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The Impact of the Creative Problem-Solving (CPS) Learning Model on the Mathematical Reasoning Skills of 8th-grade Junior High School Students Studying Systems of Linear Equations with Two Variables

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ABSTRACT

The goal of this research is to examine the effect of the Creative Problem Solving (CPS) Learning Model on Students' Mathematical Reasoning Abilities in the Topic of Systems of Linear equations with Two Variables for 8th-grade students in a Public Junior High School I Jabung of Malang. This study used an Experimental Design. The research subjects consist of 60 students from two groups. The sampling technique used is Random Cluster Sampling. The research instrument used is a test. The data analysis techniques include descriptive statistics, inferential statistics, and SPSS. The results of this study indicate a significant effect of the creative problem-solving Learning model on students' mathematical reasoning abilities. This is evident from the average score in the experimental group, which is 72.600, and the average score in the control group, which is 2.200. Based on the results of the inferential statistical analysis, the post-test value obtained is t-value = 0.694, which is greater than the t-table value of 0.58. Therefore, the null hypothesis (H_0) is injected, and the alternative hypothesis (H_1) is accepted. This means that the Creative Problem-Solving learning model significantly affects students' mathematical reasoning.

Keywords: *Creative* P*roblem Solving*, Mathematical Reasoning Ability, Systems of linear equations with two Variables.

INTRODUCTION

Reasoning ability is one of the objectives of mathematics education. Teachers, as educators and instructors, should be able to develop students' reasoning abilities. Students with strong reasoning skills will easily grasp mathematical concepts, while those with low mathematical reasoning abilities will find it challenging to understand mathematical materials. This is because mathematics content and mathematical reasoning are two inseparable things. Mathematics content is understood through reasoning, and reasoning is understood

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through learning mathematics content (Shadiq, 2004).

Using reasoning, students can build knowledge and skills in working on mathematics problems easily (Napitupulu et.al., 2016). The importance of having mathematical reasoning abilities in students is essentially under the vision of mathematics, especially in meeting future needs (Ria et al., 2021). mathematical reasoning abilities enable students to (a) recognize reasoning and proof as basic aspects of mathematics; (b) make and examine mathematical conjectures; and (c) develop and evaluate mathematical arguments and proofs (Wibowo, 2017). In a preliminary study conducted (Aprilianti & Zhanty, 2019) it was explained that mathematical reasoning has a very important role for students, students should not only understand and practice questions but students should actively participate in solving problems in mathematics learning.

Due to the crucial role of mathematics in human life, there is a need for an enhancement of the quality of mathematics education in schools. Various efforts can be made through the development of teaching strategies, teaching models, and the use of teaching media aimed at facilitating the delivery of instructional materials to students in the classroom (Dimyati and Mudijono, 2006).

Under the results of the researcher's observation during the study at State Junior High School 1 Jabung, Malang, it was found that several students do not enjoy mathematics lessons. These students lack enthusiasm for learning mathematics; during math lessons, they display a very passive attitude, meaning that if the teacher does not instruct them to complete assignments, the students will not do the tasks given by the teacher. When faced with new problems, some students are unwilling to work on them because they can only solve problems similar to the examples given previously. Furthermore, some students struggle with shortcuts and question new numbers that suddenly appear, desiring a more systematic approach to learning. There are still students who cannot solve new problems because they do not utilize their reasoning optimally. In terms of the application of teaching models, the selection of an appropriate teaching model is crucial so that students can learn effectively and efficiently. Therefore, a teacher must master and choose the right model in line with the teaching material, the environmental conditions, and the students themselves.

The chosen teaching model should also be able to influence students' motivation to learn in the classroom. The appropriateness of using the model can also affect students' abilities, especially their mathematical reasoning skills. Based on the results of these observations, the researcher selects the Creative Problem-Solving teaching model to address the difficulties experienced by students. With the Creative problem-solving teaching model, students not only learn more systematically but also have the opportunity to verify the correctness of their answers by checking.

The Creative Problem-Solving model is an instructional approach aimed at fostering students' ability to creatively and innovatively solve problems. This model promotes creative thinking, analytical skills, and collaborative abilities, all of which are vital skills for addressing complex real-world issues. Shoimin (2014) states that the Creative Problem model focuses on teaching problem-solving skills, followed by skill reinforcement. When confronted with a question, students can utilize problem-solving skills to select and develop their responses. Instead of memorization without thinking, problem-solving skills enhance the thinking process. Using this teaching model is an effort to enhance the process, and achievement, and serve a greater function, namely providing the foundation for the development of classroom teaching activities, fostering student engagement in self-assessment, and raising awareness of their personal development. Therefore, it is expected that with a teaching model that encourages students to think collaboratively and is driven by their intrinsic motivation, the learning objectives can be achieved.

The creative Problem-Solving model can guide students to generate ideas, acquire ideas, and provide solutions in problem-solving, especially in mathematics. In this approach, the teacher presents problems for the students to work on, which are related to everyday life, sparks students' curiosity, and helps them

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formulate problem-solving strategies, enabling students to find solutions using the best strategies. This is in line with the findings of Syazali (2015), which indicate that the implementation of the Creative Problem-Solving teaching model has an impact on students' mathematical problem-solving abilities. Similarly, the results of research conducted by researchers such as Nopitasari (2016) and Muin et al. (2018) demonstrate that students' mathematical problem-solving skills improve more when following the Creative Problem-Solving model compared to conventional teaching models because the creative problem-solving model can foster the development of ideas and critical thinking.

RESEARCH METHODS

Research Design

This study is an Experimental Research. The experimental research method is one of the scientific approaches used to understand the cause-and-effect relationship between specific variables in a phenomenon. In this method, researchers intentionally manipulate a variable called the independent variable to observe its impact on the dependent variable.

The design used in this study is the inequivalent Control Group Design. In this design, both the experimental and control groups were not selected randomly. The design incorporates a pretest to determine the initial condition of the average mathematics learning outcomes of students in both the experimental and control groups. The post-test is used for data analysis for both the experimental and control groups. The research design is as follows:

O_1 x O_2

____

O_3 O_4

Explanation:

O1 = pretest for the experimental group

O2 = posttest for the experimental group

O3 = pretest for the control group

O4 = posttest for the control group

X = treatment for the form of Creative Problem Solving model implementation

The Subject of research

The subjects of this research are 60 students from 8th grade D and 8th grade E at Public Junior High School I of Jabung, comprising 30 students in 8th grade D and 30 students in 8th grade E. The sample selection was carried out using the cluster random sampling technique. The sampling method involved selecting 2 groups randomly from all available groups. Similarly, from the 2 selected groups, further random selection was conducted to determine the experimental group and the control group. As a result, 8th grade D was chosen as the experimental group, which received the Creative Problem-Solving learning model, and 8th grade E was selected as the control group, which received the conventional learning model.

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Research Instruments

The research instruments used in this study are tests, namely pretests, and posttests. Pretests are employed to assess students' mathematical reasoning abilities before any intervention is given. Meanwhile, post-tests are used to determine the level of students' mathematical reasoning abilities after being exposed to the treatment using the Creative Problem-Solving Model.

Data Analysis Techniques

There are two types of data analysis used in this research: (1) Descriptive Statistical Analysis, and (2) Inferential Statistical analysis. Data analysis in this study was conducted using the Statistical Package for Social Science (SPSS). The decisions were made to determine the differences and the effects of independent variables on the dependent variable based on a significance level of $\alpha = 0.05$ (5% error rate) or a 95% confidence level.

For data analysis and hypothesis testing, the researcher used the t-test for two sets of data used as a comparative statistical test. The t-test produces a t-value that can be used to validate the hypothesis. The statistical analysis method employed in this study is the paired t-test, which compares data points before and after the treatment or intervention, also known as a time-based t-test (pretest-posttest).

RESULTS

Results

Descriptive Statistical Analysis

From the pretest and posttest results conducted in both groups, descriptive statistical analysis was carried out and is depicted in the following table:

Table 1. Mean of pretest and post-test results for the experimental and control groups

Descriptive Analysis	pretest		posttest	
	Experiment	Control	Experiment	Control
Number of Samples	30	30	30	30
Means	71,47	72,03	79,17	81,37

Based on the table above, it is evident that the experimental and control groups had similar initial abilities. This can be observed from the relatively small difference in average scores, and there was an improvement in students' mathematics learning outcomes from the pretest to the post-test. In the pretest, the average mathematics learning outcomes for the experimental group and the control group differed by 1.44. Furthermore, when looking at the post-test data, there was an increase in the average mathematics learning outcomes for the experimental group compared to the control group, with a difference of 2.20. This indicates that after applying the Creative Problem-Solving model to the experimental group, the average mathematics learning outcomes improved, implying an impact on the reasoning abilities and mathematics learning outcomes of the 8th-grade students at SMP Negeri 1 Jabung. To determine more accurately whether there is an influence of the creative problem-solving model on the reasoning abilities and learning outcomes of the experimental and control groups, inferential analysis will be conducted.

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Inferential Statistical Analysis

The data analysis technique used in this research is a two-sample t-test. The t-test is conducted to determine whether there is an influence before and after the treatment. Both the pretest and posttest consist of 3 open-ended questions related to linear systems of two variables story problems. The pretest and posttest scores are statistically analyzed using tests for normality, homogeneity, and the two-sample t-test.

Inferential Analysis of Pretest Data

Pretest scores are obtained from the mathematics evaluation test of the students before any intervention is applied. After conducting the pretest, the teaching and learning process is carried out using the Creative Problem Solving (CPS) learning model in the experimental group and conventional teaching in the control group. The pretest data analysis is processed as follows:

Normality Testi **Results for Pretest Scores**

The data analyzed in this normality test includes the pretest scores of the experimental and the control group. The informality test is conducted to determine whether the data from each group is normally distributed or not. This is because one of the assumptions that must be met before conducting the homogeneity of variance test is that the data from both groups follows a normal distribution. In this study, the normality test is computed using the Kolmogorov-Smirnov test with the assistance of IBM Statistics. The results of the normality test for pretest data can be seen in Table 2 as follows:

Table 2. Normality Test for Pretest in the Experimental and Control Group

Group	*Kolmogorof-smirnov*		Conclusion
	N	Sig	
Experiment	30	0,306	Data is normally distributed
Control	30		

Using the Kolmogorov-Smirnov test, the results for the pretest in the experimental and the control group showed a significant value of 0.306 > α (α = 0.05), which leads to the conclusion that H_0 is accepted, indicating that the data follows a normal distribution.

Homogeneity of Variance i**Test Results for Pretest Scores**

In addition to the normality test, one of the prerequisites before conducting a comparison of two sample groups is that they should have the same characteristics before receiving different treatments, which is tested through the homogeneity of variance. Since the pretest scores in both groups are normally distributed, the homogeneity of variance test for pretest data is performed. The purpose of the homogeneity test is to determine whether the experimental and the control groups have the same variance or not.

To determine whether the values of both groups are homogenous or not homogenous, it is done by comparing the $F_{statistic}$ and F_{table} values. The F_{test} is obtained by comparing the largest variance with the smallest variance. The results of the homogeneity test calculations can be seen in the appendix and summarized as follows:

Table 3. Homogeneity Test of Pretest Score Data for experimental and iControl Group

Group	Variance	N	$F_{statistic}$	F_{table}	explanation	Conclusion
Experiment	164,49	30	1,21	1,84	$F_{statistic} < F_{table}$	Homogeneous

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Control	135,92	30				

Based on the Table 3 above, it is found that F-statistic < F-table, which is 1.21 < 1.84. This means that the variances of the experimental group with the creative problem-solving learning model and the Control group with conventional learning are inhomogeneous.

In addition to manual calculations, the results of the homogeneity of variance test were assisted by using SPSS. The results of the homogeneity test for pretest data can be seen in the following table.

Table 4. Homogeneity of Variance Test for Pretest in the Experimental and Control Group

	Levene Statistic	Sig.	explanation
Based on Means	0,467	0,497	Homogeneous Data

Based on Table 4 above, with statistics based on the mean, a significance value of 0.497 > α (α = 0.05) is obtained. Therefore, H_o is accepted, indicating that the data is homogeneous.

Two-Sample Mean Difference Test for Pretest Scores

Because the variances of the experimental and the control groups are homogeneous, the statistical test for comparing the two mean learning outcomes is the t-test. The results of the t-test calculation for pretest scores in the experimental and the control group can be seen in Table 5 below:

Group	N		S_{ig}	F-statistic	F-table	Explanation
Experiment	30	36,25	12,25	-8. 397	58	$F_{table} < F_{statistic} < F_{table}$
Control	30	41,93				

Table 5. Results of the t-test for Pretest Data in the experimental and control group

Based on Table 5 above, we have obtained t-statistic = -8.398, and t-table = 58. This means that -F-table < F-statistic < F-table, which is -58 < -8.398 < 58. This indicates that H_0 is accepted and H_I is rejected. In other words, it means that the average reasoning abilities of the students in the experimental group are the same as the average reasoning abilities of the students in the control group before the treatment.

Furthermore, the researcher also used SPSS to calculate the t-test. The results of the t-test can be seen in the following table.

	t-test for Equality of Means		
	T	Df	Sig. (2-*tailed*)
Equal variances assumed	0,157	58	0,875
equal variances not assumed	0,157	57,509	0,875

Table 6. Test of Two Pretest Means for Experimental and Control Group

Based on the table above, it is evident that the significance value (2-tailed) is 0.875, which means that the significance value is greater than α. Therefore, H0 is accepted. This indicates that the average reasoning abilities of the students in the experimental group are also the same as the average reasoning abilities of the students in the control group before the treatment.

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Inferential Analysis of Post-Test

Because the pretest scores data exhibit the same capabilities, the analysis proceeds to the post-test. Post-test scores are statistically analyzed using tests for normality, homogeneity, and a two-sample mean difference test (t-test). Post-test scores are obtained from the mathematics evaluation test of the students after the treatment has been administered. The analysis of post-test data is as follows.

The results of the normality Test for Post-Test Scores

The data analysed in this normality test consists of the post-test scores for both the experimental and the control groups. The purpose of this normality test is to determine whether the data from each group follows a normal distribution or not. This is because one of the assumptions that must be met before conducting the homogeneity of variance test is that the data from both groups should be normally distributed.

In this research, the normality test is computed using the Kolmogorov-Smirnov test with the assistance of SPSS/IBM Statistics. The results of the normality test for post-test data can be seen in **T**able 7 below:

Table 7. Post-test Normality iTest for Experimental and iControl Group

Group	*Kolmogorov-Smirnov*		Conclusion
	N	Sig	
Experiment	30	0,349	Distributed data
Control	30		

Using the Kolmogorov-Smirnov test, the results for the post-test in the experimental and the control group show a significance value of 0.349, which is greater than α (α = 0.05). Therefore, it can be concluded that H_0 is accepted, indicating that the data follows a normal distribution.

Post-test Value Variance Homogeneity Test Results

Because the post-test scores data in both groups are normally distributed, the homogeneity of variance test for post-test data is conducted. The results of the homogeneity test can be seen in the appendix and are summarized in table 8 below:

Table 8. Homogeneity Test Results for Post-Test Data in the experimental and control Group

Group	variance	N	$F_{statistic}$	F_{table}	Explanation	conclusion
Experiment	163,799	30	1,60	1,84	$F_{statistic} < F_{table}$	Homogeneous
Control	137,757	30				

Based on the table above, it is found that $F_{statistic} < F_{table}$, which is 1.60 < 1.84. This indicates that the variances of the experimental group with the Creative Problem-Solving learning model and the control group with conventional learning are homogeneous.

In addition to manual calculations, the results of the homogeneity of variance test were aided by using SPSS. The results of the homogeneity test for variance in pretest data can be seen in the following table.

Table 9. Homogeneity of Variance Test for Post-Test in the Experimental and Control Group

	Levene Statistic	Sig.	Explanation
Based on means	0.713	0, .402	Homogenous Data

Based on the table above, with statistics based on the mean, a significance value of 0.402 is obtained, which is greater than α (α = 0.05). Therefore, H_o is accepted, indicating that the data is also homogeneous.

Two-Sample Mean Difference Test for Post-Test Scores

Because the variances in the experimental and the control groups are homogeneous, the statistical test for comparing the two mean learning outcomes is the t_{-test}. The results of the t_{-test} calculation for post-test scores in the experimental and the control group can be seen in the appendix in Table 10 below:

Table 10. Results of the it-Test for Post-Test Data in the Experimental and Control Group.

Group	N		Sig	$t_{-statistic}$	T_{-table}
Experiment	30	72,600	0,491	0,694	58
Control	30	2,200			

Based on the table above, we obtain t-statistic = 0.694, and t-table = 58. Thus, t-statistic > t-table, which is 0.694 > 58. It means that H_o is rejected, and H_I is accepted. In other words, the average reasoning ability of students in the experimental group is better than the average reasoning ability of students in the control group after the treatment.

DISCUSSION

The pretest results for the experimental group range from a highest score of 61 to a lowest score of 20, while the control group obtained scores with a highest of 60 and a lowest of 20. This condition indicates that neither group achieved the Minimum Passing Standard. This is due to the passive learning process, where students did not pay close attention to their teachers, and hesitated to ask questions when encountering difficulties during practice, leading to students attempting problems without knowing the correct solutions.

Based on the experience gained by the researcher during the implementation of the Creative Problem-Solving model, there was an increase in learning activity in the classroom. During the introductory phase, the researcher provided motivation and apperception by linking mathematics to everyday life, and most of the students responded positively to what the researcher conveyed. Then, in the core activities, students followed the instructions on the Student Activity Sheet provided. Although at the beginning, some students were confused when working on the Student Activity Sheet in the second meeting, the teacher assisted them and asked them to clarify the issues, and the students responded well. In the subsequent meetings, students were able to work on the Student Activity Sheet, and develop, and solve the problems presented on the sheet. The student's response was consistently active throughout the learning process, actively seeking creative solutions to problems and engaging in discussions with other students.

In addition, the creative problem-solving learning model trains students to design discoveries, think and act creatively, solve problems realistically, and make school education more relevant to everyday life. As a result, students become active, motivated, and eager to seek solutions to every challenge they face. After students have completed the activities on the Student Activity Sheet, they proceed to present the results of their discussions, and other groups respond to the presenting group if there are different answers. In the closing phase of the activity, students are capable of drawing conclusions and working on the exercises provided. In the post-test results, the experimental group obtained the highest score of 100 and the lowest score of 47, while the control group achieved the highest score of 81 and the lowest score of 40. The mathematics learning outcomes in both groups showed an average improvement from the pretest to the post-test.

The average learning outcomes of the experimental and the control group before the treatment were similar. The analysis then continued with posttest data. From the analysis of the post-test, it can be observed that the average score for the experimental group is 72.600, while the average score for the control group is 2.200. Based on the results of the inferential statistical analysis, it was found that t-statistic = 0.694 > t-table = 58, which leads to the rejection of the null hypothesis (H_0) and the acceptance of the alternative hypothesis (H_I). This means that there is a significant influence of the Creative Problem Solving learning model on students' mathematical reasoning. This is supported by the research findings of Nopitasari (2016), Senjayawati and Nurfauziah (2018), Ningsih (2021), Tabunan (2021), and Marbun et al. (2022), which demonstrate that the creative problem-solving model can enhance students mathematical reasoning. This is because students become more creative in solving mathematical problems when exposed to the Creative Problem-Solving learning model. In other words, the creative problem-solving learning model not only improves students' reasoning but also enhances their creativity. Triyono et al. (2017) have stated that the Creative problem-solving learning model can enhance students' creativity.

CONCLUSION

Based on the observations and data analysis conducted, it is evident that the average score for the experimental group is 72.600, while the average score for the control group is 2.200. The results of the inferential statistical analysis show that $t_{statistic} = 0.694 > t_{table} = 58$, leading to the rejection of the null hypothesis (H_0) and the acceptance of the alternative hypothesis (H_I). This means that there is a significant effect of creative problem-solving and learning models on students' mathematical reasoning abilities.

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