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Improving Mathematical Creative Thinking Ability In Creative Problem Solving Model With Scaffolding Strategy

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ABSTRACT

The mathematical creativity of students in Indonesia is low. Students only imitate what the teacher does; if students are faced with a problem, they find it difficult to solve it. This study aims to determine the increase in students' mathematical creative thinking skills taught using the Creative Problem Solving model with a scaffolding strategy. The method used is pre-experimental, with one class serving as the experimental class for public junior high school 1 Batumarta VI students. The instrument in this study was a description of the test questions with the material on flat sides. The results of the study showed that there was a statistical increase in students' mathematical creative thinking abilities with the Creative Problem Solving model, which obtained an N-Gain value of 0,612 From this average value, 10 students were obtained in the high category and 16 students in the medium category and 3 students in low category.
Keywords : Creative thinking, Creative Problem Solving. Mathematics, Scaffolding

ABSTRAK

Kemampuan berpikir kreatif matematis peserta didik di Indonesia tergolong rendah. Peserta didik hanya mecontoh apa yang dikerjakan oleh guru, apabila peserta didik dihadapkan dengan suatu masalah, peserta didik merasa kesulitan dalam menyelesaikannya. Penelitian ini bertujuan untuk mengetahui peningkatan kemampuan berpikir kreatif matematis peserta didik yang diajarkan menggunakan model *Creative Problem Solving* dengan strategi *scaffolding*. Metode yang digunakan adalah *Pre-Experimental* dengan satu kelas sebagai kelas eksperimen peserta didik SMP N 1 Batumarta VI. Instrument dalam penelitian ini berupa soal tes uraian dengan materi bangun ruang sisi datar. Hasil penelitian menunjukaan bahwa ada peningkatan secara statistik kemampuan berpikir kreatif matematis peserta didik dengan model *Creative Problem Solving* diperoleh nilai N-Gain sebesar 0,62 dengan kategori sedang dari niali rata-rata tersebut 10 peserta didik dengan kategori tinggi dan 16 peserta didik dengan kategori sedang dan 3 peserta didik dengan kategori rendah.
Kata kunci: Berpikir kreatif, Creative Problem Solving, Matematika, Scaffolding.

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PRELIMINARY

Education not only has a very important role in the progress of a nation, but is also a factor supporting human intellectual change. Good achievement requires an active and positive learning process so that students can develop their own potential, character, intelligence, noble character, and competence in social life. To develop education knowledge, teachers are expected to be smarter in managing classes and carrying out other learning activities.

Mathematics, as the foundation of science and technology, has a very important role. This is in accordance with the view that students can practice logical, abstract analytical, critical, and creative thinking in the process of learning mathematics (Nugroho et al., 2019). One of them is by providing opportunities for students to think creatively in order to be able to solve various challenges that arise, both in everyday life and in the world of work. Mathematics is a skill that must be possessed by students in order to be able to deal with mathematical problems and the problems of everyday life in general (Dwijanto & NR Dewi, 2019).

According to the TIMSS assessment, Indonesia as a developing country should pay attention to a number of things in order for Indonesian students' learning achievements to be internationally competitive in terms of values and knowledge by increasing students' language skills, increasing mathematics and science learning, improving mathematical abilities, and students must be accustomed to thinking at a high level in solving mathematical problems (S). The 2019 UNBK (Computer-Based National Examination) results for mathematics at SMP/MTs show that the average math score of students in Indonesia is 46.19 (Ministry of Education and Culture, UN 2019 SMP Level, 2019). The average National and Private National Examination scores in 2009 are presented in Figure 1.

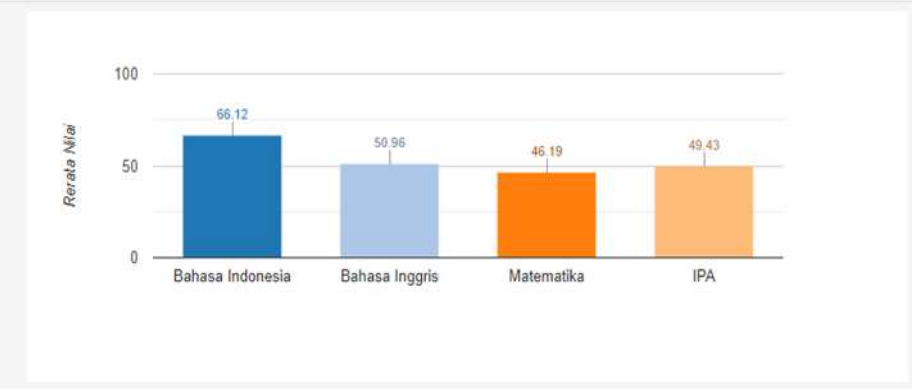

Figure 1 Average National and Private Middle School National Exam Scores in 2019

Based on the picture above, it can be seen that the average score of junior high school students' mathematics is the lowest among other subjects. The acquisition of this value shows that the learning achievement of students in mathematics in Indonesia is still relatively low. Students must be able to master related subject concepts in mathematics so that they can understand and think creatively when solving problems. (Aripin & Purwasih, 2017). Problem solving is one of the five objectives of learning mathematics. According to NCTM (2000), there are five objectives that are at the heart of learning mathematics: 1) skills in problem solving; 2) reasoning and proof skills; 3) connection skills; 4) communication skills; and 5) representation skills. Problems are questions that must be answered correctly. A problem can stimulate students to think and look for the causes of problems that arise. While problem solving is a core process in the mathematics curriculum, problem solving learning prioritizes the processes and strategies used by students in solving them, not just the results, to strengthen their mathematical creative thinking abilities.

The results of a survey conducted by the Program for International Student Assessment (PISA) in 2018 assessed 600,000 children aged 15 from 79 countries every three years. This study compared the math, reading, and science performances of each child. Indonesia is in the 74th position out of 79 countries taking the PISA test. For the mathematics category, Indonesia is ranked 7th from the bottom, which means it is in the 73rd position with an average score of 379. Indonesia is above Saudi Arabia, which has an average score of 373. Then, for the first rank, it is still occupied by China with an average score of 591 (Tohir, 2019). Therefore, mathematical skills must be directed according to the vision of mathematics. The vision of mathematics is to train the ability to think logically, critically, and creatively (Hendriana et al., 2018).

The ability to think creatively is the ability to solve problems fluently, flexibly, originality and elaboration (Ismunandar et al., 2020). Creative thinking is a skill that can be developed through research and development, according to Soeyono (Fitrianawati & Hartono, 2016). This is because creative thinking is not a hereditary factor, so it can be developed and taught with certain learning methods and strategies that can support the development of creative thinking skills. To investigate students' creative thinking processes, Wallas (Munandar & Utami, 2014) was used as a guide. The results of the study show that statistically the increase in mathematical creative thinking skills in the Creative Problem Solving (CPS) class is at a moderate level, so it can be concluded that the ability to think creatively and mathematically increases in students who use the Creative Problem

Solving (CPS) learning model. (Faturohman & Afriansyah, 2020). This can provide the understanding, skills, and knowledge they have in order to trigger creative thinking. Creative thinking skills are also needed to solve some or many problem-solving questions..

The results of observations and interviews conducted at public junior high school 1 Batumarta VI show that, in general, teachers still use conventional learning models that emphasize teacher-centered learning. Some students have not been able to develop their ideas and understanding of certain concepts because the knowledge obtained through processes is not integrated and students lack flexible meanings. Learning that still uses conventional methods and teacher-centered learning cannot be separated from lectures where the teacher always explains the material, then gives examples of questions, and at the end of the lesson, the teacher gives questions to students to work on at home. However, sometimes teachers provide learning in groups so that learning is more interesting and can be done together. In line with research, Nurfarida et al. (2019) explain that whether students are active or not can be seen by how active they are in a group or individual activity of finding their own answers to the problems given by the teacher. Therefore, teachers must be able to choose learning models and strategies that can build students' self-confidence. so that students can develop good thinking skills when they have self-confidence. 2019) explains that whether students are active or not can be seen by how active they are in a group or individual activity in finding their own answers to the problems given by the teacher. Therefore, teachers must be able to choose learning models and strategies that can build students' self-confidence. so that students can develop good thinking skills when they have self-confidence. 2019) explains that whether students are active or not can be seen by how active they are in a group or individual activity in finding their own answers to the problems given by the teacher. Therefore, teachers must be able to choose learning models and strategies that can build students' self-confidence. so that students can develop good thinking skills when they have self-confidence.

An alternative model that is used to encourage student activity in developing students' mathematical creative thinking abilities is the Creative Problem Solving Learning Model. This is related to a good learning process, which involves cultivating appropriate learning models to improve students' mathematical creativity in accordance with learning objectives. There are many learning models that can be applied to learning mathematics with this goal, for example the Creative Problem Solving learning model (Ridia & Afriansyah, 2019).

The CPS learning model can accommodate students' practice of their ability to solve problems creatively. Learning with this model can provide new experiences for students so they can show their potential thinking abilities, especially their creative abilities (Ratnasari et al., 2019). Developing students' mathematical creative thinking abilities requires creative harmony from the elements of mathematics education, especially teachers, who are required to be able to animate and stimulate students to think creatively. This study aims to determine whether the ability to think creatively and mathematically increases significantly with the help of the creative problem-solving learning model and the scaffolding strategy. Scaffolding is a theory introduced by Vygotsky that emphasizes the use of gradual support or assistance in learning and problem solving. Scaffolding acts as some assistance to children in the early stages of learning, then the teacher reduces assistance and provides opportunities for children to take on greater responsibility after the child can do it (Cahyono, 2010)

Efforts to increase students' understanding through scaffolding assistance in the form of activating students' background knowledge, providing tips or tricks, strategies, and key procedures to carry out tasks or solve problems encountered by students educate. This is intended so that students are not frustrated because they are doing a task or learning a skill that is difficult to implement. Based on research results (Ismawati & Hindarto, 2017), it appears that PBL learning with the scaffolding strategy has proven effective because it fulfills three things, namely, the proportion of students who, on the test of mathematical problem solving abilities, achieved learning mastery of 87.179%. Learning activities can be realized in the form of group study, discussion in small groups. When the teacher conveys the subject matter, which is usually done through lectures, the students only accept what is conveyed by the teacher. Through the implementation of this scaffolding strategy, students will become active in carrying out various learning activities, not only listening, but also actively involved in seeking, discovering, discussing, formulating, and reporting their learning outcomes.

The stages in the Creative Problem Solving learning model can be supported by a scaffolding strategy, including the problem clarification stage, which can support the teacher in the questioning component. The stage of disclosing problem ideas can support teachers in developing expertise in the prompting component. The stage of expressing ideas can support teachers in developing skills in monitoring activities in the cueing component. The implementation stage can support teachers in developing expertise in the

explaining component. The stages of the creative problem-solving learning model with the scaffolding strategy in this study can be seen in Table 1.

Table 1. Creative Problem Solving Steps with Scaffolding strategy

CPS steps	Teacher Activities
1. Problem clarification	1. Before the learning activities begin, the teacher says a deep prayer and everyone prays together. 2. The teacher explains the learning objectives by asking questions about the material to be studied. 3. Provide questions to check student understanding. 4. Students are grouped into 6 groups, with each group consisting of 4–5 students (scaffolding).
2. Disclosure of ideas	1. The teacher gives the LKPD to students to discuss with group members. 2. The teacher guides students to identify problems and formulate an authentic problem according to the material being taught. 3. The teacher facilitates students' cognitive processes when they experience confusion and directs them to several questions so that they can understand correctly (scaffolding).
3. Evaluation and selection	1. The teacher motivates students to collect appropriate information, carry out experiments so that original ideas emerge to find solutions. 2. The teacher gives a signal to students when they are not paying attention, the goal is to divert students' attention so that they focus more on the information that the teacher conveys (scaffolding). 3. The teacher monitors activities in class as evaluation material during the learning process. 4. Guiding students to refocus on problems to develop their understanding (scaffolding).
4. Implementation	1. The teacher helps students who do not have sufficient knowledge to complete the task (scaffolding). 2. The teacher helps and directs students to solve questions that are relevant to the material. 3. The teacher guides students in analyzing and evaluating the problem-solving process.

	4. Students present the results of their work in front of the class, including the results of group work and other groups' responses to the results of the discussion. 5. The teacher asks guiding questions so as to enable students to find and use new concepts in solving problems (scaffolding). 6. After that, the teacher checks and evaluates the learning outcomes of the students.

METHODS

The research method used is called pre-experimental design. The population is public junior high school 1 Batumarta VI, and the sample is VIII E class students as a research sample with a total of 29 students, taken by purposive sampling. This research used the one-group pretest-posttest design.

The research design is as follows:

O1 X O2

Information:

O1 = Pretest Value

O2 = Posttest Value

X = Treatment with the Creative Problem Solving learning model

--- = Sampling is not done randomly

The instrument in this study was a creative thinking ability test in the form of a written test consisting of an initial test (pretest) and a final test (posttest). The form of the test is a description test, which consists of four items on the ability to think creatively. The test questions for the ability to think creatively were previously subjected to instrument analysis to determine their validity, reliability, discriminating power, and level of difficulty given to the trial class. This is used as a benchmark for the quality of the items to be given.

The grid questions used are in accordance with the indicators of students' mathematical creativity presented in Table 2.

Table 2. Grid of Mathematical Creative Thinking Ability Test Questions

No	*Question Indicator*	*Question Number*
1.	Students are able to solve problems related to cubic shapes through the illustrations presented.	1
2.	Students are able to solve prism volume problems with illustrations of flat-sided shapes presented in various ways.	2
3.	Students are able to present learning outcomes about flat-sided geometric shapes with the illustrations provided.	3
4.	Students complete the surface area of an irregular geometric shape and design a sketch to build a new block through the illustration shown.	4

Data analysis techniques used in this study included tests of normality, homogeneity, completeness, average mathematical creative thinking abilities, and normalized N-gain tests (improvement tests). The normality test is used to see whether the data in the study are normally distributed. The homogeneity test is used to determine whether a dataset is homogeneous or not.

The completeness test was carried out to find out the average mathematical creativity and thinking ability of students in the CPS learning model with a scaffolding strategy beyond the KKM. The value of 70 is the minimum completeness criterion for mathematics in this study, with the following hypothesis:

$H_0: \mu < 70$(the average mathematical creative thinking ability of students in the Creative Problem Solving learning model with a scaffolding strategy is less than 70)

$H_1: \mu \geq 70$(the average mathematical creative thinking ability of students in the Creative Problem Solving learning model with a scaffolding strategy is greater than 70)

The minimum completeness criteria for mathematics in this study used the SPSS 25 software using the one-sample t test. The test criteria can be seen from the output results in the one-sample test table. H_0 rejected if sig. < 0.05 (Sukestiyarno, 2020).

The normalized N-Gain (improvement test) is used to determine whether the ability to think creatively and mathematically has increased significantly with students who have received the Creative Problem Solving learning model with the Scaffolding strategy. The normalized N-Gain formula used is as follows:

$$Gain\ Ternormalisasi\ (g) = \frac{S_{posttest} - S_{Pretest}}{S_{max} - S_{Pretest}}$$

Information:

$S_{posttest}$: Posttest scores

$S_{Pretest}$: Pretest score

S_{max} : The maximum score of the test (Hake in Guntara, 2021)

RESULTS AND DISCUSSION

Results

This research was conducted in April 2022 for class VIII-E students as a research sample. The first step in this study was to develop instruments for testing the ability to think creatively and mathematically when solving problems in flat-sided space. This study's data include pretest and posttest scores, as well as N-gain normalized students' mathematical creative thinking abilities. Furthermore, the calculation of the pretest, posttest, completeness test, and N-gain data was carried out with the help of SPSS 25. The pretest data was to see the students' initial abilities before being given treatment, and the posttest data was to see the students' abilities after being given treatment. The completeness test was carried out to find out the average mathematical creativity and thinking ability of students in the CPS learning model with a scaffolding strategy beyond the KKM. and Normalized N-gain is used to see whether there is an increase in students' mathematical creative thinking abilities with the Creative Problem Solving learning model. Before further calculations are carried out, normality calculations are carried out first to see whether the data is normally distributed.

Testing the normality of the pretest and posttest data using the Kolmogorov–Smirnov test with the help of SPSS 25. The results of the normality test calculations are presented in Table 3.

Table 3. Pretest and Posttest Data Normality Test Results

	Kolmogorov-Smirnov		
	Statistics	df	*Sig.*
Pretest	0.113	29	0.200
Posttest	0.123	29	0.200

Based on the results of the output tests of normality in SPSS in Table 1, look at sig. on the Kolmogorov–Smirnov table. It is known that the data before the learning model is applied (the pretest) has a sig. of 0.200, so if the sig. > 0.05, it can be concluded that the pretest data is normally distributed. While the data obtained after the learning mode was applied (posttest) obtained a sig. of 0.200, the value of sig. > 0.05 indicates that the data is

normally distributed. The results of the homogeneity test calculations are presented in Table 4.

Table 4. Pretest and Posttest Data Homogeneity Test Results

Test of Homogeneity of Variances				
	Levene Statistics	df1	df2	*Sig.*
Pretest (Based on Mean)	0.113	1	27	0.768
Posttest Based on Mean)	0.123	1	27	0.205

Based on the results of the output tests of homogeneity of variance in SPSS, it can be seen in the sig. (based on mean) on each pretest and posttest dataset. The pretest data has a sig. of 0.768, and since the sig. is greater than 0.05, it can be concluded that the pretest data is homogeneous.While the data's (Posttes') sig. of 0.205 and the value of sig. > 0.05 indicate that the data is homogeneous.

The completeness test was carried out to find out the average mathematical creativity and thinking ability of students in the CPS learning model with a scaffolding strategy beyond the KKM. The value of 70 is the minimum completeness criterion for mathematics in this study. The KKM score was obtained from the school's KKM. The calculation results are presented in Table 5 as follows:

Table 5 Average Completeness Test Results

One-Sample Test						
	TestValue = 70					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Differences	Lower	Upper
Posttest	3,421	28	0.002	6,931	2.78	11.08

Based on Table 5, the results of the calculation of the average completeness test of students' mathematical creative thinking abilities are seen in the value sig. (2-tailed) compared to 0.05. It means that value Sig. (2-tailed) 0.05 is rejected. So it can be concluded that the average mathematical creative thinking ability of students in the Creative Problem Solving Learning Model with a Scaffolding Strategy is greater than 70 at 76.93.

To find out how much the ability to think creatively and mathematically increases with the Creative Problem Solving model using the Normalized Gain criteria. The data used is the value of the Creative Problem Solving model's pretest and posttest ability to think creatively and mathematically. Normalized N-gain results are presented in Table 6.

Table 6. N gain test results

Descriptive Statistics				
	N	Minimum	Maximum	Means
N Gains	29	0.18	1.00	0.6124
N Gain Percent	29	17.78	100.00	61.3292

Based on the output table above, the N gain result is 0.612, so this value is classified as moderate statistically. In the learning process using the Creative Problem Solving model, it is included in the medium category with a percentage of 61.2%. The results of the N gain test calculations are presented in Table 7.

Table 7 Calculation results of N gain

Name	Score		N Gains	Criteria
	Pretest	PostTest		
E01	40	77	0.64	Medium
E02	35	60	0.40	Medium
E03	46	80	0.66	Medium
E04	48	67	0.38	Medium
E05	38	77	0.66	Medium
E06	45	63	0.34	Medium
E07	54	90	0.83	High
E08	40	73	0.57	Medium
E09	33	70	0.57	Medium
E10	42	73	0.56	Medium
E11	43	87	0.81	High
E12	44	77	0.62	Medium
E13	38	60	0.37	Medium
E14	45	90	0.86	High
E15	50	63	0.27	Low
E16	36	77	0.67	Medium
E17	47	80	0.66	Medium
E18	52	96	0.97	High
E19	48	80	0.65	Medium
E20	55	63	0.19	Low
E21	48	83	0.71	High
E22	37	87	0.83	High

Name	Score		N Gains	Criteria
	Pretest	PostTest		
E23	50	77	0.57	Medium
E24	45	83	0.73	High
E25	52	60	0.17	Low
E26	48	67	0.38	Medium
E27	54	87	0.76	High
E28	38	97	1	High
E29	48	87	0.79	High
Average			0.612392	

It is known that the sample class consists of 29 students. The average N-gain value of students' mathematical creative thinking ability is 0.612392; this is the students' N-gain value included in the medium cretesia. From this average value, 10 students were obtained in the high category and 16 students in the medium category. The graph of student learning outcomes is presented in Figure 2.

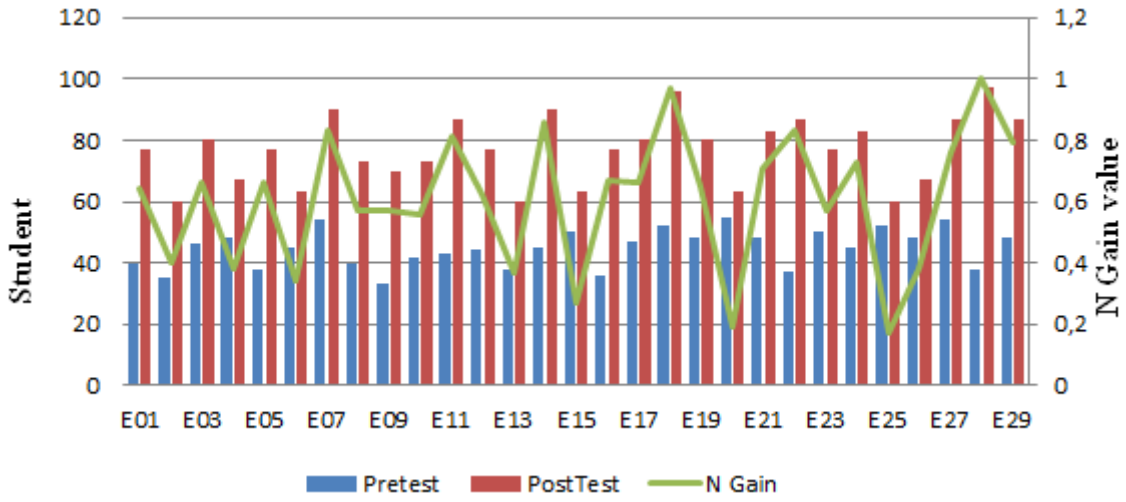

Figure 2. Graph of Student Learning Outcomes

Based on the graph, it shows that there is an increase in students' mathematical creative thinking skills taught by the Creative Problem Solving learning model with the scaffolding strategy.

Discussion

Every student has the potential to be creative in terms of arithmetic and learning. The creative problem-solving model is something new for students in the learning process.

This is in line with (Islamiya & Jamaan, 2021). The Creative Problem Solving (CPS) learning model is a learning model that can improve students' mathematical problem-solving abilities. This model can help students improve various abilities, such as when choosing and developing skills for solving problems. Other research shows that learning through the Creative Problem Solving model requires students to be active in the learning process, which can encourage students to test their knowledge and recognize errors in thinking to foster thinking power in solving a problem (Goddess & Son, 2020). The study (Widya et al., 2020) suggests that the CPS model has different steps with some similar goals. CPS is implemented at several levels of education for science and mathematics learning. CPS has a significant influence on the attainment of cognitive competence and problem solving skills.

The implementation of learning activities using the CPS model with a scaffolding strategy is assisted by student worksheets. After the teacher delivers the material and gives examples of questions, the students are grouped into several groups to work on the LKPD that has been given. It is hoped that students will be able to apply the steps in solving creative thinking skills questions and collaborate with their group mates.

Learning with the CPS model and a scaffolding strategy can be in line with indicators of the ability to think creatively and mathematically, namely the fluency indicator, where students are able to write down the information obtained in a structured manner. Indicators of detail (elaboration): students can understand questions by correctly writing down information, apply thinking skills by coming up with new ideas (originality), and solve problems with multiple solutions (flexibility). This shows that students are able to solve problems with the CPS learning model well, so that students' mathematical creativity increases. In line with research (Rahman & Maslianti, 2015), student activity during the learning process using CPS is very good, and students who are given the CPS learning model have higher or increased mathematical creativity. study (Septian et al., 2019) shows that the increase in the mathematical creative thinking abilities of students who receive learning using the Creative Problem Solving (CPS) model is better than the improvement in the mathematical creative thinking abilities of students who receive ordinary learning, and students' attitudes towards learning mathematics using the Creative Problem Solving (CPS) model are mostly positive.

In figure 11 there are 8 patterns in one full rotation, so that the rotation that occurs in the basic ornament of the flagpole of the State Museum of North Sumatra is 45°.

CONCLUSION

Based on the results of the research and discussion obtained, it can be concluded that students' mathematical creative thinking abilities have increased with the Creative Problem Solving learning model. This increase belongs to the medium category with an N-gain value of 0.612392. From the average N-gain value of the sample class, an increase of 10 students was obtained in the high category, 16 in the medium category, and 3 in the low category.

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