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Improving Students' Mathematical Critical Thinking Abilities Using Join Learning Groups Techniques

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Joint Learning Groups (JLG) are groupings of students where one group of students works with activities that are interrelated with other groups, resulting in a set of interlinked activities. Task Planning Groups (TPG) are grouped based on the task plan that the teacher will give. This research aims to determine the increase in students' mathematical critical thinking skills after different treatments in the final test. The experimental research method aims to determine the increase in students' critical mathematical thinking skills using the Join Learning Groups technique and the results of students' critical mathematical thinking using the Task Planning Groups technique regarding Systems of Linear Equations in Two Variables. Research at SMPN 11 Jambi City, which was the sample for class VIII experimental group VIIIJ control group VIIIK. Experiments were treated with the JLG technique, and controls were treated with the TPG technique. From the results of this research hypothesis research using the t-test and SPSS.25, with t_{count} = 3.08 – 1.667, the JLG Technique further improves critical thinking skills with the TPG Technique in class VIII SMPN 11 Jambi City. The results of students' critical mathematical thinking using the JLG technique were 83.33, and the TPG technique was 75.03, better than the results of students' critical mathematical thinking using the TPG technique. In this research, it is recommended that teachers pay more attention to techniques that can improve student learning outcomes.

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1. INTRODUCTION

Mathematical critical thinking skills are one of the high-level thinking processes that can be used in forming students' conceptual systems. According to Suparyanto and Rosad [1], critical thinking is a mental process that analyzes the information obtained. This information is obtained through observation, experience, communication, or reading.

Mathematical critical thinking in mathematics learning aims to direct students to have a structured and intelligent way of thinking in organizing concepts to solve problems. Liberna [2] explains that solving problems and finding various alternative solutions. Apart from that, Liberna, also explained that the lack of implementation of mathematical critical thinking in mathematics learning has led to low students' mathematical essential abilities to think in general. It is feared that this situation will have a negative impact on student's abilities in the future, both in their careers and in their daily lives.

The results of observations on mathematics learning in class VIII SMPN 11 Jambi showed that out of a total of 36 students, only eight were able to think actively and critically mathematically in learning. This ability is seen in terms of solving problems, concluding and providing opinions, or asking questions. In general, many students in this class still need help solving problems, concluding and giving opinions, or asking questions. Apart from that, from the point of view of the models or methods used by teachers in teaching, they tend to be static and do not stimulate students to explore their critical thinking abilities. Such a learning situation can, of course, hinder the development of students' abilities, especially in terms of critical mathematical thinking.

The Join Learning Groups technique is a learning method that is oriented towards group learning. In this technique, the teacher groups students in one group of students to work with activities that are interrelated with other groups [3,4]. The teaching technique Join Learning Groups (paired Storytelling) was developed as an interactive approach between students, teachers, and learning materials. Task Planning Groups (TPG) Technique Learning. The task planning group technique is a form of grouping based on the task plan given by the teacher [5]. Both techniques have been empirically proven to have a positive impact on student learning processes and outcomes, making it possible to apply them in mathematics learning at SMP 11 Jambi City.

Critical thinking skills can be achieved by someone who has cognitive abilities [6,7,8]. This is because in solving a problem, a person must know and understand the problem first. Therefore, cognitive abilities play an important role in critical thinking. These critical thinking skills are not innate from birth but emerge when trained or applied through the learning process by educators as facilitators in the learning [9,10]. So that innovations in a learning process can grow and improve students' cognitive abilities and critical thinking skills.

Critical thinking skills are part of cognitive abilities [11,12]. Cognitive abilities are abilities related to a person's intelligence or thinking ability, which are generally associated with mastery of concepts. Utari (2012) states that the cognitive domain contains behavior that emphasizes intellectual aspects such as knowledge and thinking skills. In Bloom's revised taxonomy, Effendi [13] defines the cognitive domain categories as follows: C1 Remembering, C2 Understanding, C3 Applying, C4 Analyzing, C5 Evaluating, and C6 Creating. Because it is related to mastery of concepts, it is essential to carry out learning that is oriented towards developing cognitive abilities. Developing cognitive abilities is the same as developing critical thinking abilities.

Efforts to develop critical thinking skills for students at SMP Negeri 11 Jambi City are a necessity. This is based on the idea that students' relatively low critical thinking abilities are also related to their not-yet-optimal mastery of mathematical concepts. In accordance with the problem to be researched, this research aims to determine whether the improvement in the mathematical critical thinking skills of students who take part in learning through the Joint Learning Groups technique is better than the critical mathematical thinking abilities of students who take part in learning through the Task Planning Groups technique in class VIII. Jambi City 11 Public Middle School.

2. MATERIALS AND METHODS

In this research, primary data is data obtained from the final test results of the sample class

after the research was conducted. Secondary data is data obtained from mathematics teachers at SMPN 11 Jambi City. The instrument used in the research is in the form of descriptive questions given in essay form, namely given as a pretest before learning and a posttest after learning. The instrument was created to measure students' mathematical critical thinking abilities after being taught using the Join Learning Groups and Task Planning Groups techniques. This test instrument is on SPLDV material and given to the experimental class and control class.

The normality test is to test whether the data is normally distributed or not. If the data is normally distributed, then the t-test is used to test the equality of the two averages. However, if the data is not normally distributed, then hypothesis testing uses a non-parametric test, namely the U-test. There are many kinds of normality tests, but the one used in this research is the Chi-Square test.

The homogeneity test used in this research is the F test, which is used to see whether there is feasibility or a simultaneous influence between the independent variable and the dependent variable used in a study [14,15]. The F test is carried out by comparing the significance value (Sig.) with the confidence level to be achieved (α), which is 0.05, or comparing the F_{count} and F_{table} values. The decision-making criteria in the F-test are as follows: (1) If the significance value of F>0.05, then Ho is accepted. This means that the independent variables do not have a significant influence on the dependent variable simultaneously. Conversely, if the significance value of F is ≤0.05, then Ho is rejected, and Ha is accepted. This means that the independent variable simultaneously has a significant influence on the dependent variable. (2) Compare the F_{count} and F_{table} values. If the F_{count} value is greater than the F_{table} value, then Ho is rejected, and Ha is accepted.

3. RESULTS AND DISCUSSION

As previously mentioned, the data obtained in the research was collected using technical tests. The test was carried out separately in the control class and experimental class. The material taught in this research is Systems of Linear Equations in Two Variables (SPLDV). At the end of the meeting, students were given a posttest in the form of a mathematical critical thinking instrument with six essay questions. The instruments given as posttests in the experimental class and control class were the same, and the duration of the work on the same questions was 90 minutes. The instrument is adjusted to the indicators of mathematical critical thinking abilities being measured. The posttest given to the two students was tested for its feasibility using validity and reliability tests, as well as the level of difficulty and distinguishing power of the questions.

The highest score obtained by experimental class students was 100, and the control class was 96. This score shows that the highest score in the experimental class was 4 points higher than the control class. Apart from that, the lowest score obtained by experimental class students was 48, and the lowest score by control class students was 28. This shows that the lowest score in the experimental class was 4 points higher than the control class. The average mathematical critical thinking ability of experimental class students is higher than that of the control class, namely 83.33, while the control class is 70.73, which has a difference of 18.72.

The results of the posttest carried out by the students are then processed to obtain a further description of the student's mathematical critical thinking abilities. The mathematical critical thinking skills measured in this research are the ability to analyze arguments, make conclusions, and evaluate and solve problems [16,17]. Mathematical Critical Thinking Ability of Experimental Class Students. In other words, the tendency of the data to collect (the mode) is above average. The kurtosis value or sharpness of the data shown is -0.484, which is smaller than 0.263, so it can be interpreted that the curve model is platykurtic, which means the data varies. This data is also presented in Table 1:

Table 1. Description test in the experimental group

Description	Score
N	36
Range	48
Minimum	40
Maximum	52
Mean	35.56
Standard Deviation	11.51893
Variant	132.666
Skewness	-0.331
Curtosis	-0.484

Based on these results, it was found that the skewness of the data was 0.801, which means it

slopes negatively or slopes to the left. In other words, the tendency of the data to collect (the mode) is above average. The kurtosis value is 0.950, which is greater than 0.263, so it can be interpreted that the curve model is leptokurtic, meaning that the data has a sharp curve. The sharper the curve, the smaller the standard deviation so that the data is more grouped or homogeneous.

Table 2. Comparison of mathematical critical thinking abilities of experiment group and control group

	Exsperiment Group	Control Group
N	36	36
Minimum	40	34
Maximum	52	84
Mean	83.75	70.72
Standard Deviation	11.52	8.40
Variant	132.686	70.587

The standard deviation for the experimental class is 11.52, while the standard deviation for the control class is 8.40, which shows that the difference in data distribution is 1.998. The data variance can show the distance or closeness of the data variation to the average. The experimental group has a variance coefficient of 31.9%, while the control group has a variance coefficient of 19.7%.

In the indicator for analyzing arguments, the difference between the experimental class and the control class is 1.05%, the indicator for making conclusions has a difference of 9.65%, the indicator for evaluating has a difference of 18.72%, and the indicator for solving problems has a difference of 10.55%. The most significant difference lies in the evaluating indicator, and the most minor difference lies in the indicator's analysis of the argument. The highest mathematical critical thinking ability in the experimental and control group lies in the evaluating indicator of 83.33% and 70.73%. In comparison, the lowest critical thinking ability in the experimental class and control class lies in the problem-solving indicator of 61.82% and 52.27%. N-Gain Experimental and Control group.

Table 3. Average test results for control and experimental group

Class	Pretest	Posttest	N- Gain	Category
Experiment	61.62	83.33	0.61	Moderate
Control	59.88	70.73	0.24	Low

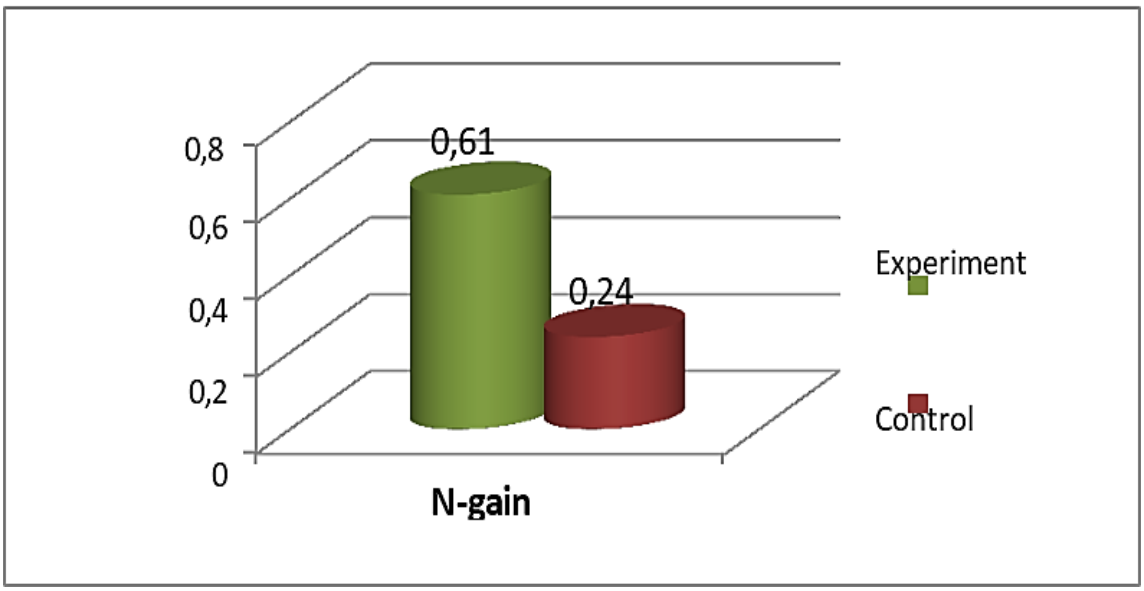

Fig. 1. Comparison of the N- Gain results for the experimental and the control group

Based on the Table 3, it can be seen that the N-Gain of the experimental class is 0.61, which means it is in the medium category. Meanwhile, it can be seen that the N-gain of the control class is 0.24, which means it is in the low category. A comparison of the N- Gain results for the experimental and the control group can be seen in the bar chart Fig. 1.

The results of the hypothesis test that have been carried out show that the mathematical critical thinking abilities of students in classes that use learning using the Join Learning Groups technique are more significant than the mathematical critical thinking abilities of students in classes that use task planning groups learning techniques. The following is a description of the learning process that occurs in the experimental class and control class on SPLDV material.

The results of the Kolmogorov-Smirnov and Shapiro Wilk tests show that the Kolmogorov-Smirnov p-value (Sig) is 0.157 > 0.05 in the Experimental group. Because it is > 0.05, based on the Kolmogorov-Smirnov test, the data for each experimental group is usually distributed. The p-value of the Kolmogorov-Smirnov test in the Control Group was 0.013 < 0.05, so the Control Group was not normally distributed, and based on the Shapiro-Wilk test, the Shapiro-Wilk p-value (Sig) of the Experimental Group was 0.339 > 0.05 in the Experimental group. Because the test results were > 0.05, based on the Shapiro-Wilk test, the data for each experimental group was normally distributed. The P value of the Shapiro-Wilk test in the Control Group is 0.089 > 0.05, so the Control Group has a normal distribution. If the data is not normally distributed, the solution is to use a non-parametric test, namely the Mann-Whitney U Test.

The group of Levene test results for homogeneity discussed above is non-homogeneous. Because it is non-homogeneous, use the second line, namely Group t count 5.073. DF in the t-test is N-2, i.e., in this case, 72-2=70. It can be compared with this calculated t group with the t table at Df 70 and probability 0.05. The magnitude of the difference between the means of the two groups is shown in the Mean Difference column, namely 12.05556. Because the group is positive, the experimental group has a higher mean than the control group.

Based on the data and results of the analysis as described above, namely the influence of learning using the join learning groups technique or task planning groups technique on students' critical mathematical thinking abilities, it was concluded that (1) there is a significant difference between the critical thinking abilities of students taught using the Join Learning Groups Technique and Task Planning Groups Technique. The mathematical critical thinking ability of students in the control class, whose learning process applies the Task Planning Groups Technique learning, is lower compared to the experimental class, which uses the Task Planning Groups Technique learning model. The highest mathematical critical thinking ability of students in the experimental class lies in the indicators of evaluating, analyzing arguments, making conclusions, and solving problems; (2) the mathematical critical thinking ability of students in classes whose learning uses join learning groups techniques is higher than the average student in classes that use task planning groups learning techniques.

This research has implications for the urgency of using the Join Learning Groups Technique and the Task Planning Groups Technique in mathematics learning to improve students' critical thinking abilities [18,19]. Apart from that, the results of this research inspire for other researchers to conduct further research regarding the use of the Join Learning Groups Technique and the Task Planning Groups Technique in mathematics learning to explore the potential of all students to make it more optimal.

4. CONCLUSION

Based on the results of the analysis and discussion regarding the influence of learning using the join learning groups technique or task planning groups technique on students' mathematical critical thinking abilities, it was concluded that (1) there is a significant difference between students' critical thinking abilities taught using the Join Learning Groups Technique and the Task Planning Groups Technique. The mathematical critical thinking ability of students in the control class, whose learning process applies the Task Planning Groups Technique learning, is lower compared to the experimental class, which uses the Task Planning Groups Technique learning model. The highest mathematical critical thinking ability of students in the experimental class lies in the indicators of evaluating, analyzing arguments, making conclusions, and solving problems; (2) the mathematical critical thinking ability of students in classes whose learning uses join learning groups techniques is

higher than the average student in classes that use task planning groups learning techniques.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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