The Influence of the Brainstorming Learning Model on Mathematical Communication Skills and Linguistic Intelligence

Salsabila Salsabila[1], Zulfa Mufidah[1], Netriwati Netriwati[1]

[1] Universitas Islam Negeri Raden Intan Lampung, Indonesia
Correspondence: ✉ zulfamufidah26@gmail.com

Article Info	Abstract
	Mathematical communication skills are essential for students learning mathematics, but many have low mathematical communication skills. This quasi-experimental design research aims to determine the influence of the brainstorming learning model and linguistic intelligence on mathematical communication abilities and the interaction between the brainstorming learning model and linguistic intelligence on mathematical communication abilities. This research involved class VIII students at Ma'arif 10 Bangunrejo Junior High School for the 2023/2024 academic year with a research sample of 55 students (27 class VIII A students as the experimental class and 28 class VIII B students as the control class). Mathematical communication skills data was obtained using an essay test, while linguistic intelligence data was obtained using a questionnaire. The collected data was analyzed using the Two Way Anava statistical test with a significance level of 0.05, where before testing, it was found that the data was normally distributed and homogeneous. The results of this research inform that the brainstorming learning model affects mathematical communication skills, while linguistic intelligence does not affect mathematical communication skills. Furthermore, there is no interaction between the brainstorming learning model and linguistic intelligence on mathematical communication abilities.

INTRODUCTION

Mathematical communication skills are the ability of students to express mathematical ideas orally or in writing through pictures, diagrams, formulas, and others [1]. Based on the pre-research conducted, students' mathematical communication skills test results have mostly not reached the KKM. The percentage of mathematical communication skills test results from class VIII A to VIII B that reached the KKM was 17%, while those that had not reached the KKM were 83%. It can be said that the mathematical communication skills of students in classes VIII A to VIII B are not yet communicative because many test results still show students' lack of mathematical communication skills.

Mathematical communication skills are necessary while learning mathematics because they are the basis for thinking about solving mathematical problems or problems in everyday life. One of the internal factors that can influence mathematical communication skills is linguistic intelligence [2].

Linguistic intelligence is using language to organize ideas or concepts accurately and clearly to convey opinions to others [3]. Based on the results of interviews conducted with mathematics teachers, he explained that students are less able to use the correct language and words to convey their ideas by mathematical provisions. He also explained that he did not yet understand the differences in intelligence possessed by students, especially in linguistic intelligence.

Linguistic intelligence plays an essential role in students' mathematical communication skills. Students with high linguistic intelligence can express their opinions verbally and in writing well to solve a mathematical problem quickly; conversely, students with low linguistic intelligence will have difficulty solving mathematical problems [4].

These problems can be overcome by implementing a learning model that can stimulate students to actively express ideas, concepts, and opinions, one of which is by using the brainstorming learning model. The brainstorming learning model is a way of learning by inviting students to express their opinions actively without criticism or comments. Then, the ideas are collected in written form. This will help students feel more appreciated and motivated if their opinions are not immediately rejected or commented on [5]. Brainstorming learning models can train students to express ideas or opinions that are already in their minds so that they will be able to develop their mathematical communication skills [6].
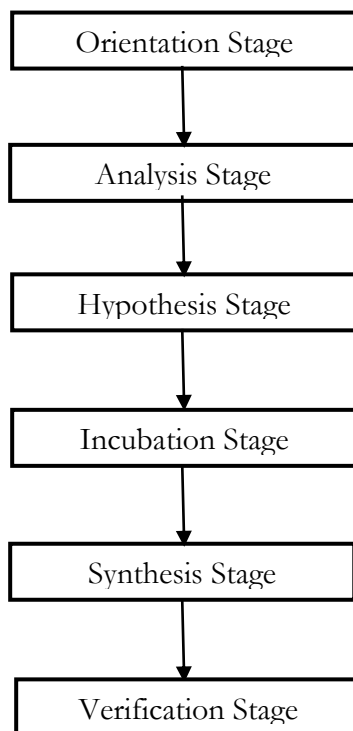
Research that is in line with the above problems is research conducted by Edward Alfian, Nurdin Kaso, Sumardin Raupu, and Risky Arifanti, showing that the average mathematics learning outcomes of students taught with the brainstorming model are better than the average mathematics learning outcomes of students who are not taught with the brainstorming learning model [7]. The difference in this study lies in the object being measured. In their research, Ike Betria and Romika revealed that applying the brainstorming learning model in geography courses can increase student creativity [8].

METHODS

The research method describes how researchers collect information or data to be processed and analyzed [9]. This research was conducted at SMP Ma'arif 10 Bangunrejo. The type of research used was *quasi-experimental design,* namely research that has groups but cannot function fully to control external variables that affect the experiment [10]. The population of this study was all students of class VIII of SMP Ma'arif 10 Bangunrejo. The sample of this study was class VIII A and VIII B. The sampling technique used cluster random sampling obtained two sample classes, namely class VIII A as an experimental class by applying the brainstorming learning model and class VIII B as a control class by applying the conventional model.

This study consists of two independent variables (x) and one dependent variable (y). The independent variables are the brainstorming learning model and linguistic intelligence, while the dependent variable is mathematical communication skills. Data collection techniques include tests, questionnaires, observations, and documentation. The tests in this study are mathematical communication skills and questionnaires to measure linguistic intelligence. The data analysis technique used is a two-way ANOVA test to determine the effect of independent variables on the dependent variable.

The steps of the brainstorming learning model used are as follows [11]:

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┌─────────────────────────┐
│    Orientation Stage     │
└─────────────────────────┘
             │
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┌─────────────────────────┐
│     Analysis Stage       │
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             │
             ▼
┌─────────────────────────┐
│    Hypothesis Stage      │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│    Incubation Stage      │
└─────────────────────────┘
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             ▼
┌─────────────────────────┐
│     Synthesis Stage      │
└─────────────────────────┘
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             ▼
┌─────────────────────────┐
│    Verification Stage    │
└─────────────────────────┘
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The indicators of mathematical communication skills used are as follows:
1. Explain mathematical ideas orally, in writing, or in pictures.
2. Evaluate and analyze mathematical ideas both orally and in writing.
3. Using mathematical language, terms, and symbols to model a problem [12]

The indicators of linguistic intelligence used are (1) Rhetoric, the student's ability to carry out actions with language to influence others. (2) Mnemonics, namely, student's ability to use language to master and remember information. (3) Explanation: student's ability to convey and provide information. (4) Metalanguage, namely, the student's ability to use language to analyze that language [13].

RESULTS AND DISCUSSION

The research hypothesis uses a significance level of 5%, and the calculation is completed with the help of the SPSS program. The ANOVA test is carried out after the prerequisite analysis tests are met, namely the normality test and the homogeneity test, with the results that the data are normally distributed and homogeneous so that the ANOVA test can be carried out. The following are the results of the hypothesis test using two-way ANOVA, namely:

Table 1. Two-Way ANOVA Test Results

Dependent Variable: Mathematical Communication skills

	Sum of Squares	df	Mean Square	F	Sig.
Method	1886.892	1	1886.892	16,868	.000
Intelligence	462,489	2	231,244	2,067	.137
Method * Intelligence	95,092	2	47,546	.425	.656

Based on the table above, it can be concluded that:

1. H_0A is rejected because the significance value is 0.000 < 0.05. It can be concluded that the brainstorming learning model influences mathematical communication skills.
2. H_0B is accepted because the significance value is 0.137 > 0.05, and it can be concluded that linguistic intelligence does not influence mathematical communication skills.
3. H_0AB is accepted because the significance value is 0.656 > 0.05. It can be concluded that there is no interaction between the brainstorming learning model and linguistic intelligence in mathematical communication skills.

The Influence of Brainstorming Learning Model on Mathematical Communication Skills

The results of the two-way ANOVA test showed that mathematics learning on the Cartesian coordinate material using the brainstorming learning model influenced students' mathematical communication skills. The influence of the brainstorming model on mathematical communication skills can be seen by comparing the average test results in the experimental and control classes. The average test result for the experimental class was 74.63, while the control class was 58.50. This shows that the brainstorming learning model influences students' mathematical communication skills.

Based on observations during the study when the brainstorming learning model was applied, students responded well, especially when expressing opinions. Students were enthusiastic about conveying their ideas verbally and in writing in their respective groups. Furthermore, when discussing with their groups to determine the most appropriate answer, here students exchange opinions, thoughts, ideas, and concepts, each using appropriate mathematical terms or symbols so that they will have broader knowledge and a sense of self-confidence in their abilities will arise which will affect the development of mathematical communication skills.

The description above is by the research conducted by Popi Junita, Hariani Juwita, and Jemiyo Siswanto entitled "The Effect of Brainstorming Learning Model on the Learning Outcomes of Class VIII Students on Cube Material". This study's results show that applying the brainstorming model can improve students' mathematics learning outcomes. This is because, in this learning, students are free to express their opinions and exchange opinions in solving problems, which affects their learning outcomes [14]. Then, the research was conducted by Novyanti and Alinurdin entitled "The Effect of Brainstorming Learning Model on Students' Self-Confidence in PPkn Lessons". The results of this study show that the brainstorming model can change students' self-confidence because, when expressing their opinions in class, students learn to manage their emotions and are confident in their abilities to be shown to their group, which can be relied on [15].

The Influence of Linguistic Intelligence on Mathematical Communication skills

The results of the two-way ANOVA test showed that linguistic intelligence did not influence mathematical communication skills. This is to the results of the test given at the end of the learning that there was no difference in test results between students who had low, medium, or high linguistic intelligence in terms of mathematical communication skills, both classes using the brainstorming model and the conventional model had relatively the same average results. The average results of the experimental class linguistic intelligence observation data were 64.25, and the control class was 60.04. It can be seen that the average results are relatively the same.

Several things can influence the absence of influence of linguistic intelligence on mathematical communication skills. First, regarding language skills to influence others or rhetoric, some students feel that their opinions are rarely heard, so they are reluctant to express their opinions. Second, many students still have difficulty remembering how to solve problems, while examples of solutions have been given previously. Therefore, students are less developed in terms of mathematical communication. Furthermore, the absence of influence of linguistic intelligence on mathematical communication skills is because when filling out the questionnaire, it is close to the time of changing hours, so when filling out the questionnaire, some students check the boxes and are not honest. Several students do not participate in the learning process, leaving them behind. This can affect the results obtained.

This study is in line with the study conducted by Ida Zubaida, Widya Kusumaningsih, and Rina Dwi Setyawati entitled "Profile of Critical Thinking Ability of Junior High School Students in Solving Mathematical Problems Reviewed from Linguistic Intelligence and Logical-Mathematical Intelligence". The results of this study show that linguistic intelligence has not met all indicators of critical thinking [16]. Ulfa Hidayati Soliha conducted further research entitled "Mathematical Communication Skills Profile of Linguistic Intelligence and Logical-Mathematical Intelligence Students in Solving Task". The results of this study show that students can complete tasks but are not accurate because students with linguistic intelligence can provide reasons orally and in writing but not in solving problems systematically [17].

Brainstorming Learning Model and Linguistic Intelligence on Mathematical Communication Skills

The two-way ANOVA test results showed no interaction between the brainstorming learning model and linguistic intelligence in mathematical communication skills. This means that the brainstorming learning model and linguistic intelligence have their respective roles in mathematical communication skills. The application of learning using the brainstorming learning model motivates students to learn and increase their knowledge with their linguistic intelligence so that they can interact with the ongoing learning process and obtain the desired results [18]. Internal factors can influence learning readiness, motivation, learning experience, fatigue, intelligence, interests, and talents. At the same time, external factors are school, environment, socializing, and society [19]. These two factors influence each other so that the learning process is not only influenced by the brainstorming model and linguistic intelligence. It can be interpreted that the influence of the brainstorming model on mathematical communication skills is not

caused by linguistic intelligence. The opposite also applies; the brainstorming model does not cause the influence of linguistic intelligence on mathematical communication skills. In line with the research conducted by Alhusna Nupiah, the results of this study were that there was no interaction between the use of the brainstorming model and learning interest in learning outcomes in class. The difference in this study lies in the object being measured [20].

CONCLUSION

Based on this study's analysis and discussion results, the following conclusions were obtained: (1) The mathematical communication skills of students in classes using the brainstorming model have a better average than classes using the conventional model. (2) Linguistic intelligence does not affect students' mathematical communication skills. (3) There is no interaction between the brainstorming model and linguistic intelligence in mathematical communication skills.

Following the conclusion, the suggestions that can be put forward are: (1) Schools are expected to be able to provide suitable learning facilities so that teachers are more active in guiding students and do not lag behind developments, (2) Teachers are expected to be able to use learning models that encourage students to be active in the learning process such as the brainstorming model, and teachers can find out the linguistic intelligence of each student, (3) Students are expected to continue to develop their mathematical communication skills because these skills greatly influence student learning outcomes, (4) Other authors are expected to be able to apply the brainstorming learning model to other materials and see other mathematical abilities by using this learning model.

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