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The Effect of Articulation Type Cooperative Learning Model on Students' Mathematical Concept Understanding

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ABSTRACT

This study stems from the low understanding of mathematical concepts among students and aims to examine whether there is a difference in understanding mathematical concepts between students who learn using the cooperative learning model of the articulation type and those who learn using the conventional learning model. The study employs a **Quasi-Experimental design** with a **Pre-test Post-test Control Group Design**, involving class VII.1 (experimental class) and VII.2 (control class) at SMP Babussalam Pekanbaru. The results of data analysis using a t-test showed that $t_{calculated}$ **(2.98)** > t_{table} **(2.01)** at a 5% significance level, leading to the acceptance of H_a. This demonstrates that the cooperative learning model of the articulation type significantly improves students' understanding of mathematical concepts compared to the conventional learning model, with the average score of the experimental class being higher than that of the control class.

Keywords: ***articulation type cooperative learning model, mathematical concept understanding***

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1. INTRODUCTION

Mathematics is one of the fundamental fields of study that supports the advancement of technology and science. As a discipline that plays a crucial role in everyday life, mathematics serves as the foundation for many other fields of study, such as physics, economics, engineering, and computer science (Soedjadi, 2000). However, learning mathematics often becomes a significant challenge for students, especially in understanding abstract and complex concepts (Suryadi, 2015). Many students can only memorize procedural steps without understanding the underlying meaning, making it difficult for them to apply these concepts to real-life situations (Ruseffendi, 2006). International surveys like PISA (Programme for International Student Assessment) have also recorded low mathematical literacy levels among Indonesian students (OECD, 2024). This underscores the need for innovations in teaching models to enhance the quality of conceptual understanding in mathematics.

As an effort to overcome this challenge, the implementation of cooperative learning models has been recognized as an effective approach to improve the quality of mathematics learning. In this model, students are encouraged to work in small groups, facilitating active interactions that help deepen their understanding of the material (Nugraha, 2020). One of the intriguing types of cooperative learning models to study is the articulation type. Research by (Nurhayati E. , 2016)demonstrated that implementing the cooperative learning model of the articulation type could improve the mathematics learning outcomes of Grade VII junior high school students. In this study, students who learned through the articulation model showed better conceptual understanding compared to those taught using conventional methods. Additionally, another study by (Wijaksono, 2022)found that the cooperative learning model of the articulation type was effective in enhancing the mathematics learning outcomes of Grade VIII junior high school students. Students involved in this learning model showed significant improvements in their understanding of mathematical concepts.

The cooperative learning model of the articulation type provides students with the opportunity to articulate their understanding to their group members. This process encourages students to think more

critically, reinforces their understanding, and enhances their communication skills (Irawan, 2018). By acting as both conveyers and receivers of information, students are trained to articulate their understanding, which in turn deepens their comprehension of mathematical concepts. This learning model also aligns with the principles of constructivism, where students learn through social interaction and build their own knowledge. This was evidenced by (Hasanah, 2022) research, which found that the articulation model improved students' ability to understand geometric concepts because they actively constructed their understanding through group discussions.

The implementation of the cooperative learning model of the articulation type requires thorough preparation by teachers, including material planning and effective time management. Teachers need to ensure that every student actively participates in discussions and the presentation of material (Hastuti, 2019). Thus, the goal of learning to enhance students' understanding of mathematical concepts can be achieved.

In the context of education in Indonesia, the application of the cooperative learning model of the articulation type aligns with the government's efforts to improve the quality of education, particularly in mathematics. By improving conceptual understanding in mathematics through innovative teaching methods, it is hoped that students will be better prepared to face challenges in the globalization era. However, the implementation of this model also requires appropriate strategies to be effective. The main challenges in applying the cooperative learning model of the articulation type are the need for teachers' thorough preparation and students' adaptation to the new teaching method (Hastuti, 2019). Therefore, in-depth research is needed to investigate the effectiveness of this model in various learning contexts.

This study aims to analyze the impact of the cooperative learning model of the articulation type on students' understanding of mathematical concepts. It also seeks to compare the effectiveness of this model with conventional teaching models in improving conceptual understanding. It is hoped that this study will provide significant contributions to the development of mathematics teaching methods in Indonesia. By utilizing the cooperative learning model of the articulation type, it is expected that students will find it easier to understand abstract mathematical concepts. Furthermore, the results of this study could serve as a reference for educators in designing innovative teaching strategies that are relevant to students' needs. Consequently, it is expected that the findings of this study will positively impact the quality of mathematics education in Indonesia.

2. RESEARCH METHOD

This research is part of a quantitative approach. The method applied is Quasi-Experimental, with a research design using the Pretest-Posttest Control Group Design. The population of this study consists of seventh-grade students at SMP Babussalam Pekanbaru for the 2023/2024 academic year, comprising four classes: VII.1, VII.2, VII.3, and VII.4. The sample in this study consists of classes VII.1 and VII.2, where VII.1 serves as the experimental class using the cooperative learning model of the articulation type, and VII.2 serves as the control class using the conventional learning model. In this study, the researcher uses the Random Sampling technique to select two classes randomly from the population, which will first be tested for homogeneity using the Bartlett's Test. Bartlett's Test is used to determine whether the population has the same or homogeneous variance.

The instruments used for data collection in this study are tests of mathematical concept comprehension abilities, consisting of pretests and posttests. The tests are in the form of questions regarding concept comprehension, and the assessment is based on the indicators of concept comprehension to evaluate the effectiveness of the applied learning models. The tests consist of four items. Before the pretest and posttest are administered to the experimental and control classes, they are first tested on a class other than the experimental and control classes, which is a member of the population, to assess the validity and reliability of the questions. The instrument test for data collection is conducted to ensure the appropriateness of the instruments in the data collection process. The instruments used must be valid and reliable. The validity test aims to determine the authenticity of each item while measuring how accurately the instrument can perform its measurement function (Muharni, 2024)). The validity of the items is determined by calculating the correlation between the score of each item and the total score using the Product Moment correlation formula. Meanwhile, the

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reliability of the test is analyzed using Cronbach's Alpha method to ensure the consistency of the test results in representing the measured construct (Muharni, 2024)

Data analysis is performed by comparing the students' scores in the experimental and control classes to evaluate the effect of the articulation-type cooperative learning model on students' mathematical concept comprehension abilities. Data analysis techniques involve statistical tests, namely normality tests, homogeneity tests, and hypothesis tests. The normality test is conducted to determine whether the data from both sample groups follow a normal distribution. In this study, data normality is tested using the chi-square formula. The homogeneity test aims to check whether both sample groups have the same variance, and the homogeneity test used is the F-test. As for the hypothesis testing, this study uses the "t" test. The "t" test is used to test the comparative hypothesis of two independent samples, namely Separated Variance and Pooled Variance.

3. RESULTS AND DISCUSSION

A. Population and Sample of the Study

The sample selection was carried out through several stages, as follows:

1) Collecting the semester math exam scores of seventh-grade students at SMP Babussalam Pekanbaru.
2) Conducting a homogeneity test for each data group by:
   - Determining the variance for each class.

   The results of the variance calculations for each class can be seen in the table :

Table 1. Varians Values

Varians Values Sample	Class	S^2	N
Type of Variable: Comparison of Pretest Score	VII.1	16,29	31
	VII.2	8,04	31
	VII.3	20,40	31
	VII.4	21,04	31

- Insert the statistical values for the homogeneity test into Table 2 of the Bartlett's test as follows:

Table 2. The Barlett's Test

No	Sample	db = (n – 1)	S_i^2	Log S_i^2	Db (Log S_i^2)
1	VII.1	30	16,29	1,212	36,36
2.	VII.2	30	8,04	0,91	27,20
3.	VII.3	30	20,40	1,31	40,60
4.	VII.4	30	21,04	1,323	39,69
		Σ(n – 1)= 120	**-**	**-**	**143,85**

- Calculating the Variance of the Four Samples:

$$S^2 = \frac{n_1 S_1^2 + n_1 S_2^2 + n_1 S_3^2 + n_1 S_4^2}{n_1 + n_2 + n_3 + n_4} = 16{,}44$$

- Calculating the Value of $X^2_{calculated} = \ln(10) \times ((\text{LogS2 x } (\Sigma \text{ n} - 1)) - \Sigma db \log S^2) = 4{,}75.$

  Comparison of $X^2_{calculated}$ dengan X^2_{table} with testing criteria: If $X^2_{calculated} \geq X^2_{table}$, the variances are not homogeneous, but if $X^2_{calculated} \leq X^2_{table}$, the variances are homogeneous. For $\alpha = 0{,}05$ and degrees of freedom (df) = n -1 = 4 – 1 = 3, the value of $X^2_{tabel} = 7{,}81$. The comparison result is $4{,}75 \leq 7{,}81$, atau $X^2_{calculated} \leq X^2_{tabel}$, Thus, the variances are homogeneous. Since the variances are homogeneous, it can be concluded that all four classes are homogeneous. Therefore, the researcher selected two classes as samples using the Random Sampling technique, namely Class VII.2 as the experimental class and Class VII.1 as the control class.

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B. Analysis of Question Instruments

The steps in determining the question instruments were carried out through the following stages:

1) **Question Validity Test**

The results of the validity calculations for the question items obtained in this study can be seen in Table 3:

Table 3. Validity Results of Question Items

Item Number Question	Correlation Coefficient	$t_{calculated}$	t_{table}	Decision	Interpretation
1.	0,561	3,586	1,701	Valid	Moderate
2.	0,957	17,462	1,701	Valid	Very High
3.	0,549	3,474	1,701	Valid	Moderate
4.	0,685	4,972	1,701	Valid	High

From Table 3, it can be observed that all four question items have $t_{calculated}$ values greater than ttable, indicating that the questions are valid.

2) **Question Reliability Test**

Based on the reliability test results for all question items, the test reliability coefficient was found to be 1.158. When compared to r_{table}=0.355, it is evident that $r_{calculated}$>rtable. This indicates that the test results are reliable.

3) **Preparing the Question Instruments**

Based on the results of the validity and reliability tests, it can be concluded that all the analyzed questions can be used as test instruments, as all four were found to be valid.

C. Data Analysis

1) Pre-test Data Analysis

The data analysis process was carried out through several steps, as follows:

a) Normality Test

The results of the normality test calculations for students' mathematical concept comprehension in the pre-test are presented in Table 4:

Table 4. Normality Test for Pre-test

Class	$X^2_{calculated}$	X^2_{table}	Criteria
Experimen	8,2071	11,070	Normal
Control	4,5910	11,070	Normal

Based on the calculations at a 5% significance level, it can be observed that $X^2_{hitung} \leq X^2_{tabel}$, Therefore, it can be concluded that the data from both the experimental class and the control class follow a normal distribution.

b) Homogeneity Test

Based on the calculations, the largest variance is 571.69, and the smallest variance is 193.65, resulting in $F_{hitung} = 2{,}95$. According to the testing criteria, $2{,}95 > 1{,}93$ atau $F_{hitung} > F_{tabel}$ indicating that the variances are not homogeneous.

c) Hypothesis Test

Based on the prerequisite hypothesis test results, the pre-test data for the experimental and control classes showed a normal distribution but had non-homogeneous variances. Subsequently, data analysis was conducted using the "t" test with the Separated Variance formula.

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From the calculations, t_{hitung} was compared with t_{tabel} at a 5% significance level is 1,77 < 2,05 or $t_{hitung} < t_{tabel}$, Thus, H_0 is accepted, and H_a is rejected It can be concluded that there is no significant difference in concept comprehension between the students in the experimental class and the control class before the implementation of the cooperative learning model of the articulation type in mathematics learning.

2) Post-test Data Analysis

The data analysis process was carried out through the following steps:

a) Normality Test

The results of the normality test for students' mathematical concept comprehension in the post-test are presented in Table 5.

Table 5. Normality Test for Post-Test

Class	X^2_{hitung}	X^2_{tabel}	Criteria
Experimen	6,6726	11,07	Normal

From the calculations, it can be observed that:

- For the experimental class: $X^2_{hitung} \leq X^2_{tabel}$ or 6,6726 ≤ 11,07, indicating that the data is normally distributed.
- For the control class: $X^2_{hitung} \leq X^2_{tabel}$ or 5,8595 ≤ 11,07, indicating that the data is normally distributed.

b) Homogeneity Test

From the homogeneity test table, the largest variance is 280.76, and the smallest variance is 159.64, resulting in $F_{hitung} = 1{,}76$. According to the testing criteria, 1,76 ≤ 1,88 or $F_{hitung} \leq F_{tabel}$ indicating that the variances are homogeneous.

c) Hypothesis Test

Based on the prerequisite hypothesis test results, the post-test data for the experimental and control classes showed normal distribution and homogeneous variances. Data analysis was then conducted using the "t" test with the Polled Variance formula.

From the calculations, t_{hitung} was compared with t_{tabel} at a 5% significance level is 2,98 > 2,01 or $t_{hitung} > t_{tabel}$, thus H_a is accepted, and H_0 is rejected.. This indicates a significant difference in mathematical concept comprehension between students who learned using the cooperative learning model of the articulation type and those who learned using the conventional learning model.

Based on the average scores, the experimental class achieved an average score of 79.31, which is higher than the control class's average score of 67.64. This indicates a positive impact of the cooperative learning model of the articulation type on students' mathematical concept comprehension. In addition to enhancing students' understanding of mathematical concepts, this study also found that the cooperative learning model of the articulation type helps students become more independent, collaborate in groups to complete learning materials, and improve interactions among peers. Furthermore, each student has the opportunity to share their group discussion results in front of the class.

Despite many indications of the positive impact of the cooperative learning model of the articulation type, there were some limitations in the study. These include difficulties in managing students due to the large number of groups, some groups being less active, and some students not participating in discussions, instead remaining passive and ignoring the researcher’s instructions. Limited class time also meant not all groups had the opportunity to present their findings, as students did not utilize the allotted discussion time efficiently. Moreover, the cooperative learning model of the articulation type was only applied to the topic of sets and not to other mathematical topics.

4. CONCLUSION

The analysis results indicate that students taught using the cooperative learning model of the articulation type achieved higher levels of mathematical concept comprehension compared to those taught using conventional teaching methods. Therefore, the cooperative learning model of the articulation type can be considered to contribute positively to enhancing students' understanding of mathematical concepts. This model is expected to serve as an alternative teaching approach to help students develop other mathematical skills and apply them to various topics in mathematics learning.

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