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The Effect of The Application of CPS and PBL Models on Students' Mathematical Creative Thinking Abilities in Junior High School

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***Abstract*:**
This study aims to determine whether there are differences in the results of the influence of the application of the *Creative Problem Solving* (CPS) model, the *Problem Based Learning* (PBL) model and the *Direct Instruction* (DI) model in improving mathematical creative thinking skills in the material of quadrilaterals and triangles of class VII students of SMPN 9 Kota Jambi. Using an experimental *posttest only control research design*, this study involved the population of all class VII students of SMPN 9 Kota Jambi in the 2023/2024 academic year totaling 204 students from 7 classes. Through the *Random Sampling technique* , three classes were selected as samples, namely VII A, VII B, and VII C. Data collection was carried out using two instruments: observation sheets for the implementation of learning and evaluation tests for mathematical creative thinking skills. To analyze the collected data, statistical analysis using One way Anova showed a significance value of 0.000 which was smaller than 0.005. These findings indicate different effects of the application of the three learning models - CPS, PBL, and DI - on improving mathematical creative thinking skills. *Posttest* data showed that the group of students who received learning with the CPS model achieved an average score of 16.94, while the PBL group obtained an average of 16.26. Both groups showed superior results compared to the group using the DI (Direct Instruction) learning model

Keywords: Creative problem solving; problem-based learning; mathematical creative thinking.

Introduction

Education is a process aimed at making students become intelligent, knowledgeable, and educated people. Education also has a big influence in advancing the quality of human resources of a nation when facing problems in the development of technology, science, and knowledge that are developing very rapidly (Baro'ah, 2020) . Therefore, schools must provide students with competent provisions and skills from an early age so that they are ready to face future problems. One of them is an understanding of mathematics material, starting from elementary school level and continuing continuously to higher education level.

As the foundation of various disciplines, mathematics has a vital role and irreplaceable practical applications in human daily activities because it always

depends on it. Currently, it is seen that almost all sciences always involve mathematics in them. Mathematics is an important part of science and an important basis in the world of education. Where the subject has been taught since elementary school to college. In mathematics teaching and learning activities, there is a process of coaching and guidance that aims to develop students' mastery of mathematical competence (Priatna et al., 2019) . become the main means to improve students' abilities, including logical reasoning, analytical skills, systematic thinking, critical thinking, creativity, and collaboration skills, all of which have practical value and can be applied in their lives.

Mathematics occupies a strategic position in the world of education because of its role as a fundamental science that has various practical applications in life. Mathematics learning takes place continuously from elementary school to college, becoming part of the compulsory curriculum at every level of education (Rahmawati & Jamaluddin, 2024) . During mathematics learning, students will face and encounter many problems. Therefore, it is expected that students can solve existing problems (Kusaeri, 2019) . Following the contents of the independent curriculum in mathematics subjects, students are required to be able to develop their abilities, one of which is the ability to think creatively mathematically. And also in the independent curriculum it is explained that the usefulness of studying mathematics is that it can improve students' ability to think creatively, so that the value of the lesson feels meaningful to students (Kemendikbud, 2022) . Therefore, students' mathematics learning must be improved, which can be done by practicing 21st century skills, one of which is mathematical creative thinking skills.

Anditiasari et al., (2021) argue that creative thinking skills reflect students' abilities in developing original ideas and finding innovative solutions to various problems, which produce thoughts or works that have never been produced before. Mathematical creative thinking skills are defined by Triyani & Azhar (2021) as the ability to find solutions to mathematical problems easily. Creative thinking means finding a new way to see something or creating a new perspective can produce innovative ideas that have never existed before. This ability is an ability that students must master when they are going to study mathematics.

During learning, students must have the ability to think creatively and actively. This is needed to foster a strong sense of curiosity, independence, self-confidence, and courage in making decisions about problems. The opportunity to hone creative thinking skills allows students to face challenges with more confidence and skill. On the other hand, limited space to develop creativity can cause students to give up easily and lose motivation when faced with challenging situations (Huliatunisa et al., 2020) . In addition, a person's expertise in mathematics is related to their creativity in thinking. Students who have a good mathematical understanding tend to show a more developed level of creative thinking. Those who show high creativity in thinking tend to have mathematics achievements at the intermediate to superior level. On the other

hand, students with low levels of creative thinking generally show less satisfactory mathematics performance (Syahara & Astutik, 2021) . Therefore, in the process of learning mathematics, it is important to emphasize the development of students' mathematical creativity. This ability is one of the 21st century skills that students need to solve problems during learning and in everyday life. (Mardhiyah et al., 2021) .

The results of initial observations in class VII of SMPN 9 Kota Jambi revealed the condition of students' creative thinking abilities in working on geometry problems, especially on the material of quadrilaterals and triangles. The findings show that students have not mastered all aspects of mathematical creative thinking. Especially in the aspect of fluency , students still have difficulty in producing various appropriate and comprehensive solutions. For flexibility , students only provide one way of solving without exploring other perspectives. In the aspect of novelty (*originality*), students have not been able to provide new and unique solutions according to their own thoughts. While for elaboration , students have not been able to provide systematic and detailed solutions. Realizing the reality in the field, namely the still low level of mathematical creativity among students, increasing creative thinking abilities in mathematics requires the implementation of appropriate and effective methods. Two methods in realizing students' mathematical creativity are CPS and PBL.

Hasanah et al., (2024) provide the opinion that *Creative Problem Solving* (CPS) is an educational approach that emphasizes the development of students' abilities in solving problems creatively, students will use their knowledge and gain thinking experience, which will improve their ability to solve problems . This model allows students to participate more actively during the problem-solving learning process. Isrok'atun & Rosmala (2018) provide an explanation of each of the three words that make up *Creative Problem Solving* to define the concept. *Creative* refers to the element of novelty, while *problem* refers to a situation that shows a challenge, offers an opportunity, or anxiety. *Solving* refers to a way to deal with the problem. The *Creative Problem Solving (CPS)* model emphasizes problem-solving activities combined with strengthening various skills, so that it can encourage the development of creativity in thinking . The main components of the CPS model, namely expressing opinions, evaluating, and selecting, require students to collect various ideas to use during the decision-making stage.

Meanwhile, Ati & Setiawan (2020) stated that *Problem Based Learning* (PBL) is a learning method that presents contextual problems from life as a learning medium. Through this approach, students are trained to develop critical thinking and problem-solving skills, which ultimately help them understand the basic concepts of the subject better. Students are also required to have the ability to organize their knowledge, develop higher skills, be independent, and increase their own self-confidence. By solving problems, students can demonstrate their creative thinking skills in conveying their creative innovations to find solutions. The *fluency aspect* appears when students convey various ideas and ideas that they have fluently when answering a problem.

The *flexibility aspect* appears when students are able to present many solutions in various different ways. The *originality aspect* appears when students are able to create new and different solutions to a given problem (Ardeniyansyah & Rosnawati, 2018) .

In the era of modern learning, the integration of CPS, PBL, and critical thinking skills becomes a complementary approach in developing students' abilities. PBL presents contextual problems as learning stimuli, which are then analyzed in depth through the critical thinking process. Furthermore, CPS plays a role in guiding students to find innovative solutions through systematic stages. The combination of the three learning models helps create an effective learning atmosphere to improve students' capacity to think analytically and creatively when solving problems. This study aims to identify the extent to which the differences in effectiveness between the implementation of *Creative Problem Solving* (CPS), *Problem Based Learning* (PBL), and *Direct Instruction* in developing the mathematical creative thinking skills of grade VII junior high school students, especially in learning the geometry of quadrilaterals and triangles.

Research Methods

The experimental approach was chosen as the method in this study, by adopting a quantitative paradigm through *True Experimental Design* . In this research format, researchers have full control over external variables that can affect the experimental process. The typical characteristic of *True Experimental Design* lies in its sampling technique, where both the experimental group and the control group are randomly selected from a predetermined population (Sugiyono, 2020). *The true experimental design* applied in this study uses the *Posttest Only Control Design model* . This model applies three groups selected using a random method (R). The first two groups receive treatment (X), while the third group does not receive treatment. The group with *treatment* is categorized as the experimental group, while the group without treatment is the control group. The effect of giving treatment can be observed through the results of O_1 and O_2 .

The research design used can be observed in table 1.

Table 1. Research Design

Group	**Treatment**	***Posttest***
Experiment I	X_1	O_1
Experiment II	X_2	O_2
Control	X_3	O_3

Information :

X_1 : Treatment using the CPS learning model

X_2 : Treatment using the PBL learning model

X_3 : Treatment using the DI learning model

O_1 : shows the *posttest results* of the class using CPS

O_2 : shows the *posttest results* of the class using PBL
O_3 : shows the *posttest results* of the class using DI

The research location was at SMPN 9 Kota Jambi. The population studied included all grade VII students at the school. In sampling, class VII A was assigned to the first experimental group, class VII B to the second experimental group, while class VII C acted as the control group. This study followed three systematic stages: preparation, implementation, and analysis. To collect data, two main types of instruments were used - observation sheets that monitored learning activities from both students and teachers, and a final test (*posttest*) to measure the level of students' mathematical creative thinking abilities. The CPS model was applied to experimental class I, PBL to experimental class II, and DI to the control class. After the treatment was given, all classes underwent a posttest to measure problem-solving abilities in the material of quadrilaterals and triangles. Data analysis used SPSS 21 with the *one-way ANOVA method* to identify the significance of the differences between the three learning models on students' mathematical creative thinking abilities. Furthermore, the Tukey test was run to measure the magnitude of the difference in the effect of treatment on students' mathematical creative thinking abilities.

Results and Discussions

After *the treatment was given* to the experimental and control groups, students completed a posttest designed to measure indicators of creative thinking skills. The test format used was descriptive questions consisting of 2 question items. The posttest data were then analyzed through two stages of testing: normality test and homogeneity test. The results of the posttest data normality test are presented in table 2, while the results of the *posttest data homogeneity test* are shown in table 3.

Table 2. Results of Normality Testing for Creative Thinking Ability Test

Class	**Kolmogorov-Smirnov** [a]		
	Statistics	**df**	**Sig.**
Experiment I	.126	35	0.171
Experiment II	.124	35	0.190
Control	.138	33	0.111

Table 3. Results of Homogeneity Testing for Creative Thinking Ability Test

Levene Statistics	**df1**	**df2**	**Sig.**
.901	2	100	0.409

The results of the normality test show that the three class groups have normal data distribution, with the following details of the significance values: experimental class I (0.171), experimental class II (0.190), and control class (0.111). Because all of these significance values exceed the threshold of 0.05, the posttest value data from the three classes meet the normality assumption. Furthermore, table 3 shows the

significance value obtained of 0.409. So it can be concluded that all of these classes have homogeneous creative thinking ability test data variance.

After the hypothesis test requirements are met, the next stage is to carry out the hypothesis testing. Analysis of differences in the average value of creative thinking ability between sample groups is carried out through two stages of statistical testing. It begins with the application of one-way ANOVA, which is complemented by further analysis using the Tukey test to detect how significant the differences are between the groups studied. The results of the statistical calculations from the one-way ANOVA are presented in detail in table 4.

Table 4. One-way Anova Test Results for Creative Thinking Ability Test

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	108,565	2	54,282	9,314	.000
Within Groups	582,814	100	5,828		
Total	691,379	102			

In table 4 it can be seen that the significance value of the learning model obtained is 0.000 (0.000 <0.05). Thus, the conclusion that can be drawn is that the average test scores for the three sample groups are significantly different, indicating that implementing the learning model will affect students' mathematical creative thinking abilities.

To analyze how big the difference in *treatment effects* is, further analysis is carried out using the Tukey test. Table 5 below presents the results of the Tukey test comparing the effects of various learning models applied .

Table 5. Tukey's Advanced Test Results

Multiple Comparisons

Dependent Variable: Skor

Tukey HSD

(I) Kelas	(J) Kelas	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Creative Problem Solving (CPS)	*Problem Based Learning* (PBL)	.686	.577	.463	-.69	2.06
	Direct Instruction (DI)	2.458*	.586	.000	1.06	3.85
Problem Based Learning (PBL)	*Creative Problem Solving* (CPS)	-.686	.577	.463	-2.06	.69
	Direct Instruction (DI)	1.772*	.586	.009	.38	3.17
Direct Instruction (DI)	*Creative Problem Solving* (CPS)	-2.458*	.586	.000	-3.85	-1.06
	Problem Based Learning (PBL)	-1.772*	.586	.009	-3.17	-.38

*. The mean difference is significant at the 0.05 level.

Data analysis in Table 5 shows a comparison of the results of the mathematical creative thinking ability test between learning models. The results show a superior value of 0.686 points compared to the *Problem Based Learning* (PBL) group. A greater

difference is seen when comparing the CPS model with *Direct Instruction* (DI), where CPS outperforms DI by a difference of 2.458 points. Meanwhile, the PBL group also showed better performance by a difference of 1.772 points above the DI group.

multiple comparisons output results show that the significance value for the application of the CPS and PBL Models is 0.463 > 0.05, this states that the average difference in the application of the CPS and PBL Models is not descriptively significant. The table above shows a significance value of 0.000 <0.05 for the application of the CPS and DI Models, it can be concluded that the two models are different. Thus, the average difference in the application of the CPS and DI Models is descriptively significant. Furthermore, the significance value for the application of the PBL and DI Models is 0.009 <0.05. Descriptive statistical data analysis shows a significant gap in the average student scores between the three classes that apply different learning models. This variation in average scores indicates that each learning model has a different impact on student learning outcomes.

To see the average similarity of the learning models, it can be seen from the Tukey HSD output in table 6 below:

Table 6. Results of the Average Similarity Test for the Creative Thinking Ability Test

***Posttest* Results**			
Tukey HSD [a,b]			
	N	Subset for alpha = 0.05	
		1	2
Control Class	33	14.48	
Experimental Class II	35		16.26
Experimental Class I	35		1 6.94
Sig.		1,000	.470

From table 6 above, the analysis results group the data into two subsets. The first subset contains the average value of mathematical creative thinking ability from the *Direct Instruction* (DI) group, while the second subset consists of the average value of the CPS and PBL groups. This grouping indicates that student performance in CPS and PBL is at an equivalent level. On the other hand, there is a significant gap when comparing the results of the DI group with the CPS and PBL groups.

Based on the results of the one-way anova test, it shows that the significance obtained is 0.000 <0.05, meaning that H0 is rejected and H1 is accepted. This explains that there is a significant influence between the average *posttest value* and questions that indicate creative thinking skills in the three classes. Tukey test analysis on the average posttest value shows a comparison between learning models: between CPS and PBL produces a significance of 0.463 (exceeding 0.05) which indicates no significant difference, while the comparison of CPS with DI produces a value of 0.000 (less than 0.05) which indicates a significant difference, while the significance value between PBL and DI classes is 0.009 <0.05. Based on the analysis that has been done, it can be concluded that differences in learning methods between classes produce

significant variations in the level of students' mathematical creative thinking skills. This proves that there is a real effect of different learning treatments on mathematical creativity in each class.

The results of the investigation showed that the implementation of CPS and PBL learning strategies proved effective in increasing the capacity of mathematical creative thinking in students. This is due to several factors that each learning model has. The advantages of implementing the CPS model are that this learning model can help students understand concepts through solving a problem, being active during learning, this learning process develops cognitive capacity and problem-solving skills in students, while allowing them to apply the understanding gained to new and different daily life contexts so that learning feels meaningful and through this model allows students to develop comprehensive and creative thinking skills during the learning process. The *Creative Problem Solving* (CPS) model has a distinctive advantage because it encourages students to engage in learning activities that hone mental abilities. This learning process provides space for the emergence of innovative ideas and diverse creative approaches in finding solutions. The uniqueness of this model lies in its ability to facilitate divergent thinking and unconventional problem-solving methods (Handayani & Amaliyah, 2022) .

In line with this, there are several advantages of the PBL model, namely students are trained to solve problems that may occur in their daily lives through contextual problems so that they can build their own knowledge through solving these problems so that learning will only focus on problems and allow students not to learn irrelevant material. This model also helps students to find their own material or solutions to the problems given to them (Yani et al., 2023) .

In addition to explaining the influence of the CPS and PBL models that have an impact on increasing students' creative thinking skills, this study also obtained specific data results regarding the most effective model of the three models. Based on the results of statistical tests, it can be seen that the average CPS class is 16.94, this value is greater than the average PBL class, which is 16.26. Based on the research findings, the application of the CPS model shows higher effectiveness in developing students' creative thinking skills compared to the use of the PBL and DI models. This is in line with research conducted by Rahma & Wicaksono (2023) that the use of the CPS method has a positive impact on increasing students' creative thinking skills. This learning model makes it easier for students to master the material while honing their abilities in solving mathematical problems. Which in mathematical creative thinking prioritizes the systematic thinking process, starting from problem recognition, idea development, to solution formulation, compared to memorization-based learning.

Then based on the results obtained, it shows that in the fluency component , all sample classes achieved a level of mathematical creative thinking ability of 81.50%, which indicates a fairly high achievement in this indicator. The level of students' ability to solve test questions shows significant variation. Some students are still limited to

providing one answer with a less detailed explanation. On the other hand, some students are able to provide multiple quality answers with structured and clear steps. In the *flexibility indicator* which reached 70.79%, it can be seen that some students have been able to apply various solution methods correctly. However, there are still students who have difficulty developing variations in problem solving methods. Meanwhile, the *originality indicator* recorded an achievement of 52.22%. This figure indicates that students' ability to produce unique and different solutions still needs to be improved. In working on questions, students have the capacity to use alternative approaches that are unique compared to general solutions. The fourth indicator, *elaboration* , based on the scores obtained for each indicator, shows that students' mathematical creative thinking ability in this indicator reached 56.82%. Students are able to answer questions correctly in one or more ways accompanied by detailed solutions, but there are some students who are less detailed in writing their solutions to the questions.

Conclusions and Suggestions

Referring to the analysis of the results and discussions that have been presented, it can be concluded that there is a positive impact of the implementation of the CPS and PBL models on students' mathematical creative thinking skills. This success was achieved because both learning models encouraged students to participate more actively in developing their knowledge and thinking capacity. Based on these findings, it is recommended that educators apply the CPS and PBL learning models as a strategy to improve students' mathematical creative thinking skills in the learning process. However, to further explore the function and matching of a cooperative learning model in general, further quantitative research is also needed

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