ISSN 2502-5872 (Print)
ISSN 2622-3627 (Elektronik)

Volume 8 Number 3, August 2023, 845-856

STUDENTS' CREATIVE THINKING ABILITY THROUGH OPEN-ENDED PROBLEM LEARNING

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ABSTRACT

One of the elements affecting students' success rates in the learning process is their capacity for mathematical creativity. According to survey findings, pupils still have a limited capacity for mathematical creativity in their learning, as evidenced by the markers of this capacity. This study sought to ascertain how adopting open-ended problem learning models affected students' mathematical and creative thinking skills. This study employs quantitative research and descriptive methodologies. This study employed a research design was quasi-experimental research. The investigation employed a posttest-only control group design. Students in class VII made up the study's population. Class VIIb and VIIc samples were used in this study. Class VIIc serves as the control class and follows a traditional learning approach while Class VIIb serves as the experimental class. Research strategies for gathering data take the shape of tests. t-test data analysis formula. Based on the one-sided test calculation results, it can be seen that the average mathematical creative thinking ability of students using the Open-Ended Problem learning model is higher than the average mathematical creative thinking ability of students using conventional learning models, meaning that there is an influence using the Open-Ended Problem learning model on students' mathematical creative thinking abilities. The study's overall conclusion is the Open-Ended Problem learning approach has an impact on students' mathematical and creative thinking skills.

Keywords: Mathematic Creative Thinking, Open-Ended Problem, Two-Dimentional Figure

How to Cite: Erprabowo, A & Caswita, C. (2023). Students' Creative Thinking Ability Through Open-Ended Problem Learning. *Mathline: Jurnal Matematika dan Pendidikan Matematika, 8*(3), 845-856. http://doi.org/10.31943/mathline.v8i3.456

PRELIMINARY

Education is a way to increase the knowledge acquired by formal and informal institutions to attract a skilled workforce (Aziizu, 2015). Education is the most important aspect in developing a good character in terms of relating, responding, acting, and thinking (Pradana, Fatimah, Rahmawati, Windya, & Erprabowo, 2023). In essence, education is an effort to instill principles that serve as a guide in carrying out daily activities. Education acts as a dividing line between past, present and future generations, whether they are qualitatively more advanced or more degenerate. Thus, it can be said that the progress and decline of a nation's civilization, both bad and good, is largely determined by the educational process carried out by that nation (Afsari, Safitri, Harahap, & Munthe, 2021).

There are many teaching professions in Indonesia, especially mathematics teachers.

Mathematics is a way to find an answer to the problem at hand, both in using information, information about shapes and sizes, computer information, and thinking about ourselves, how we see it and the relationships used. Mathematics appears as a result of human thought processes both in terms of ideas, processes and reasoning. All students must take math classes in order to build their capacity for logical, analytical, methodical, critical thinking, and collaborative work (Kusumawardani et al., 2018).

The Industrial Revolution 4.0, which took place throughout the 20th century, and the 21st century are closely intertwined demands more creative thinking and rapid technological development from humans. The capacity to think creatively can be improved through instruction and learning (Maskur et al., 2020). In learning mathematics there are students who have done it. Critical thinking and logical thinking and reasoning skills also require creative thinking skills so that others can develop and understand their mathematical creative ideas for others and can improve thinking skills and creative thinking (Moma, 2015).

Students' mathematical creative thinking skills are one of the expected mathematical competencies in schools (Afriyansyah & Putri 2014). The teaching and learning processes, particularly when it comes to learning mathematics, should pay more attention to the mathematical skills that students really need, which are limited to critical thinking skills, problem solving skills, mathematical relationships, mathematical reasoning abilities, and mathematical creative thinking skills (Fatwa et al., 2019).

Creative thinking is an activity that is carried out when someone proposes or generates a new thought, where the thought describes a combination of previous thoughts that have never been implemented (Juwita et al., 2019). Higher order thinking (HOT) is a process that includes the capacity for creative thought. One of the 2013 curriculum goals that students must meet is HOT (Gais & Afriansyah 2017). The capacity to come up with original, novel solutions to complex mathematical problems is referred to as mathematical creativity. Creative is a way of thinking that can create new styles, ideas, interpretations, creations, and works. The ability to think creatively depends on how students develop new thoughts (Septian, et al., 2019).

Putra et al., (2018) introduces five indicators in mathematical creative thinking, namely: 1) Fluency (implementation of different ideas); 2) Flexibility (smart foresight); 3) Originality (creating something new); 4) Completion (creating something from another idea); and 5) Evaluation (evaluation and implementation of ideas). This is in line with opinion Sariningsih, (2017) The capacity to generate many ideas (fluency), generate various ideas (flexibility), produce new products or ideas (originality), investigate the relationship between choices and alternatives, and evaluate and change are all related to the capacity to think creatively in mathematics. establishing new relationships, modifying and expanding plans or ideas, and changing outdated ways of thinking and habits.

In relation to attitudes towards students are learning maths as required to have good

fighting power in solving the problems they are facing. Additionally, students must have the mindset of appreciating the value of mathematics in life, which includes curiosity, focus, and excitement in learning the subject as well as being tenacious and confident when it comes to problem-solving. One of the attitudes that becomes an internal factor in influencing the success of someone learning mathematics is also called mathematical resilience (Hidayat, 2017; Nurmasari, 2014).

Ummah & Amin (2018) mentions that measurement of creative thinking can be done with three indicators namely fluency, flexibility and novelty. Fluency is the capacity to present numerous solutions to an issue. Flexibility is the ability to solve problems using several different methods or paths. Innovation is the ability to come up with various original solutions that have real value, or the ability to demonstrate answers, usually students lack the knowledge to solve problems. (Rozi & Afriansyah 2022).

However, the facts in schools prove that mathematical creativity among students abilities are very low, as explained in the findings Suparman & Zanthy (2019) states that the ability to think creatively is still weak. One of the weaknesses of the instruction provided by the teacher is the lack of effort to develop students' mathematical creative thinking abilities. Meanwhile, the capacity for thought must be increased in learning. Develop students' thinking skills by using facts or student experiences to solve problems presented as material. Learning is not only about students being able to master various learning materials provided by the teacher, but also about how students can develop their ideas and concepts. The development of ideas and concepts is based on the child's ability to describe the results of his observations of various facts and information he receives in everyday life (Nopitasari, 2017).

The poor ability of creative thinking is caused by students' mistakes in applying creative mathematical thinking which includes making mathematical models, seeing the suitability between the elements and concepts contained therein, and also errors when performing arithmetic operations. Evidenced by the findings of research done by Humaeroh (2016) which states that just one student out of 28 has the capacity to think creatively, whereas 17 students go into the less category and 10 students fall into the very less category. Changed in the form of a percentage, the sufficient category reached 3.57%, the low category reached 60.71, and the very poor category with a percentage of 35.71%.

Apart from the above, Octaviyani et al., (2020) explains the poor capacity for mathematical creativity due to learning in schools which usually only involves training in analytical thinking processes which are limited to verbal reasoning and logical reasoning. For students who are used to converging thinking and facing a problem, they find it difficult to solve problems creatively and make learning uncomfortable, especially when studying mathematics.

This issue may also be noticed in a Metro City school, where the majority of students still have scores lower than the minimal completeness standard (MCS), which is less than 72. Table 1

displays the findings from observations made at one of the junior high schools, regarding students mathematical creative thinking abilities as follows:

Table 1. Results of the Assessment of Students' Mathematical Creative Thinking Ability

No	Score	Categories	Amount	Percentage
1	≥ 72	Complete	10	31%
2	< 72	Not Complete	22	69%
		Amount	32	100%

Based on table 1 above, it was found that 69% of the total students still had scores below the minimum completeness standard (MCS). It can be concluded that the total number of students who complete is less than students who do not complete. The kids' limited capacity for mathematical creativity can be due to several factors, including the teaching and learning process which is still focused on the teacher and learning models that are not liked by students.

Teachers frequently employ the lecture technique, when pupils merely listen, during the learning process. Teachers often provide examples that demonstrate immediate solutions, but offer few opportunities for active participation, so students simply take notes. This situation reduces the activity and creativity of students. Based on the problems above, we need a learning approach that can overcome these problems. The designed learning approach is an approach that helps students build their knowledge and is able to create students to solve the problems they face. One approach that can improve creative thinking and student performance is an open approach (Utami et al., 2020).

Teachers frequently use the lecture method, in which students simply listen, to facilitate learning (Sa'dijah, Rafiah, Gipayana, Qohar, & Anwar, 2017). Firdaus et al. (2016) an open approach starts from the point of view of assessing students' high-level mathematical thinking abilities objectively. Although initially used to assess higher-order thinking skills, it has recently been found to improve the quality of learning. This approach begins by having students participate in an open-ended problem that is constructed to have multiple "incomplete" or "open-ended" correct answers. Besides that, Restanto and Mampouw (2018) explain that geometry material can be used to identify students' creative thinking skills.

Based on the problems and previous research that has been described above, it is found that there has been no research that examines the open-ended problem learning model for mathematical creative thinking skills in two-dimentional figure material, especially in triangles and rectangles. Therefore, this study aims to determine the effect of open-ended problem-based learning models on students' mathematical creative thinking abilities.

METHODS

This study employs quantitative research and descriptive methodologies. This study

employed a research design was quasi-experimental research. The investigation employed a posttest-only control group design. Open-ended problem learning is the unrelated factor (X) and The dependent variable here is the capacity for imaginative thought (Y). This research was conducted in April 2022. The participants in this study were all students class VII students of SMP Negeri 04 Metro for the 2021/2022 academic year which consisted of 8 classes with the following description:

Table 2. Distribution of Class VII Students of SMP Negeri 04 Metro

Class	The number of students
VII A	32
VII B	32
VII C	32
VII D	30
VII E	30
VII F	30
VII G	29
VII H	30

Cluster random sampling was employed to determine the sample in this research. Cluster random sampling is a technique for determining the sample when the item to be investigated or the data source is very large. So obtained class VII B serving as the experimental group and class VII C serving as the control group, where each class consisted of 32 students. The experimental class will be treated with an open-ended problem learning model, while the control group will be taught using traditional methods. This study employed a posttest-only control group design.

Data collection techniques used one methods that is tests, where the research tool was a test of mathematics creative thinking abilities. In the form of essay questions. The material used is two-dimentional figure material (Rectangles and Triangles). This material was chosen because it adapts to the material being studied by class VII students as the research sample. In addition, in this material it was found that students' creative thinking skills were still low. Mathematical creative thinking ability: 1) fluency, 2) flexibility, 3) originality, and 4) detail (detailing) and 5) Metaphorical thinking. By using validity tests, reliability tests, test difficulty levels, and test differentiation, the instrument is tested to prove whether the instrument is feasible to be tested.. As shown by the results of the instrument test in table 3 below:

Table 3. Instrument Test Results

No.	Validity Test	Reliability Test	Difficulty Level Test	Difference Power Test	Conclusion

No.	Validity Test	Reliability Test	Difficulty Level Test	Difference Power Test	Conclusion
1	Valid	Reliable	Hard	Good	Used
2	Invalid		Easy	Poor	Not Used
3	Valid		Hard	Medium	Used
4	Valid		Easy	Medium	Used
5	Valid		Moderate	Medium	Used
6	Invalid		Hard	Poor	Used
7	Invalid		Moderate	Poor	Not Used
8	Valid		Easy	Good	Used

Based on table 3 above, 5 questions were obtained which were used to determine students' creative thinking abilities. A preparatory test is performed before to testing the hypothesis. Here there are two pretests, namely the normality test and the homogenity test. Normality test using Kolmogorov-Smirnov because the number of samples used in this study was more than 30 students, and the Levene's test is used for homogeneity. After the data is tested and the required hypotheses are met (normality and homogenity), hypothesis testing is possible. The t test was employed to assess the hypothesis in this study.

RESULT AND DISCUSSION

The acquired data will be subjected to a preliminary test before being subjected to the hypothesis test. The normalcy test is the first necessary test. The Kolmogorov-Smirnov Test is used to determine normality test. Table 3 shows the results of the normality test:

Table 4. Kolmogorov-Smirnov Test Results

Class	Kolmogorov-Smirnov		
	Statistic	**df**	**Sig.**
Exsperiment	0,097	32	0,200
Control	0,100	32	0,200

Based on table 4 above, the results of the Shapiro Wilks test > 0.05 mean that both classes are normally distributed**.** That is, It can be concluded that students' mathematics creative thinking talents in the experimental and control groups derive from typically dispersed populations (H_0 is accepted).

The second prerequisite test is the homogeneity test. Levene's test was utilized in this work as a statistical test. Table 4 displays the results of the Levene's test:

Table 5. Levene's Test Results

Class	Levene's Test	df1	df2	Sig.
Mathematical Creative Thinking	0,111	1	62	0,741

It can be seen in Table 5 above, that all significance values are > 0.05 for both the experimental and control groups. As a result, it is possible to conclude that all data is homogeneous.

After all the required prerequisite tests have been met, it can be continued with the independent sample t test. Table 5 displays the results of the independent sample t-test:

Table 6. Independent Sample T-Test Results

	Levene's Test		t-test for equality of means				
	f	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference
Mathematical Creative Thinking	0,111	0,741	3,042	62	0,03	13,90625	4,57139

It is shown in Table 6 above, that the Levene's test results are the same as the Levene's test values in table 4, which means homogeneous. After the data from both classes is homogeneous, it can be seen that the t count > t table. This is reinforced by a significance value (2-tailed) <0.05 (reject H_0). So that there is an influence between the group that gets the group treatment and the Open-Ended Problem Learning Model that gets the conventional learning model treatment when it comes to enhancing kids' mathematical creative thinking abilities. The learning results reveal that there are substantial differences in mathematical creative thinking abilities between the experimental class that uses the Open-Ended Problem learning model and the control class that uses the conventional learning model. This is because in learning Open ended Problems, students are given the freedom to answer questions without fixating on one way of solving. This is in accordance with the opinion of Hsm et al. (2021)because of its open nature, it can provide opportunities for students to face challenges in finding solutions and finding the most appropriate alternative answers. This is in line with Listiani et al. (2022) open ended questions can give students the freedom to think actively and creatively.

Sari (2015) and Hakim (2014) that in learning that uses the open-ended problem model, it can provide students with opportunities to obtain information or experience in finding and addressing challenges. various strategies according to what they understand. Research results from Wanelly & Fauzan, (2020) also mentioned that the open-ended principle the learning model is more effective. Than conventional models to enhance students' mathematics creative thinking

skills. Because the goal of this open-ended learning paradigm is to help students build creative thinking abilities and mathematical mindsets through simultaneous problem solving (Yuliana, 2015). By giving open-ended problems, it will train students in determining various strategies in solving a problem (Hutauruk, 2015).

Open-ended problems can certainly make a positive contribution to the mathematics creative thinking talents of kids. This is because in learning that uses the open-ended problems model, students are used to being given problems that demand to improve their creative thinking skills (Ariani et al. 2014). Open-ended problems or questions are types of learning that can be used to create students' knowledge in a variety of ways, stimulating students' capacities to understand mathematical ideas in addressing provided issues (Putra et al., 2020). By giving freedom to students to look for answers according to the abilities of the students, they do not feel burdened and forced to complete the assignments given according to the will of the teacher (Parwati, 2013).

An open approach is a method of learning mathematics that encourages creative activity and mathematical thinking by allowing students to explore numerous strategies and methods that they believe are appropriate for their elaboration skills (Sabrina & Iswari, 2018).

Wulandari et al., (2020) says open-ended problems will provide an opportunity for students to recognize various strategies or many solutions/completion according to their knowledge. An open approach to student mathematics learning is very important for each student to have the freedom to improve their problem-solving abilities according to their level of ability and interest (Hafidzah et al., 2021), and helps students to provide opportunities for students to convey their ideas and concepts that is the initial part of problem solving (Noor, 2020)

In addition, the use of open-ended problems in learning can foster students' problem-solving abilities. The use of open-ended can explore the abilities and understanding that exist in students. When learning uses open ended, students have a way of getting the correct answers by containing various correct solutions.

CONCLUSION

Conclusions may be derived based on the analysis results, namely, 1) there are variations in the acquisition of scores between the conventional group and the mathematical creative thinking abilities group; and 2) there is an influence of mathematical creative thinking skills that are given the Open-Ended Problem model treatment with groups that are given conventional learning models.

Based on the conclusions above, the suggestions given are: 1) The Open-Ended Problems Model can be an option that helps students in the teaching and learning process; 2) Open-Ended Problems can make students develop their thinking in solving a mathematical problem; and 3) The researcher hopes that other researchers can apply and

develop Open-Ended Problems learning models that are more innovative and creative, especially for other mathematical abilities.

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