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THE EFFECT OF JIGSAW COOPERATIVE LEARNING MODEL ON STUDENTS' MATHEMATICAL COMMUNICATION SKILLS

(PENGARUH MODEL PEMBELAJARAN KOOPERATIF JIGSAW TERHADAP KETERAMPILAN KOMUNIKASI MATEMATIS SISWA)

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Abstrak

Penelitian ini bertujuan untuk mengetahui apakah model Cooperative Learning tipe Jigsaw berpengaruh terhadap kemampuan komunikasi matematis siswa dan mengetahui seberapa efektif model pembelajaran kooperatif tipe Jigsaw terhadap kemampuan komunikasi matematis siswa. Desain penelitian ini adalah eksperimen semu. Sampel penelitian ini adalah siswa kelas IX-E dan siswa kelas IX-F dengan total 64 orang. Hasil penelitian ini adalah: (1) Model Pembelajaran Kooperatif Jigsaw berpengaruh positif terhadap kemampuan komunikasi matematis siswa. Hal ini terlihat dari nilai signifikansi uji dua sisi yang diamati sebesar 0,031 < 0,05. Maka H_0 ditolak dan H_a diterima. (2) Keefektifan Model Pembelajaran Kooperatif Jigsaw diambil dari hasil N-Gain yaitu sebesar 0,16. Dapat disimpulkan bahwa keefektifan model pembelajaran kooperatif tipe Jigsaw terhadap kemampuan komunikasi matematis siswa berada pada kategori sedang.

Kata kunci: *Keterampilan Komunikasi Matematis, Model Pembelajaran Kooperatif Jigsaw*

Abstract

This research aims to know whether the Jigsaw Cooperative Learning model affects students' mathematical communication skills and to know how effective is the Jigsaw-type cooperative learning model on students' mathematical communication skills. The design of this research is quasi-experimental. The sample of this research is students in class IX-E and students in class IX-F. The results of this research are: (1) The Jigsaw Cooperative Learning Model has a positive effect on students' mathematical communication skills. This can be seen from the significance value for the two-tailed test is observed as 0.031 < 0.05. Then, H_0 is rejected and H_a is accepted. (2) The effectiveness of the Jigsaw Cooperative Learning Model is taken from the N-Gain result, which is 0.16. It can be concluded that the effectiveness of the jigsaw cooperative learning model on students' mathematical communication skills is in the moderate category.

Keywords: *Jigsaw Cooperative Learning Model, Mathematical Communication Skills*

INTRODUCTION

Mathematics is an essential subject in education. It is widely used in many areas of life. Mathematics is recognized as a crucial science in advancing knowledge and technology (Kartikasari et al., 2018). It would be difficult or even impossible for someone to live in the 20th century without applying mathematics to their lives (Kusmaryono, 2014). The significance of mathematics in human life underscores the necessity to learn and proficiently master it. Through mathematics education, students are expected to become human beings who can think logically, carefully, accurately, critically, creatively, innovatively, imaginatively, and hardworking. With these hopes, mathematics education becomes an essential aspect of education for achieving educational progress in Indonesia. The National Council of Teachers of Mathematics or NCTM determines that there are 5 (five) process standards that students must master through learning mathematics, namely: (1) problem-solving, (2) reasoning and proof, (3) connection, (4) communication; and (5) representation". These five process standards are called Mathematical Power (Allen et al., 2020).

In teaching and learning mathematics, there will inevitably be situations where students ask questions or communicate with their classmates or the teacher. In this communication, the teacher also conveys and explains mathematics material, and students will try to accept and understand the material presented by the teacher. Communication is a crucial element in the learning journey and can breathe life into the process, representing a key objective in learning mathematics (Samawati, 2021). Mathematical communication skills play a vital role in mathematics education. Through mathematical communication, students can solve mathematical problems and better understand the mathematical concepts they have learned (Hariati et al., 2022). Student's ability to communicate their mathematical ideas when solving problems or conveying the process and results of problem-solving is also a capacity that can create high-level scientific considering capacities such as coherent, explanatory, precise, essential, inventive, and profitable (Asnawati, 2017). According to Afiani (2017), there is a significant influence of Mathematics Communication Skills on Mathematics Learning Achievement.

Nevertheless, empirical evidence indicates that students' mathematical communication skills are still low. One of the reasons for students' low mathematical communication skills is the inadequate understanding of the concepts in the subject matter, resulting in misconceptions and errors in comprehending what is being asked in the problems (Zaditania & Ruli, 2022). This is also consistent with the interview conducted by the researcher. The researcher interviewed Mr. Hutahaean, one of the mathematics teachers at SMP Negeri 37 Medan. He stated that the teaching model he uses is still teacher-centered. However, he also mentioned using Problem-Based Learning, although it has not been effectively implemented. During the observation, the researcher found that the learning model used in the class is the direct Instruction Learning model and also students were not actively participating in the learning activities. Students also lack focus in the learning process. When the researcher asked the students their opinion about mathematics, they answered that math is complex, complicated, full of formulas,

hard to understand, and boring. However, some students said that math is exciting and fun.

In addition to the interviews, the researcher also administered a diagnostic study test to the ninth-grade students (class IX-E) at SMP Negeri 37 Medan on Monday, November 13, 2023. The test focused on the core topics of quadratic equations, functions, and geometric transformations. The diagnostic test given to the students was open-ended questions aimed at assessing the students' initial mathematical communication skills. The diagnostic test consisted of 2 questions, each with three sub-questions. From the 6 indicator mention above, there are 18.75% students who can express the mathematics idea in the form of drawing, there are 15.625% students who can provide mathematical explanation and reasons, there are 25% student who can do mathematical expression, there are 62.5% student who discuss, listen and write about mathematics with their friend while doing the diagnostic test, and there are 46.875% student who can make the conclusion from the solution they give.

Therefore, teachers need to select an appropriate teaching model to influence the enhancement of students' communication skills. One of the teaching models that can be applied is the Jigsaw cooperative learning to achieve the desired learning objectives. The Jigsaw Cooperative Learning Model is a collaborative approach that emphasizes teamwork, active participation, and shared responsibility among students. The Jigsaw method aims to promote students' responsibility for their learning and that of their peers. Rather than just absorbing the provided content, students must be ready to share and teach others within their group. This establishes a mutual dependence among students, requiring collaborative endeavors in understanding the assigned material. Through active participation, effective communication skills development, peer teaching, and creating a positive learning environment, this model equips students with the tools needed to express and comprehend mathematical ideas. This model is chosen because the Jigsaw Cooperative Learning Model is an instructional approach that encourages students to be active and collaborate in mastering the subject matter to attain the maximum learning objectives (Aziz et al., 2019). This will foster student interaction within the group, enhancing communication skills. This is further supported by the findings of a study conducted by Pertiwi et al., (2020), which demonstrated the influence of the Jigsaw cooperative learning model on improving students' mathematical communication skills. Hence, the researcher is keen to delve deeper into this subject through a literature review to sharpen the theoretical foundation for future researchers.

This research aims to describe whether the Cooperative Learning Jigsaw model has an effect on students' mathematical communication skills and how effective the Jigsaw type cooperative learning model is on students' mathematical communication skills. This research is useful for teachers so they can expand their knowledge by improving mathematical communication skills using the Jigsaw type cooperative learning model and as information material for readers or researchers who want to conduct similar research.

LITERATURE REVIEW

Jigsaw Cooperative Learning Model

The jigsaw learning model represents a variation of the Cooperative

Learning model, involving a group learning approach where each participant contributes information, experiences, ideas, attitudes, opinions, abilities, and skills to enhance the collective understanding of all members (Kartikasari et al., 2018). This learning model divides information from books or chapters into smaller, more manageable segments.

The Jigsaw method fosters students' accountability for their learning and their peers. Beyond simply acquiring the given material, students must be prepared to share and instruct others within the group. This creates an interdependence among students, necessitating collaborative efforts in comprehending the assigned material. Jigsaw is a form of cooperative learning that emphasizes students more than teachers, taking on more significant responsibilities in the learning process (Suendarti, 2017).

The phases of learning through implementing a jigsaw learning model can potentially cultivate students' social demeanor, encompassing discipline, tolerance, self-assurance, and teamwork. Self-assurance among students is evidenced by their willingness to pose questions within the school community and to present their understanding to peers. Accepting diverse viewpoints exemplifies tolerance, the ability to reach consensus, and the readiness to collaborate with individuals from varied cultural and religious backgrounds. Discipline is demonstrated through adherence to established rules, including punctuality and diligent information gathering beyond classroom settings. Teamwork is evident in students' eagerness to assume expert roles and actively contribute within the jigsaw framework to attain collective learning objectives. The jigsaw learning model effectively fosters the development of tolerance in social attitudes, while conventional learning approaches may not adequately nurture disciplinary attitudes, self-assurance, and collaborative skills (Septiani et al., 2020).

Mathematic Communication Skills

Mathematical communication skills encompass a student's capacity to represent mathematical problems or concepts using various tools such as natural objects, images, graphs, or tables, as well as the ability to utilize mathematical symbols (Hafifah & Bharata, 2018). The indicator of written mathematics communication skills used in this study is taken from (Rohid et al., 2019). The first indicator is the ability to draw and declare a situation or mathematical ideas in tables or drawings. The second indicator is the ability to explain concepts, conditions, and mathematical relations in writing and revisit a description or paragraph. The third indicator is the ability to make mathematical expressions, including expressing situations, tables, or images into language, symbols, ideas, or mathematical models.

The Implementation of the Jigsaw Cooperative Learning Model to Enhance Mathematical Communication Skills

The jigsaw learning model has been noted to enhance students' sense of responsibility toward their learning and that of their peers (Şengül & Katranci, 2014). In this model, students not only absorb the material but also must present their assigned content to group members, fostering interdependence and necessitating collaborative efforts to meet learning objectives (Chang & Benson, 2020; Karacop & Diken, 2017). Utilizing a community learning strategy through the jigsaw method has enhanced learning outcomes and deepened students'

comprehension. Additionally, the jigsaw approach holds promise for nurturing cooperative skills, mutual trust, and understanding among students, regardless of gender (Olukayode & Ekima Tina, 2014). Students engaged in jigsaw learning acknowledge increased cooperation and information sharing among peers, suggesting that the jigsaw method may positively influence students' social attitudes.

Implementing the Jigsaw Cooperative Learning Model to enhance mathematics learning outcomes involves organizing students into small, diverse groups. Each group member becomes an expert on a specific aspect of the material and then collaborates with members from other groups to share their expertise. In the context of mathematics education, this approach can be efficient.

RESEARCH METHODOLOGY

The research is a quasi-experimental design study aimed at determining whether or not there is an effect or impact resulting from something imposed on the research subjects, namely students. This research employs a quasi-experimental design to determine the presence or absence of an impact or consequence resulting from a stimulus on the research subjects, namely students. The research design utilized in this study is the Pretest-Posttest Design. Within this design, two groups are randomly selected and subjected to a pretest to assess the initial conditions and identify any differences between the experimental and control groups.

The research was conducted at SMP Negeri 37 Medan and was held in the second semester for Grade IX students at SMP Negeri 37 Medan in the 2023/2024 academic year. The data collection technique utilized in this research is a test. Tests are employed to gather data on students' mathematical communication skills in mathematics learning using the Jigsaw cooperative learning model. The tests conducted in this study include a pre-test at the beginning of the research to assess students' initial proficiency in the upcoming material. Additionally, there is a post-test at the end of each intervention to determine the improvement in students' mathematical communication skills regarding the taught material.

The research instruments employed in this study are communication mathematics skill tests (pretest and posttest). The instruments utilized in this research consist of pretests (administered at the beginning) and posttests (administered at the end of the lesson) with five essay questions that have been validated with content related to curved surface geometry.

In accordance with the research design utilized in this study, specifically employing pretest and posttest control groups along with an experimental group, the data analysis involves conducting a t-test. The conditions for conducting a t-test include the data being approximately normally distributed and the variances of the populations being compared being equal.

1. Normality Test

   The data used for the normality test includes the pretest and posttest questions administered to ninth-grade students regarding implementing the Jigsaw cooperative learning model.

   The normality test employed in this research is the Kolmogorov-Smirnov normality test, assisted by SPSS 26, and the criteria are as follows: If the significance value is > 0.05, then the data is normally distributed.

2. Homogeneity Test

The homogeneity test employed in this research is the Levene Statistic test, assisted by SPSS 26, and the criteria are as follows: If the significance value is > 0.05, then the variance of two or more data groups is equal (homogeneous).

3. Hypothesis Testing

Hypothesis testing is conducted using SPSS 26 and the independent sample t-test. The significance level used in hypothesis testing is 0.05. If the obtained significance value is > 0.05, then H_0 is accepted, and H_a is rejected. This means that there is no effect between the independent variable and the dependent variable.

The decision-making criteria are as follows:

a. Verbal Hypothesis

H_0 = There is no difference in the mean score in mathematical communication skills in the topic of Cylinder, Cone, and Sphere in Grade IX at SMP Negeri 37 Medan for the academic year 2023/2024 of the student taught using the jigsaw cooperative learning model and direct instruction learning model.

H_a = There is a difference in the mean score in mathematical communication skills in the topic of Cylinder, Cone, and Sphere in Grade IX at SMP Negeri 37 Medan for the academic year 2023/2024 of the student taught using the jigsaw cooperative learning model and direct instruction learning model.

b. Statistical Hypothesis.

H_0: $\mu_1 = \mu_2$

H_a: $\mu_1 \neq \mu_2$

Notation:

μ_1 = The mean score of mathematical communication skills of students taught using the Jigsaw Cooperative Learning Model.

μ_2 = The mean score of mathematical communication skills of students taught using Direct Instruction Learning.

4. Normal Gain (N-Gain)

This test is used to determine the effectiveness of the given treatment (Oktavia et al., 2019). The formula used to calculate the normality gain according to Meltzer is as follows.

$$N\ Gain = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$$

Explanation:

S_{post} = Score Posttest

S_{pre} = Score Pretest

S_{max} = Score Maximum

The criteria for effectiveness interpreted from the normality gain values according to Meltzer can be seen in the following Table 1:

Table 1 Interpretation of Normality Gain Value

Normality Gain Values	Criteria
$0.70 \leq n \leq 1.00$	High
$0.30 \leq n < 0.70$	Moderate
$0.00 \leq n < 0.30$	Low

RESULT AND DISCUSSION

The research began by carrying out a normality test. The normality test was performed to evaluate if the obtained data had a normal distribution. The normality

test employed in this research is the Kolmogorov-Smirnov normality test, assisted by SPSS 26, and the results are as follows:

Table 2 Normality Test of Students' Communication Skills

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
pretest_kontrol	,132	31	,181	,976	31	,689
pretest_eksperimen	,144	31	,102	,935	31	,059

Based on Table 2, it can be seen that the significance value of the normality test of the student's communication skills test data in the control class and experimental class is greater than $\alpha = 0.05$. The normality test results are 0.181 for the control class and 0.144 for the experimental class. This means that the student's communication skill scores in both groups of sample data are normally distributed.

Then, the homogeneity test was performed to evaluate whether the variances of the obtained data distributions were equal. The normality test employed in this research is the Lavene-Statistic homogeneity test, assisted by SPSS 26, and the results are as follows:

Table 3 Homogeneity Test of Student Communication Skills

		Levene Statistic	**df1**	**df2**	**Sig.**
Hasil	Based on Mean	,772	1	60	,383
	Based on Median	,791	1	60	,377
	Based on the Median and with adjusted df	,791	1	57,264	,378
	Based on trimmed mean	,845	1	60	,362

Based on table 3, it can be seen that the significance value of the homogeneity test of the student's communication skills test data in the control class and experimental class is greater than $\alpha = 0.05$. The homogeneity test results are 0.383 based on the mean. This means that the obtained data were homogenous.

After fulfilling the prerequisites of the study, namely the tests for normality and homogeneity, hypothesis testing can be conducted. Hypothesis testing tests formulated hypotheses and leads to conclusions to accept or reject the hypothesis. The hypothesis to be tested is formulated as follows:

H_0: $\mu_1 = \mu_2$

H_a: $\mu_1 \neq \mu_2$

Notation:

μ_1 = The mean score of mathematical communication skills of students taught using the Jigsaw Cooperative Learning Model.

μ_2 = The mean score of mathematical communication skills of students taught using Direct Instruction Learning.

Hypothesis testing is conducted using SPSS 26 and the independent sample t-test.

Table 4 Group Statistics

	kelas	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
hasil_posttest	Kelas_Kontrol	31	16,61	4,544	,816
	Kelas_Eksperimen	31	18,68	2,548	,458

The table above indicates that both groups have 31 samples each. The final test score of the experiment group is higher than that of the control group, as seen

from their respective averages of 18.68 and 16.61.

Table 5 Independent Samples Test

		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)
hasil_posttest	Equal variances assumed	5,559	,022	-2,207	60	,031
	Equal variances not assumed			-2,207	47,171	,032

Table 5 is the main table of the independent sample t-test analysis. The significance value for the two-tailed test is observed as 0.031 < 0.05. Then, H_0 is rejected and H_a is accepted. Thus, there is a significant difference in point scores between the control and experiment groups. Based on its descriptive values, there is a difference in the mean score in mathematical communication skills in the topic of Cylinder, Cone, and Sphere in Grade IX at SMP Negeri 37 Medan for the academic year 2023/2024 of the student taught using the jigsaw cooperative learning model and direct instruction learning model. This is in line with research Firnanda et, al. (2024), that there is a difference in the mean score in students' mathematical communication skill taught using the jigsaw cooperative learning model.

This test was conducted to the effectiveness of the Jigsaw Cooperative Learning model on students' mathematical communication skills.

$$N\ Gain = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} = 0.160428$$

The N-Gain approach measures the relative change in students' understanding before and after a lesson. By making this comparison, N-Gain analysis provides teachers with detailed insights into the effectiveness of a specific curriculum or teaching method. The results quantitatively indicate how well students have mastered the taught material. With an N-Gain result of 16%, the effectiveness of the jigsaw cooperative learning model on students' mathematical communication skills falls into the low category.

There are several challenges to conducting the Jigsaw Cooperative Learning Model in this research. Lack of student focus, the teacher must ensure that each student is accountable for their learning and for contributing effectively to their group can be difficult to enforce, so some students may not dominate the discussion while others may not contribute as much, leading to an imbalance in learning and communication practice. Complexity of Material, mathematical concepts can be difficult to break down and explain to peers, especially for students who are still mastering the material. Specifically in this study, the indicator of drawing in students' mathematical communication skills remains low, as seen in the majority of scores where students received a score of 2, and only one student achieved a score of 4. Therefore, teacher assistance is needed to facilitate better teaching materials to improve the drawing indicator.

The conclusion of the qualification results based on the pretest and posttest results of students' mathematical communication skills are presented in table 6:

Table 6 Result of Pretest and Posttest Qualification

Data	Class	Value	Qualification	Frequency	Percentage
Pretest	Control Class	85.01 – 100	Very Good	3	9.68%
		70.01 – 85.00	Good	5	16.16%
		55.01 – 70.00	Fair	9	29%
		40.01 – 55.00	Low	5	16.16%
		00.00 – 40.00	Very Low	9	29%
		TOTAL		**31**	**100%**
	Experiment Class	85.01 – 100	Very Good	0	0%
		70.01 – 85.00	Good	6	19.36%
		55.01 – 70.00	Fair	12	38.7%
		40.01 – 55.00	Low	6	19.36%
		00.00 – 40.00	Very Low	7	22.58%
		TOTAL		**31**	**100%**
Posttest	Control Class	85.01 – 100	Very Good	3	9.68%
		70.01 – 85.00	Good	4	12.925%
		55.01 – 70.00	Fair	11	35.47%
		40.01 – 55.00	Low	9	29%
		00.00 – 40.00	Very Low	4	12.925%
		TOTAL		**31**	**100%**
	Experiment Class	85.01 – 100	Very Good	3	9.68%
		70.01 – 85.00	Good	11	35.47%
		55.01 – 70.00	Fair	13	41.925%
		40.01 – 55.00	Low	4	12.925%
		00.00 – 40.00	Very Low	0	0%
		TOTAL		**31**	**100%**

Based on table 6, it can be observed that for the pretest scores in the experimental group, no students reached the "very good" qualification. In contrast, 3 students achieved a "very good" score in the control group. For the "good" qualification, there were 6 students in the experimental group and 5 students in the control group. Then, for the "fair" qualification, there were 12 students in the experimental group and 9 students in the control group. For the "low" qualification, there were 6 students in the experimental group and 5 students in the control group. For the "very low" qualification, were 7 students in the experimental group and 9 students in the control group.

Furthermore, for the post-test scores, it can be seen that there was an improvement in the experimental group, where 3 students achieved a "very good" score, while in the control group, there was no change, with 3 students achieving a "very good" score. For the "good" qualification, there were 11 students in the experimental group and 4 students in the control group. For the "fair" qualification, 13 students were in the experimental group and 12 students in the control group. For the "low" qualification, there were 4 students in the experimental group and 8 in the control group. For the "very low" qualification, there were 0 students in the experimental group and 4 students in the control group.

The evaluation result of students' mathematical communication skills for each class of mathematical communication skills indicator shown in Table 4.12 measure by qualification guidelines mathematical value communication skills: (1) Drawing, (2) Written Text, (3) Mathematical Expression, (4) Conclusion.

Table 7 Jigsaw Cooperative Learning Model on Students' Mathematical Communication Skills

Indicator	Score	Pre-test Frequency	Post-test Frequency
Drawing	4	0	1
	3	1	8
	2	0	14
	1	30	6
	0	0	2
Written Text	4	5	5
	3	12	14
	2	9	12
	1	1	0
	0	0	0
Mathematical Expression	4	1	4
	3	4	22
	2	26	5
	1	0	0
	0	0	0
Conclusion	4	5	9
	3	0	17
	2	15	4
	1	11	1
	0	0	0

Table 7 shows that the jigsaw cooperative learning model has the most significant impact on the indicators of "Mathematical Expression" and "Conclusion". For the "Drawing" indicator, many students still scored 2 on the post-test, meaning they can draw pictures, diagrams, graphs, and tables to complete but are incorrect. Based on Table 7, it can be observed that in the pretest, students were still attempting to express mathematical ideas in the form of drawings according to the instructions given. However, there was a decline in performance during the posttest, where two students failed to provide any response.

These results are reinforced by previous research conducted by Maharani (2022) in the form of the influence of the Jigsaw type cooperative learning model on students' mathematical communication skills. Jigsaw type cooperative learning is able to develop students' mathematical communication skills even though they study in groups. This learning can motivate students to provide information to their friends, motivated to bring their group to excel so that each student supports each other in the learning process.

In addition, it is also supported by research conducted by Surahman et al. (2022) with the results that there is an effect of implementing the Jigsaw cooperative learning model on students' mathematical communication skills. The researchers found that the use of the Jigsaw cooperative learning model had an impact on improving students' mathematical communication skills in the experimental class because this model can provide students with opportunities to improve their mathematical communication skills. This strategy begins learning with problems that are often found in everyday life, and the goal is to help students learn to communicate better with others. After that, students are encouraged to actively participate in solving the problems given together with their group mates.

CONCLUSION AND SUGGESTION

From the research that has been carried out, it can be conclusioned (1) The Jigsaw Cooperative Learning Model has a positive effect on students' mathematical communication skills. This can be seen from the significance value for the two-tailed test is observed as 0.031 < 0.05. Then, H_0 is rejected and H_a is accepted. (2) The effectiveness of the Jigsaw Cooperative Learning Model is taken from the N-Gain result, which is 0.16. It can be concluded that the effectiveness of the jigsaw cooperative learning model on students' mathematical communication skills is in the low category. In this research, the most significant impact of the Jigsaw Cooperative Learning Model on the indicators of Mathematical Communication skills are "Mathematical Expression" and "Conclusion".

The advice that can be given is that teachers must design a learning process that can improve students' mathematical communication skills and train students to get used to working on problems that can improve students' mathematical communication skills.

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