) developing problems by changing the conditions of previous problems (Putri, 2017). Fatah et al., (2016) Learning with *an open-ended approach* is better in improving students' mathematical creative thinking skills even though it is reviewed from different school categories.

Open-ended questions are still rarely presented by teachers in learning. One of the materials that can be developed into open problems in mathematics is to build a flat-sided space. However, in reality, students with high, medium and low levels of mathematical ability experience difficulties in: (1) determining mathematical models in solving correctly presented problems, (2) determining concepts and strategies in solving problems and (3) understanding mathematical problems (Fatimah & Purwasih, 2020). Build a flat-sided space has a variety of solutions in determining the answer. Therefore, students can use their mathematical creative thinking skills in determining the answer to the problem of building a flat-sided space. Building a flat-sided space has been given since elementary school and has been studied in grade VIII of junior high school. By giving open questions, students can determine various ways to solve them.

Along with the development of the times, the use of information and communication technology is growing rapidly. The geogebra application can be used as an aid in mathematical materials such as geometry, algebra, and calculus (Eviliasani et al., 2022). One of the media that plays an important role in developing creative thinking skills is GeoGebra (Sugandi et al., 2021). GeoGebra offers several benefits in various mathematics learning activities as a medium for demonstrating, visualizing, and constructing abstract concepts (Hohenwarter et al., 2004). Unlike the use of commercial software that can usually only be used in schools, geogebra can be installed on personal computers and used anytime and anywhere by students and teachers. For teachers, geogebra offers an effective opportunity to create an interactive learning environment that allows students to explore a variety of mathematical concepts. As in the research conducted by Yullah et al., (2022) the presentation of problems using geogebra can help students in identifying and solving problems and attract students' interest because geogebra provides a quick response process to students.

Based on previous research conducted by Meltedi Safutra, (2021) providing results that there is an influence of the open-ended learning method on the mathematical creative thinking ability of grade VII students. This research is very important because considering that learning in the current era requires students to think creatively, one of the benefits of creativity is stress reduction (Runco, 2007), as well as being able to develop an open mindset in solving a problem. Research conducted by Jasiah et al., (2023) shows that the use of geogebra applications is able to improve students' creative thinking skills because it can help students to develop their creative thinking skills in solving various types of problems given.

Therefore, based on the description seen based on data from previous research and the relationship between *the open-ended* approach, and creative thinking ability, the researcher conducted a study entitled 'The Influence of Mathematics Learning with *an Open-ended Approach* Assisted by Geogebra on the Creative Thinking Ability of Junior High School Students'.

3. Research Questions

How does *the open-ended* approach assisted by the GeoGebra application affect students' creative thinking skills?

4. Hypothesis

Based on the above research question, the following hypothesis is formulated to predict the influence of the geogebra-assisted open-ended approach on the creative thinking ability of junior high school students:

$H_0: \mu_1 = \mu_2$: There was no significant difference between the average *pretest* and *posttest scores* of students' creative thinking skills

$H_1: \mu_1 \neq \mu_2$: There was a significant difference between the average pretest and posttest scores of students' creative thinking skills

5. Research Methodology

5.1 Research Design

The research design carried out was *a one-group pretest-posttest design*, which is an experimentalresearch conducted on only one group and no stability and clarity test of the group's condition was carried out before being treated. The research design *of one group pretest-posttest design* was measured using *a pretest* that was carried out before being given treatment and *a posttest* that was carried out after being given treatment. The following one *group pretest-posttest design scheme* is shown in the following table.

Table 1 One *Group PreTest-PostTest Design Scheme*

Before Treatment	**Treatment**	**After Treatment**
Pretest		***Posttest***
A	X	B

Table 1 shows that in stage A, the researcher gave a pretest to the class that would receive X treatment, namely mathematics learning with an open-ended approach. Furthermore, in stage B, the researcher gave a posttest to the same class after receiving X treatment.

5.2 Settings

This research was carried out in the odd semester of the 2024/2025 school year. The place of this research was carried out at SMP Negeri 12 Yogyakarta which is located at Jl. Tentera Siswa No.9, Bumijo, Kec. Jetis, Yogyakarta City, Special Region of Yogyakarta 55272

5.3 Participants of the Study and Sampling Technique

Population refers to a group of individuals with certain traits and characteristics selected by researchers for research purposes and drawing conclusions (Sugiyono, 2017). The population in this study is all grade VIII students of SMP Negeri 12 Yogyakarta with a total of 180 students divided into six classes. The sampling technique used is *Non-Probability Sampling* with the type selected, namely *Random Sampling*. This study took a sample of 30 students consisting of class VIII A.

5.4 Instruments and Data Collection

In general, data collection is a strategic step in research because the main purpose of the research is to obtain data to meet the standards that have been set in answering the formulation of the problems expressed in the research (Sari *et al*., 2022: 18). This research uses data collection techniques in the form of documentation, and tests.

a. Documentation Techniques

Documentation techniques are a way of collecting data by recording or retrieving data that already exists in documents or archives (Djaali, 2021).

b. Test Techniques

Djaali, (2021) According to the test, it is a systematic procedure that is made in the form of standardized structured tasks, then given to individuals or groups that become the unit of analysis to be

done, answered, or responded to in the form of written, oral, or deeds. The test method used in this study is to measure students' creative thinking skills.

In this study, the instrument used to obtain data is in the form of a mathematical creative thinking ability test. The mathematical creative thinking ability test used in the building material of the flat-sided space is in the form of a description test that the researcher designed by himself by paying attention to the basic competencies and indicators of competency achievement in the building material of the flat-sided space. This creative thinking ability test is used to measure students' ability to think creatively before and after being given treatment. The test before being given treatment aims to find out the student's initial ability. Meanwhile, the test given after the treatment aims to determine the success of students in learning

5.5 Data Analysis

In this study, the calculation to test the hypothesis of this study can use *the t sample dependent test.* The t-test is used to partially test the influence between independent variables and dependent variables. The calculation process uses the help of the JASP program.

6. Normal Distribution of Data

Table 2 Results of the normality assumption test using Shapiro-Wilk in the experimental class

CLASS	Statistical Results	Decision
Pretest creative thinking skills	0,063	Usual
Posttest creative thinking ability	0,055	Usual

Table 2 above identifies the data in the experimental class. The normality test with a significance level of 5% in the experimental class for *the pretest* of creative thinking ability of 0.063 means that H_0 is accepted, for *the posttest* it is also 0.055 means that H_0 is accepted. So it can be concluded that the *pretest-posttest data* of creative thinking skills in the experimental class came from a normally distributed population.

7. Results and Discussion

The data from *the pretest* and *posttest* results of creative thinking skills from the experimental class will be presented in the following table.

Table 3 Results *of Pretest* and *Posttest* of Creative Thinking Ability

Description	**Experimental classes**	
	Pretest	***Posttest***
Grade point average	2	7,8
Percentage (%) of value	16,7	64,3
Standard deviation	1,34	1,93

Based on the results of the descriptive analysis in table 3 above, it can be seen that the experimental class has increased. In the experimental class, the average percentage of students' initial ability to think creatively was 16.7. After being given treatment in the experimental class, the average creative thinking ability increased by 47.6 points. So that the average score of the student posttest percentage is 64.3.

In addition, to see the percentage improvement between pretest and posttest on creative thinking skills for each indicator, it can be presented in the following table.

Table 4 Percentage Increase Between Pretest and Posttest on Creative Thinking Ability for Each Indicator

Indicators	Pretest (%)	Posttest (%)	Increased
Fluency	36,6	86	49,4
Flexibility	15,0	70	55
Novelty	1,5	12,1	10,6

Based on table 4 above, the overall indicators of creative thinking ability have increased from *pretest* to *posttest*. The highest increase was in the *flexibility* indicator of 55%, followed by *the fluency* indicator of 49.4%, then the *novelty* indicator of 10.6%.

8. Descriptive Statistics

A hypothesis test was carried out to determine the influence of learning using an *open-ended approach* assisted by the geogebra application on students' creative thinking skills.

Table 5 Average Score of Students' Creative Thinking Ability

Many Students	*Pretest*	*posttest*
22	2	7,8

The results of the calculation in table 5 above show that the average *posttest* The experimental class obtained 7.8 higher than the average *pretest* The experimental class is 2. The data will be used to test the influence criteria that have been set. The influence can be seen from the results of the calculation of the value of students' creative thinking ability using the *Paired sample t test* with the help of the JASP program.

The results of the test of creative thinking ability with *the paired sample t test* with the help of JASP are shown in the following table:

Table 6 Results of the Paired Sample T Test of Creative Thinking Ability of Experimental Class Students

Class	Mean	T count	Table	P value	Significant Level	Decision
VIII A	-5,72	-12,8	- 1,72	< 0.001	5% = 0.05	H_0 rejected

Table 6, shows the results of the paired sample t test obtained a calculated t value = -12.8 < -1.72 and a p value of < 0.001. Because the p value < 0.05, it was rejected, meaning that there was a significant difference H_0 *in the average pretest* score from the average *posttest* score of the experimental class students. So it can be concluded that learning that uses *an open-ended* approach assisted by geogebra applications has an influence on students' creative thinking skills.

9. Discussion

Educators are constantly changing learning methods to ensure that students can develop skills and knowledge that are relevant to the demands of the times. Therefore, innovation in learning is an unavoidable need. The application of learning innovation is an effort to realize meaningful learning for students. In this context, *the open-ended* approach assisted by the geogebra application is used as a

promising innovation in increasing the effectiveness of mathematics learning. This approach not only emphasizes the assignment of mathematical concepts, but also on the discovery or use of many solutions in solving problems.

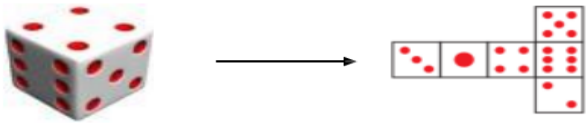
The assessment of students' creative thinking skills is seen in the results of *the students' pretest* and *posttest*, then calculations are carried out with *the paired sample t test*. The results of *the pretest* represent the students' initial abilities before being given treatment in the form of *an open-ended approach* assisted by geogebra. Meanwhile, the results of the *posttest* show the ability of students after being given treatment. The assessment is carried out with an essay test sheet. Based on the results of the hypothesis test that has been described previously, it is concluded that *the open-ended approach* assisted by the geogebra application has an influence on students' creative thinking ability. Based on the results of the *paired sample t test*, in the data of creative thinking ability, the t calculation was obtained of -12.8 less than the t table which is -1.72, indicating that there is a significant difference between the average score *of the pretest* and the average *posttest* of students' creative thinking ability in class. So it can be concluded that learning that uses *an open-ended* approach assisted by geogebra applications has an influence on students' creative thinking skills.

This shows that the results of the hypothesis can be said that *the open-ended approach* assisted by the geogebra application has a significant influence on students' creative thinking skills. In addition, the average score of the *posttest* is higher than the average score of *the pretest* of creative thinking ability. The improvement of creative thinking skills is allegedly influenced by the learning innovations used, namely the *open-ended* approach assisted by the geogebra application. This is in line with the opinion that Rochmanto, (2014) *the open-ended* approach is one of the approaches that helps students solve problems creatively and appreciate the diversity of thinking that may arise while working on problems. Then the research Turmudi et al., (2016) shows that the application of the open-ended approach is able to improve students' creative thinking skills both in schools with high, medium, and low categories. The open-ended approach assisted by GeoGebra has no significant effect when considering the characteristics of the study, sample size and level of education (Rachmawati et al., 2023). In addition, students also discuss in their groups to solve problems so that they can complement each other's thinking which allows the emergence of many ideas that can develop students' creativity in thinking. This is in accordance with the opinion Agustang, (2022) that the application of open-ended learning improves students' creative thinking skills, by providing the freedom to express creative ideas in problem solving. Furthermore Huda, (2014), the collaboration of students' thinking results allows more ideas or ideas to emerge so that they can open the horizons of students' thinking creativity, so in improving students' mathematical creative thinking skills can be supported by group or cooperative learning.

The improvement of creative thinking skills is suspected because in the implementation of *the open-ended* approach assisted by the geogebra application, it is able to build new knowledge from relevant previous learning experiences through the process of investigation, explanation and collaboration to find problem solving. Thus, it can be concluded that *the open-ended* education approach assisted by the geogebra application has an influence on improving students' creative thinking skills.

When given *a pretest*, most students have not been able to solve problems optimally. Questions that are considered easy with *fluency*, *flexibility* and *novelty* indicators are still not answered correctly by all students. The following is a snippet of pretest question number 1.

1. Perhatikan gambar berikut

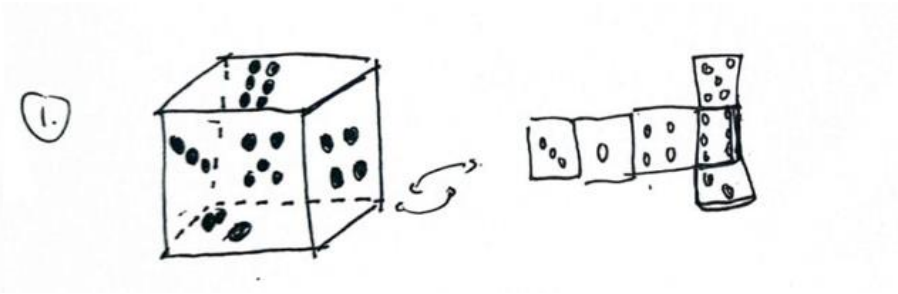


Dadu adalah bangun ruang berbentuk kubus dengan anka khusus, dimana aturannya bahwa jumlah dari titik-titik yang terdapat pada dua sisi yang berhadapan selalu berjumlah 7.
Dari pernyataan keterangan tersebut, cobalah kalian buat minimal 3 jaring-jaring dadu yang berbeda, yang mana jika dilipat membentuk kubus memenuhi aturan bahwa titik pada sisi yang berhadapan berjumlah 7!

Figure 1 Pretest Question Number 1.

To be able to answer number 1, students only need a strong understanding of mathematics and the ability to think creatively. So that students only need to understand what is meant in the question and be able to read the information contained in the picture. Next, Figure 14 will show one of the snippets of students' answers to pretest question number 1

Figure 2 Students' Answers to *Pretest* Question Number 1



Based on the image above, it shows that the students' answer model has not been able to explore their knowledge so that the answers given are still lacking for the creative category. Only a few students were able to give a variety of answers. Some students answered by giving various shapes, but the placement of numbers to produce the number 7 is still many who are wrong or even do not put the numbers on the dice nets.

Furthermore, the image will show a snippet of question number 2 *pretest* creative thinking skills.

2. Seorang pelajar memiliki kotak alat tulis di meja belajarnya yang berbentuk balok. Jika panjangnya 18 cm, lebar 10 cm, dan tingginya 15 cm, tentukanlah:
   a. Berapakah luas permukaan kotak alat tulis tersebut?
   b. Gunakan cara yang lain (selain cara a) untuk menentukan luas permukaan dari kotak alat tulis tersebut!

Figure 3 Question Number 2 Pretest

To be able to answer question number 2, students need to understand what is meant in the question and be able to read the information contained in the picture. The ability to think creatively allows students to look at problems from various perspectives and find new approaches in solving mathematical problems. Likewise in question number 3 which requires students to know the concept and formula of the

building volume of the flat side space. The following is a snippet of the students' answers to the questions *pretest* number 2 and 3 of the experimental class.

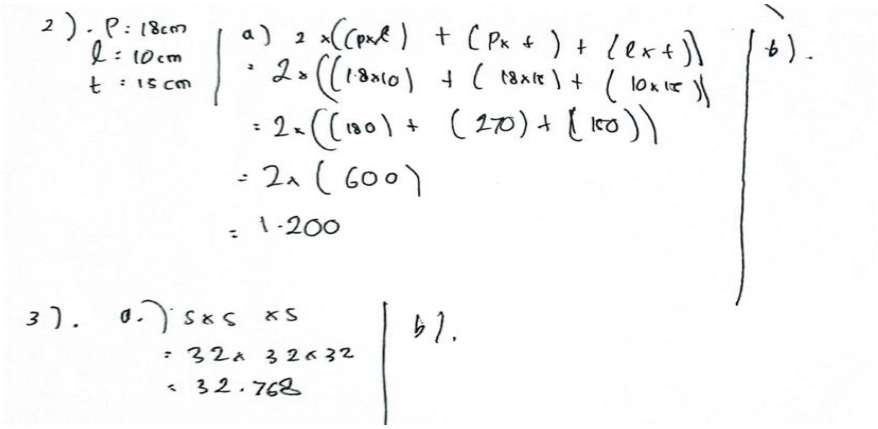


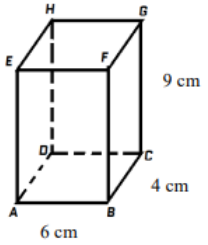
Figure 4 Students' Answers to Pretest Questions Number 2 and 3

In questions number 2 and 3, in the process some students are still not able to answer it and only a few students answer correctly. Students are still lacking in remembering formulas, lack understanding of the concept of building a flat-sided space, and lack understanding of what the problem wants. So that only a few students answered and the answers were incomplete and still did not find alternative answers. So that students are still very lacking in creative thinking skills.

After being treated, students were given *a posttest* to re-measure their mathematical creative thinking skills. In this *posttest question*, almost all students in the experimental class have been able to answer correctly. This can be seen in the posttest score, creative thinking skills are improved and students are improved in understanding the questions so that they are able to correct previous mistakes during *the pretest*.

Furthermore, it will be explained about the creative thinking ability of students after being given treatment, a test that can measure students' creative thinking ability is held again by conducting *a posttest*. Here's a snippet of *posttest* question number 2.

2. Diketahui balok ABCD.EFGH sebagai berikut. Tentukanlah!



a. Hitunglah volume balok ABCD.EFGH!
b. Gambarlah bangun ruang sisi datar lain yang memiliki volume yang sama dengan balok ABCD.EFGH tersebut!
c. Tulislah ukuran dan hitunglah volume dari bangun ruang sisi datar b!
d. Gambarlah bangun ruang sisi datar lain/berbeda dari balok ABCD.EFGH dan hasil b yang memiliki volume yang sama dengan bangun ruang ABCD.EFGH!
e. Tulislah ukuran dan hitunglah volume dari bangun ruang sisi datar d!

Figure 5 Snippet of *Posttest* Question Number 2

To be able to answer number 2, students need to understand and be able to think creatively on the questions and be able to read the information contained in the picture. Likewise with questions number 1 and 3. The following is a snippet of the students' answers to posttest question number 2.

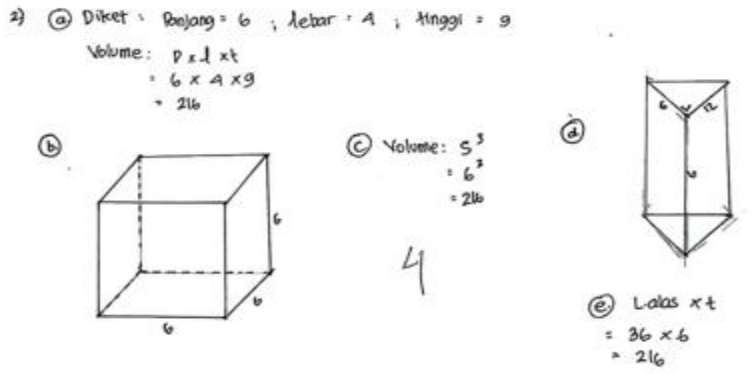


Figure 6 Snippet of student answers in *posttest* question number 2

In the figure, students have shown their creative thinking skills on *fluency, flexibility*, and *novelty indicators*. Students have good *fluency* who are able to quickly and smoothly draw other flat figures based on the information provided. To meet the fluency indicator, students only need to have the ability to generate ideas or solutions quickly and without hindrance. Fluency indicators are not related to the complexity of the solutions produced, but rather how smoothly and quickly students can come up with ideas or solutions in a particular context.

To meet the flexibility indicator, students only need to have the ability to use a variety of different approaches or strategies in solving a given problem. This means that students must be able to change their approach or try a different method if the method they first tried doesn't work or doesn't fit the situation. In the context of the above questions, flexibility can be shown by the ability of students to create different flat shapes and determine their volume. Meanwhile, to meet the originality indicator, students need to have the ability to produce new, unique, or creative ideas or solutions in solving a given problem. They not only follow existing patterns or methods, but are also able to think outside the box and create something different or innovative. Students need to have the ability to think creatively, create new or unconventional solutions, and demonstrate the ability to look at problems from different perspectives. Students can create different flat shapes and determine the volume where the answer is included in the same and correct 3 student answers.

10. Conclusion

Based on the results of data analysis and discussion in the previous chapter, with a significance level of 5% and the results of the calculation of $T_{calculation}$ = -12.8 with T_{table} = -1.72, it can be concluded that learning using *an open-ended* approach assisted by the geogebra application has a significant influence on the creative thinking ability of grade VIII students of SMP Negeri 12 Yogyakarta. With a pretest percentage of 16.7% and a posttest percentage of 64.3% which shows an increase based on the treatment given. Then for the indicator that experienced the highest increase was the flexibility indicator while the lowest increase was the *fluency indicator*.

This study has limitations, namely there are other variables that affect the results of research that cannot be controlled by researchers, including the student learning environment, student learning style, and the time of research implementation. Then some students have minimal initial abilities so it is difficult to follow the lesson well. This is due to the lack of understanding of mathematics in most students, even almost all of them. Furthermore, student conditions that cannot be controlled by researchers such as student attendance in participating in lessons where not all students can take part in the lesson optimally.

11. Implication

Based on the results of data analysis, discussion and conclusion in this study, the implications of the results of this study are obtained, namely *the open-ended* approach assisted by geogebra application can be used as an alternative learning to improve students' creative thinking skills. This learning can be used as innovative learning to improve student achievement in mathematics learning.

References

Agustang, A. (2022). *Teacher's Strategy for Increasing Students' Creative Thinking Ability Through Open-Ended Learning in Elementary Schools*. *7*(1). https://doi.org/10.26618/jed.v%vi%i.6838.

Ahmadi, Johan, A., & Kurniasari, I. (2013). *Identifikasi Ttingkat Berpikir Kreatif Ssiswa dakam Memecahkan Masalah Materi Persamaan Garis Lurus ditinjau dari Kemampuan Matematika Siswa dan Perbedaan Jenis Kelamin*.

Al-Abed, M. Z. M. (2023). The Role of Creative Thinking in Facing the Difficulties of Gifted Students from the Point of View of Basic Stage Teachers. *Jordanian Educational Journal*. https://doi.org/10.46515/jaes.v8i4.454.

Badan Standar Kurikulum Dan Asesmen Pendidikan Kementerian Pendidikan Kebudayaan Riset, D. T. R. I. (2024). *Projek Penguatan Profil Pelajar Pancasila*. Kemendikbud.

Departemen Pendidikan Nasional. (2006). *Standar Isi Kurikulum Tingkat Satuan Pendidikan*. Depdiknas.

Djaali. (2021). *Metodologi Penelitian Kuantitatif*. Bumi Aksara. https://books.google.co.id/books?id=wY8fEAAAQBAJ.

Eviliasani, K., Sabandar, J., & Fitriani, N. (2022). Problem-Based Learning Assisted by GeoGebra to Improve Students' Mathematical Understanding. *AL-ISHLAH: Jurnal Pendidikan*, *14*(1), 85–98. https://doi.org/10.35445/alishlah.v14i1.1092.

Fatah, A., Suryadi, D., Sabandar, J., Raya Jakarta Km, J., & Serang Banten, P. (2016). Open-Ended Approach: An Effort In Cultivating Students' Mathematical Creative Thinking Ability And Self-Esteem In Mathematics. *Journal on Mathematics Education*, *7*(1), 11–20.

Fatimah, A., & Purwasih, R. (2020). *Analisis Kesulitan Siswa SMP di Islamic Boarding School dalam Menyelesaikan Soal Pada Materi Bangun Ruang Sisi Datar*. *3*, 625–632. https://consensus.app/papers/analisis-kesulitan-siswa-smp-di-islamic-boarding-school-fatimah-purwasih/e281a4fde8dc574c819fdb55df065079/.

Hardiyanti. (2025). Teacher Creativity in Developing Primary School Students' Creative Thinking Skills. *International Journal of Teaching, 2(1)*, 80–85. https://ccg-edu.org/index.php/ijt/index.

Hohenwarter, M., Kepler, J., Fuchs, K. J., & Fuchs, K. (2004). *Combination of dynamic geometry, algebra and calculus in the software system GeoGebra*. https://www.researchgate.net/publication/228398347.

Huda, U. (2014). *Peningkatan Kemampuan Berpikir Kreatif Matematis Dan Habits Of Thinking Independently (HTI) Siswa Melalui Pendekatan Open-ended Dengan Setting Kooperatif*.

Jasiah, Mardiati, Helmi Ali, Nofri Yudi Arifin, Villia Anggraini, & Zainol Hasan. (2023). Pengaruh Penggunaan Aplikasi Geogebra terhadap Keterampilan Berpikir Kreatif. *Jurnal Pendidikan Tambusai, 7(2)*, 6550–6557.

Kementerian Pendidikan dan Kebudayaan. (2013). *Konsep dan Implementasi Kurikulum 2013 1 1*. Kemendikbud.

Meltedi Safutra. (2021). *Pengaruh Metode Pembelajaran Open Ended terhadap Kemampuan Berpikir Kreatif Matematis dan Self Efficacy Siswa Kelas VII*.

Piirto, J. (2014). *Creativity for 21st Century Skills: How to Embed Creativity Into the Classroom*. https://www.researchgate.net/publication/263374102.

Pope, R. (2005). *Creativity: Theory, History, Practice*. British Library Cataloguing in Publication Data.

Prayitno, S., Novitasari, D., Triutami, T. W., & Tyaningsih, R. Y. (2023). Creative Thinking Level of Students in Posing Conditional Probability Problems. *Jurnal Didaktik Matematika*, *10*(1), 17–33. https://doi.org/10.24815/jdm.v10i1.29016

Putri, O. R. U. (2017). *Pengembangan Buku Siswa Bercirikan Open Ended Mathematics Problem Untuk Membangun Berpikir Kreatif* (Vol. 2, Issue 1).

Rachmawati, A. D., Juandi, D., & Darhim, D. (2023). Examining the effectiveness of a GeoGebra-assisted open-ended approach on students' mathematical creative thinking ability. *Jurnal Elemen*, *9*(2), 604–615. https://doi.org/10.29408/jel.v9i2.16483.

Rochmanto. (2014). *Pengaruh Pendekatan Open Ended Terhadap Kemampuan Berpikir Kreatif Matematis Siswa*.

Runco, M. A. (2007). *Creativity: Theories and Themes: Research, Development, and Practice*. Elsevier Academic Press.

Shimada, S., & Becker, J. P. (1997). *The Open-Ended Approach: A New Proposal for Teaching Mathematics*. National Council Of Teachers Of Mathematics.

Silver, E. A. (1997). *Fostering Creativity through Instruction Rich in Mathematical Problem Solving and Problem Posing*.

Sugandi, A. I., Sofyan, D., Maesaroh, S., Linda, L., & Sumarmo, U. (2021). Efektivitas Pendekatan Induktif Deduktif berbantuan Geogebra terhadap Peningkatan Kemampuan Berpikir Kreatif Siswa pada Masa Pandemi. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(1), 367. https://doi.org/10.24127/ajpm.v10i1.3452.

Turmudi, T., Fatah, A., Sabandar, J., & Suryadi, D. (2016). Open-ended Approach: an Effort in Cultivating Students' Mathematical Creative Thinking Ability and Self-esteem in Mathematics. *Journal on Mathematics Education*, *7*, 9–18. https://doi.org/10.22342/jme.7.1.2813.9-18.

Yullah, A. S., Susanto, S., & Suwito, A. (2022). Efektivitas Model Pembelajaran Discovery Berbantuan Geogebra ditinjau dari Kemampuan Berpikir Kreatif Siswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(2), 1222. https://doi.org/10.24127/ajpm.v11i2.5010.