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The Effectiveness of Project-Based Learning and Problem-Based Learning Models on Students' Mathematical Creative Thinking Abilities Viewed from Learning Motivation

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ABSTRACT

This research aims to understand how teaching methods influence innovative thinking skills, examine the influence of learning motivation on creative thinking abilities, and examine the impact that occurs on creative thinking abilities due to the interaction between the learning model and learning motivation. The chosen research method is experimental. The research sample involves students from class VIII.7 and class VIII.9 of SMP N 2 Rembang, totaling 64 students. The data collection technique applied is through tests. Two-way ANOVA tests are applied in the data analysis. The results of this study indicate that there is a significant partial influence between the learning model and learning motivation on students' creative thinking abilities, where high learning motivation makes students excel in learning compared to other learning motivations. Additionally, there is also a mutually interactive relationship between learning models and learning motivation on creative thinking abilities.

Keywords: *learning model, mathematical creative thinking ability, learning motivation.*

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INTRODUCTION

Education is a joint effort of society and the state to guide the younger generation in preparing for a better future for the progress and continuity of the nation (Elihami & Syahid, 2018). Mathematics serves as a means for students to achieve desired skill standards (Damayanti & Afriansyah, 2018). The government also aims for students to attain proficiency by employing advanced thinking skills (HOTS). As per (Ishartono et al., 2023), Higher Order Thinking Skills (HOTS) pertain to elevated levels of cognitive abilities problem-solving processes, analysis, synthesis, evaluation, and creativity. These abilities are the main focus of the government and are applied in national examination evaluations, seen as highly important skills in the 21st century (Yoki Ariyana dkk, 2018). High-order thinking abilities span various abilities, among them are skills related to innovative thinking (Yunita et al., 2018).

According to (Triyani & Azhar, 2021) in the context of creative thinking, ability refers to innovative thinking skills related to the field. Exploration of mathematics has driven exploring CT to expand understanding of concepts in the process of learning mathematics (Aizikovitsh-Udi & Cheng, 2015). According to Mednick, creative thinking is the process of connecting a concept into an unusual combination, ultimately generating new unique ideas (Treffinger et al., 2002). (Siswono, 2004) argues innovative thinking is a utilized process to create innovative ideas, develop unusual or new concepts, and find solutions to specific problems. According to (Syahrin et al., 2019) if a student has creative thinking abilities, then the student can generate various ideas when solving mathematical problems to choose the right answer.

Chesimet explains that in adapting the Torrance Test for Creative Thinking (TTCT), Three creative elements are considered: fluency, flexibility, and originality. He describes fluency refers to provide multiple ideas in answering mathematical questions; Flexibility is described capacity to generate various ideas and solutions for mathematical problems; whereas originality is characterized as the capability to create unusual innovations and solutions that are not typically the same as the problem (Chesimet et al., 2016). Many countries emphasize the significance of building Thinking critically and creatively Skills (CCTS) in their education programs, with the aim of creating an innovative generation in the future. As an illustration, The recently implemented curriculum 2013 within Indonesia emphasizes the development of "accurate and innovative thinking skills" in addressing mathematical problems as the main goal of national education (Kemendikbud, 2017).

To enhance mathematical innovative thinking skills, interactive teaching strategies towards students are needed. One example of a teaching model is project-based learning (PjBL), where students are fully engaged in planning and completing projects, aiming to enrich both technical and social skills of students (Jalinus et al., 2020). Using PjBL, the learning outcomes in mathematics at school can serve as real indicators of students' abilities in creative thinking (Ummah et al., 2019). Learning approach based on projects process refers to (Rahayu & Hartono, 2016), described as a method where students are empowered to achieve understanding of the material through tasks, resulting in students

producing tangible works that have real value and relevance. As per (I. Lestari & Juanda, 2019), The model for project-based learning within PjBL is a learning approach that implements project work in student learning, where teachers provide opportunities for students to manage the class using various approaches. Thus, PjBL is a viable option to consider for strengthening students' mathematical creative thinking skills.

Research obtained by (Marliani, 2016) reveals creative students' abilities in mathematical thinking tend to be minimal. The inadequacy of students' creative thinking skills in mathematics is influenced by suboptimal teaching methods in the subject. There are several teaching methodologies that can be implemented in mathematics education, such as Problem Based Learning (PBL) methodology (Ridia & Afriansyah, 2019). According to (Happy & Bondan Widjajanti, 2014), PBL an educational strategy to encourage to encourage students' problem-solving skills. According to (Khamid & Santosa, 2016), the implementation of PBL in teaching involves active participation of students in learning and the development of understanding of the information provided, creating enjoyable learning experiences through interactions between students and educators , along with among students.

Learning motivation has a significant influence on the education process (Khotimah et al., 2018). The ARCS learning approach a development of the ARCS motivation theory, which interprets motivation as stemming from fulfilling personal needs and aspirations for success. This model consists of four essential components in the learning process: attention, relevance, confidence, and satisfaction (Molaee & Dortaj, 2015). Research conducted by (Suprihatin, 2015) states that motivation is a source of energy that drives individuals to have a high level of desire in carrying out an activity. According to (Fauziah et al., 2017), Highly motivated students more likely to gain a deeper understanding of learning objectives. Additionally, students who actively contribute to the learning process usually have high motivation and may be able to complete tasks with good quality. According to (Emda;Amna, 2017), learning motivation plays a significant role in achieving success in student education. Success in learning can be attained when there a strong willingness and motivation to learn. According to (kurnia eka Lestari, n.d.), it is also recommended that during learning, is important encourage learning motivation by instilling a strong drive and need for learning, strengthening interest and attention in the context of mathematics, practicing perseverance and resilience to face challenges, and fostering enthusiasm and motivation in achieving success.

Findings of the study carried out by (Yunita et al., 2021) found that with a confidence level of 95%, the effectiveness of the PjBL model is significantly higher in enhancing skills related to creative thinking, with a random effects model applied with a magnitude of 1.190. The study carried out by (Rachmantika et al., 2022) aimed to measure students' creativity using project-based learning approaches through online learning. Findings from the research indicate the implementation of project-based learning methods is effcient in enhancing students' creative thinking skills in topic number patterns. Research performed by (Ningsih et al., 2021) aimed to identify impact of using

PjBL learning model students creativity. The research findings reveal that impact the impact of the project-based learning model on students' creative thinking. abilities, which is categorized as appropriate in implementing the learning model using Project Based Learning.

Based on (Nugroho et al., 2013), "Efficiency of the Problem-Based Learning Approach on Creative Thinking Abilities in Mathematics". The study aimed to understand the correlation between motivation and creative thinking abilities in the context of mathematics. Referring to the findings obtained, revealed through implementation of problem-based learning models using learning CDs, it helped improve effectiveness in enhancing students' capacities in creative thinking in the context of mathematics. Research conducted by (Sari, 2020) aimed to identify the relationship between learning motivation and the development of students' mathematical creative thinking abilities. The findings revealed that there is a positive correlation between mathematical creative thinking abilities and learning motivation in the context of PBL learning. According to the study by (Noverianto & Munahefi, 2023), it aimed to observe the enhancement of students' mathematical creative thinking skills and evaluate the correlation between students' The correlation between motivation to learn and mathematical creative thinking abilities in the context of innovative learning. The findings of the research revealed Students with high levels of learning motivation tend to cultivate good mathematical creative thinking skills.

From Based on the explanation provided above, the researcher is keen to conduct a study entitled "The Effectiveness of Project-Based Learning and Problem-Based Learning on Students' Mathematical Creative Thinking Abilities: A Study on Learning Motivation." This objective of this study to examine partial effects of learning motivation and teaching models on creative thinking abilities, as well as to determine if there is an interaction between teaching models and the influence of learning motivation on creative thinking abilities.

METHOD

The experimental method is applied as the research method in this study. The experimental method is a type of research approach carried out to determine statistical impact a treatment applied to a specific situation (Sugiyono, 2019). This research was conducted at SMP N 2 Rembang located at Jl. P. Sudirman No. 127, Jl. Jend. Sudirman No.158, Kabongan Lor, Kec. Rembang, Kabupaten Rembang, Central Java. Eighth-grade students at SMP N 2 Rembang are designated as the population in this study. There are two classes, namely class VIII.7 and class VIII.9, designated as the research samples, with each class consisting of 32 students.

The sampling technique was conducted randomly from the population of eighth-grade students at SMP N 2 Rembang, totaling 64 students. The experimental groups were selected from class VIII.7 as the treatment group using the PBL learning model, while class VIII.9 was selected as the treatment group using the PjBL learning model. The independent variables include learning motivation and teaching model, while creative thinking ability is designated as the The variable that depends on other factors in

this study. The research sample consists of 32 students from each treatment group, focusing on the Pythagorean theorem material.

During the research implementation and data collection stage at SMP N 2 Rembang, the first phase of the study will involve distributing questionnaires and conducting pretests before the use of LKPD (Student Worksheets) to both samples. In the next phase, the researcher will conduct the experimental class treatment using LKPD in both the PjBL and PBL classes. In the final phase, the researcher will distribute post-treatment learning motivation questionnaires and post-tests to the PjBL and PBL classes. The pre-treatment questionnaire serves to determine if both groups have similar motivations. The post-treatment questionnaire the goal is to ascertain whether there are discrepancies in the average scores after the treatment. The initial test (pretest) aims to assess whether both samples have balanced abilities before the treatment. The final test (post-test) aims to assess the results after the treatment.

The concluding stage of this study involves data analysis, which includes comparing the mean values of the two samples. An initial assessment, called the prerequisite test, involves testing for normality by examining the normality of residual standard values to determine the normality of the data. Data is considered normal if the significance value exceeds 0.05. If the data follows normal distribution, the subsequent stage involves performing tests for homogeneity and two-way ANOVA. The homogeneity test can employ a two-way ANOVA to establish homogeneity of the data. Data is considered homogeneous if the significance value is < 0.05. Two-way ANOVA is applied to essess the impacts of two separate factors on a single dependent variable. If the outcomes of the Two-Way ANOVA indicate a. significant effect of one or both factors, as well as a significant interaction between them, the next step is to conduct post-hoc tests. Researcher uses the Tukey HSD post-hoc test. Post-hoc tests help identify significant differences between specific groups, as Two-Way ANOVA only provides information that there is an overall difference between groups but does not provide details on where these differences lie.

RESULTS AND DISCUSSION

RESULTS

This study took place over three sessions. The students' mathematical creative thinking abilities were identified through the distribution of pretest and posttest exams to the students. The students' mathematical creative thinking Abilities were assessed through tests utilizing instruments chosen bty the researcher to collect data. Before conducting the test exams, students first filled out a learning motivation questionnaire. The questionnaire method was applied to obtain data related to students' mathematical learning motivation. After obtaining the data, residual normality testing and homogeneity testing were conducted as prerequisites prior to performing tests using two-way ANOVA.

Before conducting the Two-Way ANOVA test, it is necessary to perform a check on the statistical prerequisite tests. This is aimed at examining whether the students' abilities from both sample groups have met the assumptions of normality and homogeneity. The normality test will be conducted using the Shapiro-Wilk

method as shown in Table 1.

Table 1. Results of Shapiro-Wilk Normality Test Residuals.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Standardized Residual for Creative_Thinking_Ability	.100	64	.189	.964	64	.056

The test for normality is conducted to determine it the data generated from the study follow a normal distribution. Normality is assessed using the Shapiro-Wilk normality test on residuals. The data is considered normal if the significance value is > 0.05. In Table 1, after the calculations, it is stated that the significance value is greater that 0.05. This suggests that the data follows a normal distribution. After the data has been found to be normally distributed, the homogeneity test will be conducted.

Table 2. Homogeneity Test

F	df1	df2	Sig.
1.522	5	58	.197

After ensuring that the data is normally distributed, the subsequent step involves conducting the homogeneity test. If the significance value is > 0.05, then the data a is considered homogen. As seen in Table 2, after the calculations, the significance value is 0.197. This indicates that the data is homogeneous.

Table 3. Two Way Anova Analysis test results

Tests of Between-Subjects Effects

Dependent Variable: Creative Thinking Ability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Learning_Model (A)	203.889	1	203.889	4.055	.049
Motivation_to_learn (B)	706.364	2	353.182	7.024	.002
Learning_Model * Motivation_to_learn (B)	441.063	2	220.532	4.386	.017
Error	2916.428	58	50.283		
Total	484222.000	64			

From Table 3, the researcher concludes the results of the two-way ANOVA analysis: students' creative thinking abilities are partially and significantly influenced by the variables of teaching model and learning motivation, and an interaction between learning motivation and teaching model on creative thinking abilities is found.

DISCUSSION

In the context of achieving the research objectives outlined earlier, this study aims to identify effectiveness of the impact of teaching models on students' creative thinking abilities. The analysis is conducted to gain a deep understanding of the relationship between the teaching models used and students' creative thinking abilities. Thus, statistical steps and evaluations are carried out to determine the best teaching model in order to advance students' creative thinking abilities.

First research objective is to examine whether the teaching model impacts creative thinking skills. According to the findings acquired earlier as outlined in the research objectives, from Table 3, we can see that the Sig. value is < 0.05, specifically 0.049. This means that both sample groups, the teaching model significantly influences students' creative thinking abilities. After calculating the average values to identify the appropriate teaching model for developing creative thinking abilities, following the two-way ANOVA test calculations, the mean value for PjBL class is 87.411. Meanwhile, the average value for the PBL class is 83.530. It can be inferred that PjBL teaching model is more appropriate for utilizaion in evaluating students' creative thinking abilities.

Next, second research objective is executed until examine whether learning motivation influences creative thinking abilities. Based on the Two-Way ANOVA test presented in Table 3, in the second row, it is evident that the Sig. value is 0.002 or below 0.05. This condition indicates that there is a between between students' learning motivation and their creative thinking abilities, as reflected in the average values of students' learning motivation. When calculated through the two-way ANOVA test, the average value for high learning motivation is 89.330, for low learning motivation is 80.157, and for moderate learning motivation is 86.923. It is possible inferred students exhibiting strong motivation to learn display superior performance compared to those with moderate or low motivation. Therefore, the order from best to worst is students with high motivated to learn, students who have moderate motivation to learn, and students who have low motivation to learn.

In the context of achieving the third objective, which is to test the relationship between teaching models and learning motivation on creative thinking abilities, referring to Table 3 regarding the Two-Way ANOVA test, it is observed in the Sig. column, the third row, that the Sig. value is 0.017 or below 0.05. This condition reveals that there is an interaction between teaching models and the influence of learning motivation on creative thinking capabilities. Problem-Based Learning (PBL) model can enhance students' learning motivation, resulting in better creative thinking skillsin contrast to students using the Project-Based Learning (PjBL) model. This is supported by the outcomes of the two-way ANOVA test, wherein the average score for creative thinking abilities in PjBL group was 88.786, while in the PBL group it was 89.875. However, the PjBL teaching model, when applied to students with moderate learning motivation, yields better skills in creative thinking than the PBL model. This is possible seen the average creative thinking ability scores for the PjBL class being 86.846 and for the PBL class being 87.000. Furthermore, students with low learning motivation who use the PjBL teaching model will

develop better creative thinking abilities than those using the PBL model. This is evident from the average creative thinking ability scores for the PjBL class being 86.600 and for the PBL class being 73.714. In the conducted study, it was found that the appropriate teaching model can be chosen based on students' learning motivation levels. The PBL model is more suitable for highly motivated students, while the PjBL model is more suitable for students with moderate learning motivation. However, it should be noted that the PjBL teaching model also produces satisfactory results for students with minimal learning motivation. Derived from the study findings, there is a possibility indicating a correlation between teaching methods and learning motivation that significantly influences students' creative thinking abilities in mathematics education.

CONCLUSION

Derived from the conversation presented in the aforementioned research, the findings are as follows: 1) The teaching model significantly influences students' creative thinking skills. 2) Significant effects were found on motivation for learning and creative thinking abilities among students, where highly motivated students perform better in learning compared to other levels of learning motivation. 3) Interaction between learning motivation and teaching model on creative thinking skills was observed.

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