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The Effectiveness of The Jigsaw-Type Cooperative Learning Model on the Mathematical Communication Ability of Grade X High School Students

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A B S T R A C T
This study was conducted with the aim of determining the effectiveness of the jigsaw-type cooperative learning model on students' mathematical communication ability. This research uses quantitative methods with a quasi-experimental approach. This research design uses a pretest-postest control group design. The participants of this study were grade X students of one of the high schools in North Central Timor Regency. This research was carried out in the even semester of the 2022/2023 academic year The research instrument was in the form of a mathematical communication ability test and observation sheets. The results of this study show that jigsaw-type cooperative learning is effective in improving students' mathematical communication ability. this is illustrated by the results of research that shows that the achievement and improvement of mathematical communication ability of students who learn through the jigsaw-type cooperative learning model is better than students who learn through conventional models.

Keywords: Cooperative learning, Effectiveness, Mathematics communication ability, Jigsaw-type.

1. INTRODUCTION

Learning is a process by which a person's environment is intentionally managed to allow him to participate in behavior under special conditions or produce responses to certain situations (Corey, 2017). Teaching and learning activities are a process of interaction or reciprocal relationships between teachers and students in learning units.

Mathematics plays an important role in the development of students' mathematical communication ability. According to the 2013 curriculum (C-13) annex 3 of Permendikbud No. 58 (Kemendikbud, 2014,) one of the objectives of learning mathematics is to communicate ideas, reasoning and be able to compile mathematical evidence using complete sentences, symbols, tables, diagrams, or other media to clarify situations or problems. From the description above, it can be seen that one of the objectives of learning mathematics is that students must have mathematical communication ability. Fahradina, et al

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(2014) suggest there are five reasons for the need to learn mathematics, namely (1) A means of thinking clearly and logically, (2) A means to solve problems of daily life, (3) a means of recognizing patterns of relationships and generalizing experiences, (4) a means to develop creativity, and (5) a means to increase awareness of cultural development.

Mathematical communication ability is the ability of students to convey mathematical ideas or ideas with diagrams, tables, symbols, or other media in the process of teaching and learning mathematics. According to Hodiyanto (2017) stated that mathematical communication ability consists of oral communication and written communication. Oral communication such as: discussion and explaining. Written communication such as: expressing mathematical ideas through pictures / graphs, tables, equations, or with students' own language. Clarified by Ariani, (2017) stated that the role of teachers in developing mathematical communication of elementary students is: (1) designing learning that can increase the intensity of teacher interaction with students and between students when working on problem solving problems, (2) providing motivation to students, (3) selecting tasks to be given, (4) measuring students' mathematical abilities using exploratory description problems, transfer, elaborative, and applicative.

Mathematical communication ability includes the ability of students to manifest ideas or opinions and thoughts that are able to explain the concept of mathematical ideas rationally by giving reasons both orally and in writing functions to solve mathematical problems. The learning process in schools can be utilized by teachers and students to develop students' mathematical communication ability. Logic in mathematics is able to provide the ability for students to express their opinions and mathematical thoughts which can then develop their communication ability. According to Purwandari et al. (in Wardhana and Lutfianto 2018) stated that mathematical communication is defined as a dialogue event or interrelationship that occurs in the classroom environment, where there is a transfer of messages and the transferred messages contain mathematical material learned at that time. In addition, according to Nur Afiani (2016 stated that communication ability in mathematics help teachers understand students' ability to interpret in various forms of understanding of the mathematical concepts and processes they learn. But in reality, mathematical communication ability among students is still low. As Arifin and Kartono said (in Noor, 2020) that difficulties in identifying mathematical problems and conveying solving thoughts are problems in learning mathematics. Mathematical communication ability is not fully developed either because the textbooks that students learn contain tasks with one correct answer. Meanwhile, according to Aminah et al. (2018) stated that the ability of mathematical communication to connect real objects, pictures and diagrams into mathematical ideas is relatively low. Mathematical communication ability explains ideas, situations, writing with real objects, graphic images and algebra are classified as medium. The ability of mathematical communication to express everyday events in language or mathematical symbols is low.

Afrilianto (2015) stated that mathematical communication ability is a requirement for solving problems, meaning that if students cannot communicate well, do not interpret mathematical problems or concepts, students do not solve these problems well. According to Khayroiyah et al (2019), mathematical communication ability is "the ability of students to convey their ideas or ideas in solving a problem through oral and written which includes the ability of students, expressing mathematical ideas into pictures, expressing images into mathematical ideas, and expressing mathematical ideas into mathematical models.

Zarkasyi (in Nurintan and Julyanti, 2020) stated that mathematical communication ability is the ability to convey mathematical ideas, both orally and in writing as well as the ability to understand and accept other people's mathematical ideas/ideas carefully, analytically, critically, and evaluatively to sharpenpemahaman. A broader understanding of students' mathematical communication is put forward by the National Council of Teachers of Mathematics (NCTM) (in Deswita et al., 2018) states that there are at least two important reasons, why communication in mathematics learning is important to be developed among students, including: mathematics is not just a thinking aid, a tool to find patterns, solve problems or draw conclusions, but mathematics is also a social activity in learning; as a vehicle for interaction between students and also between teachers and students. Nuraeni and Luritawaty (2016: 102-103) stated that communication is an important factor in teaching, learning, and accessing mathematics. Without communication in mathematics. We will have little information, data and facts about students' understanding in carrying out mathematical processes and applications.

According to Hodiyanto (2017) that mathematical communication ability consists of, oral communication and written communication. Oral communication such as discussion and explaining. Written communication such as expressing mathematical ideas through pictures/graphs, tables, equations, or with students' own language. According to Yulianto and Sutiarso, (2017: 292) states that mathematical communication can be seen from two aspects, namely oral communication (talking) and writing communication (writing). Oral communication is expressed through the intensity of student involvement in small groups during the learning process. While what is meant by oral mathematical communication is the ability and skill of students to use vocabulary, notation and mathematical structures to express relationships and ideas and understand them in solving problems.

Based on observations at SMAN 1 Insana, it was found that it still uses a conventional model, namely teacher-centered learning as a learning resource using the lecture method. Students listen to the teacher when teaching, record important things that the teacher conveys and do practice questions given by the teacher. Thus, there needs to be a renewal in teaching by teachers. Teachers must be able to provide learning experiences that are not forgotten by students. The selection of learning models is decisive to attract and trigger the attention of students to actively participate in teaching and learning activities. One learning model that is thought to be able to actively involve students in learning is to use a cooperative learning model.

The cooperative learning model is one of the learning models that can increase student activity, interaction, and mastery of students over the material. One of the cooperative models that can be applied is the Jigsaw type cooperative learning model. In this learning model each learner joins other group members who get the same problem (problem), and after getting the solution, they are responsible for transmitting their understanding to colleagues in the initial group (Son &Ahzan, 2017). The Jigsaw type cooperative learning model is a small group that works together in maximizing learning conditions to achieve and get the maximum learning experience, both individual experience and group experience.

The learning model must be principled on active learning, so that in the learning process and the main learning attention is directed to students who learn. The Jigsaw type cooperative learning model is one of the cooperative learning models that encourages students to be active and help each other in mastering learning materials to achieve good achievements.

According to Purwandari et al. (in Wardhana and Lutfianto 2018) stated that mathematical communication is defined as a dialogue event or interrelationship that occurs in the classroom environment, where there is a transfer of messages and the transferred messages contain mathematical material learned at that time. In addition, according to Nur Afiani (2016) stated that communication ability in mathematics help teachers understand students' ability to interpret in various forms of understanding of the mathematical concepts and processes they learn.

Hisham, Zaini et all (2018) stated the advantages and disadvantages of the learning model with the lecture method. The advantages of the lecture method are practical in terms of preparation and the media used is efficient in terms of time and cost, can deliver a lot of material, encourage teachers to master the material, it is easier to control the class, students do not need preparation, and students can immediately receive knowledge. Conversely, the shortcomings of the lecture method are boring, students are not active, information is only one way, less attached to student memory, less controlled both time and material, monotonous, does not develop student creativity, makes students only as objects of learning, and does not stimulate students to read.

According to Lie (2016) states that the Jigsaw type cooperative learning model is a cooperative learning model consisting of 4-5 people in a group who are responsible for mastering parts of the learning material that are able to teach the material to other members of the group. Robert (2017) suggests that the Jigsaw-type cooperative learning model is a small group learning process where each student relies on his teammates to be able to provide the information needed to perform well at the time of assessment.

According to Rusman (2018) revealed that the Jigsaw type cooperative learning model is a cooperative model with students learning in small groups of four to six people heterogeneously and students working together, positive interdependence, and responsibility independently. Syaripah (2014) suggests that the Jigsaw type cooperative learning model is a cooperative learning model, students learn in small groups consisting of 4-5 people by paying attention to heterogeneity, working together positively and each member is responsible for learning certain problems from the material provided and delivering the material to other group members. Isjoni (2016) suggests that the Jigsaw type cooperative learning model takes the pattern of how to work a saw (zigzag), where students carry out a learning activity by working together with other students to achieve common goals. Syarifuddin (2018) suggests that the Jigsaw-type cooperative learning model is student-centered teaching, describing teaching strategies where teachers facilitate more than direct teaching. In this student-centered strategy, teachers consciously place more attention on student engagement, initiative, and social interaction.

2. METHODS

This type of research is quantitative research with a quasi-experimental approach. Quasi-experiment is a type of research design that has an experimental group and a control group that is not randomly selected (Maryani et al, 2014). The research design used was in the form of pretest-postest control group design where each group was not randomly selected. This research was conducted on grade X students of one of the high schools in North Central Timor Regency-NTT. The sample is class X IPS 1 as the experimental class and class X IPS 2 as the control class. The research instruments used were tests of mathematical communication ability (MCA) and observation sheets for the implementation of learning. The data analysis technique used is to use an independent t-test:

$$t_{hitung} = \frac{\bar{x}_1 - x_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

But in this study, it will be analyzed using SPSS application version 16. The t-test above is used to test the comparison of completeness and improvement of students' MCA. The comparative test of student' MCA completeness uses post-test data, while the comparison test of improvement uses N-Gain data obtained through equations according to Meltzer (2002):

$$N_{Gain} = \frac{Skorposttest - Skorpretest}{100 - Skorpretest}$$

The hypotheses tested in this study are respectively the completeness and improvement of students' MCA who learn through a jigsaw-type cooperative learning model more effectively than students who learn through conventional learning. Before testing these two hypotheses, normality and homogeneity of completeness and improvement data are first tested as a condition for using parametric statistics. Both prerequisite tests and hypothesis tests are carried out using the help of the SPSS version 16 application.

The prerequisites are the normality test and the homogeneity test. The results of the normality test are used to see if the distributed data is normal or abnormal. While the homogeneity test is used to find out whether the data comes from a homogeneous or nonhomogeneous population.

Briefly inform about the material and methods used in the research, including the subjects / materials studied, the tools used, the experimental design or design used, sampling techniques, variables to be measured, data collection techniques, analysis and statistical models used.

RESULTS AND DISCUSSION

This research data is in the form of achievement data (posttest) and improvement (N-Gain) of students' mathematical communication ability. Therefore, in this section, the results of research and discussion of each are described as follows.

Achievement Mathematical communication Ability

Before conducting a hypothesis test, a normality test and a homogeneity test are first carried out. The normality test results can be seen in Table 1.

Table 1. Normality Test Results MCA achievement

		kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	Df	Sig	Statistic	df	Sig
MCA Posttest	Experiment	.207	21	.099	.844	21	.063
	Control	.239	21	.053	.837	21	.083

a. *Lillie fors Significance Correction*

Table 1 shows that the MCA posttest data of the experimental class and the control class have a significance of > 0.05, so it is stated that the MCA of students of both classes are normally distributed. The homogeneity test results can be seen in Table 2.

Table 2. Homogeneity Test of MCA achievement

		Levene Statistic	df_1	df_2	Sig.
MCA Posttest	Based on Mean	.189	1	40	.666
	Based on Median	.210	1	40	.649
	Based on Median and with adjusted df	.210	1	39.373	.649
	Based on trimmed mean	.435	1	40	.513

Table 2 shows that the achievement data of the experimental class and the control class obtained a significance value of > 0.05, so that the mathematical communication ability of students from both classes can be said to come from the same data or homogeneous data. This distribution of normal and homogeneous data allows testing his hypothesis using parametric t-test statistics. The results of the comparison test of students' MCA achievement can be seen in Table 3.

Table 3. Test the Hypothesis of MCA achievement

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	T	Df	Sig.	Mean Difference	Std. Error Difference
Equal Variances Assumed	.189	.666	3.787	40	.001	8.095	2.138
Equal Variances not assumed			3.787	39.440	.001	8.095	2.138

Table 3 shows that the significance value of the student's MCA postest on sig. (2-tailed) of 0.001 < 0.05. This shows that there are differences in the completeness of students MCA who learn through the jigsaw type cooperative learning model and conventional learning. Descriptive data shows that the average MCA achievement of students who learn using the jigsaw type cooperative learning model is 80.24 greater than students who learn conventionally the value is 76.95 therefore it can be concluded that the MCA achievement of students who learn using the jigsw type cooperative learning model is better then students who learn conventionally.

Improvement Mathematical communication Ability

Similar to due diligence, that before conducting a hypothesis test, a normality test is first carried out, and the homogeneity of student MCA improvement data (N-gain) is carried out as a condition for parametric statistical tests. The results of the normality test of student MCA improvement can be seen in Table 4.

Table 4. MCA Improvement Normality Test

		kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	Df	Sig	Statistic	Df	Sig
N-gain	Experiment	.139	21	.200	.935	21	.173
MCA	Control	.149	21	.200*	.943	21	.251

a. Lillie fors Significance Correction

**. This is a lower bound of the true Significance*

Table 4 shows that the significance of the experimental class N-gain data is 0.200 which means that the distribution of the data tends to be normal, and the significance of the control class N-gain data is 0.200 > 0.05, which shows that the distribution data of the control class N-gain data is normal. The homogeneity test results can be seen in Table 5.

Table 5. homogeneity test of MCA improvement

		Levene Statistic	df_1	df_2	Sig.
N-gain MCA	Based on Mean	.065	1	42	.800
	Based on Median	.061	1	42	.806
	Based on Median and with adjusted df	.061	1	39.05	.806
	Based on trimmed mean	.058	1	42	.810

Table 5 shows that the N-gain MCA scores of experimental and control class students obtained a significance value of > 0.05, so it can be stated that the data on the increase in MCA of students from both classes came from the same data or homogeneous data. The distribution of data on the increase in MCA of experimental and control class students is normal and homogeneous, this allows the hypothesis test using parametric t-test statistics. The results of the comparative test of increasing student MCA can be seen in Table 6.

Table 6. Test the MCA improvement Hypothesis

		Levene's Test for Equality of Variances		t-tes for Equality of Means		95% Confidence Interval of the Difference		
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std.Error Difference
N-Gain MCA	Equal variances assumed	0.73	.789	3.743	40	.001	.17619	.04708
	Equal variances not assumed			3.743	39.708	.001	.17619	.04708

Table 6 shows that the significance value of the student's N-gain MCA on the line *equal variances asumed* sebesar $0{,}01 < 0{,}05$. This shows that there are differences in the increase in MCA of students who learn through the jigsaw type cooperative learning model and conventional learning. The average N-gain MCA of students learning through jigsaw-type cooperative learning was 0.37, and students who learned conventionally amounted to 0,19, Oleh Therefore $0{,}37 > 0{,}19$ So it can be concluded that the improvement of mathematical communication ability of students who learn through the jigsaw type cooperative learning model is better than students who learn through conventional.

The results of data analysis of the achievement of mathematical communication ability of experimental class students are better than those of the control class. This is caused by several factors, one of which is when the learning process takes place using the jigsaw type cooperative learning model facilitates mathematical communication ability This is in line with research by Robert (2017) which states that there is an increase in the mathematical communication ability of students who learn with the jigsaw type cooperative learning model. The jigsaw-type cooperative learning model invites students to involve students working collaboratively with their group mates so that they can achieve common goals (Son, 2015). The jigsaw-type cooperative learning model greatly facilitates students in learning mathematics. Students more easily understand the material to improve mathematical communication ability. (Rusman, 2008) states that jigsaw-type cooperative learning is very good to use in the learning process because it can help students to improve students' mathematical communication ability.

CONCLUSIONS AND RECOMMENDATION

The findings in this study are 1) the achievement of mathematical communication ability of students who learn through the jigsaw type cooperative learning model is better than students who learn through conventional learning, and 2) the improvement of mathematical communication ability of students who learn through the jigsaw type cooperative learning model is better than students who learn through conventional learning. These findings show that the jigsaw-type cooperative learning model is effective on the mathematical communication ability of high school students. It is recommended that researchers follow up mathematically to apply the jigsaw-type cooperative learning model to other mathematical abilities.

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