Improving Mathematical Communication and Problem-Solving Ability of Students through Reciprocal Teaching

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ABSTRACT
This study primarily aims to determine how reciprocal teaching affects students' ability to communicate and solve mathematical problems. This is an experimental study in which both experimental group and control group were administered a pre-test and post-test. The control group was taught conventionally while the experimental group received reciprocal teaching and learning. The population was all eighth-grade students at a Junior High School in Pidie Jaya Regency, Aceh Province, Indonesia. Two classes of the students were randomly chosen as the samples. Instrument includes tests for students' mathematical communication and problem-solving abilities. The findings revealed that students who got reciprocal teaching and learning had statistically greater communication skills than those who received conventional learning. Students taught reciprocal teaching learning improved their mathematics communication skills statistically more than those who received the traditional one. Similarly, students who got reciprocal teaching and learning have superior mathematical problem-solving skills compared to those in the other group. These findings indicate that mathematical communication and problem-solving abilities taught simultaneously have a strong correlation.

Keywords: *Reciprocal Teaching, Mathematical Communication, Mathematical Problem Solving.*

1. INTRODUCTION

Today's advancements in science and technology have altered practically every area of existence. This situation demonstrates the significance of mastering science and technology in order to participate and contribute and have more opportunities to face increasingly growing competition. In its implementation, education covers various fields, maths is one of them. Every level of education, from elementary school to university, teaches mathematics because it is the primary subject in education, with the hope that mathematics can contribute to development activities.

Mathematics according to [1] is a method of using information, knowledge of sizes and shapes, calculation skills, and most importantly, human thinking in terms of recognizing and using relationships, to find solutions to the problems that humans confront. The government constantly works to improve mathematics instruction in primary schools, junior high schools, general secondary schools, and universities due to the importance of mathematics in society.

Mathematics has a significant impact on the growth of science and technology. A nation must develop human resources with adequate mathematical understanding if it wishes to grasp science and technology. According to Process Standards Regulation No. 22 of 2006 by the Minister of National Education, mathematics instruction aims to ensure that pupils possess the following skills:

a. Recognize concepts, explain how they relate to one another, and use algorithms to solve problems in a broad, accurate, efficient, and precise way.

b. Making inferences based on patterns and properties, applying mathematical techniques to draw conclusions, building arguments, or elaborating on mathematical concepts and assertions.

c. Understanding problems, creating complete mathematical models, and interpreting the results are all parts of problem-solving.

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d. Use symbols, tables, diagrams, or other visual aids to explain concepts and make situations or issues clearer.

e. Appreciating the value of mathematics in life, which includes being curious, paying attention, and interested in learning the subject, as well as being persistent and self-assured when solving problems.

Students' mathematical communication is one of the requirements for the mathematics learning process. In this context, communication includes both written and oral forms of communication. The importance of being able to talk, write, describe, and explain mathematical concepts is emphasized by communication standards. Because students learn in an active environment, developing communication skills in mathematics aids in engagement and idea expression in the classroom.

There are a number of reasons why communication skills are crucial for learning mathematics, including the fact that learning mathematical language, using mathematical symbols, and expressing different mathematical ideas all require communication skills. Additionally, when a student learns information in the form of mathematical concepts from a teacher or from reading, they can use these concepts to: Students will therefore react based on their perception of the information when the transformation of mathematical knowledge occurs. Students frequently have a good understanding of mathematics but fail to grasp the meaning of the knowledge since mathematics is filled with terminology and symbols.

Mathematical communication skills are also useful for training students to express their opinions supported by knowledge and ideas. Students need to strengthen their mathematics communication skills as a result. Supporting measures are taken to ensure that pupils' learning mathematical communication skills increase are very necessary, namely teacher intelligence in developing subject matter and using learning models that can teach students energetically, creatively, effectively and appropriately so that the intended learning process works well.

According to Arends, the approach that will be followed, including the learning objectives, learning stages, setting, and classroom management, is referred to as the learning model. A learning model, on the other hand, is a conceptual framework that outlines systematic methods for arranging learning experiences to meet learning goals and serves as a manual for learning designers and teachers when formulating lesson plans and learning activities, according to Sanjaya. A conceptual framework called learning outlines systematic methods for planning learning experiences in order to accomplish learning objectives. Students can acquire knowledge, skills, methods of thinking and expressing themselves, and concepts through learning models.

In connection with the description stated above, the researcher wants to try to carry out research under the title "The Effect of Implementing the Reciprocal Teaching Model on Improving Student Mathematical Communication in Middle School Students in Pidie Jaya Regency".

A number of experts have expressed several opinions about mathematical communication. For example, Greenes and Schulman [2] stated that students' success in approaches and solutions for mathematical exploration and investigation depends on their ability to effectively communicate mathematical ideas. Lastly, mathematical communication provides a forum for students to interact with friends in order to gather information, exchange ideas and discoveries, brainstorm, assess, and refine ideas in order to persuade others.

Another opinion, expressed by [3], is that communication has a broader meaning, namely; includes discussing and writing down problems and ideas that can have a positive influence on memory and concept development and problem-solving abilities. For example, in group discussions, students communicate with their peers and teachers as they organize and understand information. They critique their own work and their peers' statements to develop new mathematical understandings.

In detail, according to Eliot and Kenney, Eds, 1996, NCTM, 1989 [4] states that mathematical communication skills include, among other things, the following mathematical processes, namely: a) expressing a mathematical or daily life situation or problem in the form of an image , diagrams, mathematical language or symbols, or mathematical models; b) explain a mathematical idea with images, expressions, or own language orally or in writing; c) create a story based on a given picture, diagram, or mathematical model; d) compose questions about the given mathematical content.

According to [5] a question will be only be an issue if someone lacks laws or regulations that can be quickly applied to determine the answer to the query. Hudojo added that a question may be problematic depending on the person and the situation. This indicates that while a question may be problematic for some students, it might not be for others. It won't be an issue for teachers to ask pupils pointless questions the student.

In solving mathematical problems, the main thing besides the correct end result is the process of finding the answer. Meanwhile, good problem-solving questions are questions that cover (represent) all the subject matter that students have studied and in solving these problems only involve concepts or material that are appropriate to the student's level of thinking.

From a variety of perspectives on problem solving, it can be inferred that problem solving is the central objective of the mathematics curriculum. This means that students prioritize the process of solving a problem over the final solution when learning mathematics, and that problem solving skills are therefore considered essential. pupils studying mathematics. Even if it's not simple to achieve, because of its importance and usefulness, problem solving skills should be taught to all students at all levels.

Many experts have put forward rules or sequences of steps in solving problems. Polya [6] recommends the following:

1) Understand the problem, this can be done by rewriting the problem in your own language which can be more understandable and more operational.
2) Create a strategy or answer to it, here you can also make guesses about possible answers.
3) Carry out the plan that has been made in point 2 or solve problems according to the plan that has been prepared.
4) View or verify the accuracy of the responses. obtained.

The education model according to [7] is a teaching plan that describes the process taken in teaching and learning to achieve specific changes in student behavior as expected. In general, a teaching model is a plan for implementing teaching strategies prepared for teaching purposes.

According to [8], the Four unique features of the term learning model distinguish it from other techniques or approaches do not have, namely:

1. An intelligent theoretical justification created by the designer,
2. Learning goals to be met,
3. Teaching behaviors necessary for the model to be successfully implemented,
4. The setting necessary for learning in order to meet the learning objectives.

Meanwhile, [9] stated that benefits of teaching reciprocally include:

a. Developing student originality
b. Encourage student cooperation.
c. Fostering pupils' abilities, particularly in speaking and attitude development.
d. Because they are getting fully engaged in the material, students pay closer attention in class.
e. Develop the bravery to voice your thoughts and take the podium in front of the class.
f. Teach pupils how to quickly assess issues and reach judgments.
g. Cultivate a respectful attitude toward teachers since, when they are in the classroom—especially when they are occupied or not paying attention—students will sense the teachers' emotions.
h. May be applied to a wide range of topics and short time constraints.

2. RESEARCH METHODS

The research was carried out at SMP Negeri 2 Bandar Baru. The reason for selecting research subjects at SMP Negeri 2 in Bandar Baru, Pidie Jaya Regency, Aceh Province, was due to effective communication and mathematical problem solving at SMP Negeri 2 Bandar Baru had never received special attention. Apart from that, this school is also a school that is classified as a medium level so it is deemed appropriate to apply innovative teaching approach to help students become better communicators and solve mathematical puzzles. There are multiple classes in SMP Negeri 2 Bandar Baru's class VIII. Two classes—an experimental class and a control class—will be randomly selected from each of these classes to serve as study samples.

The data analyzed is quantitative data in the form of tests of students' communication skills and mathematical problem solving. The statistical test used in this research is the average difference test using the subsequent steps:

1. Determine the score of the initial test results and the final test of communication skills and completing mathematical puzzles for the control and experimental groups.
2. Determine the rating for enhancing one's ability to communicate and solve mathematical problems utilizing the normalized N-gain formula as introduced by Hake [10], namely:

After obtaining A pretest and post-test table was made using the pretest and post-test data. Next, the pretest and post-test scores were averaged and their standard deviations were computed. Next, the gain that is normalized is computed.

3. RESULTS AND DISCUSSION

The summary of the research's findings is predicated on the elements noted and discovered in the research.

Tests of mathematical problem solving and communication abilities were used to collect quantitative data at the start and finish of the learning process. This information was gathered from 62 students: 30 students in the control class received traditional instruction, and 32 students in the experimental class received reciprocal

teaching and learning. The study's findings are described as follows.

a. Test of Differences in Mean Normalized Gain Scores for Mathematical Communication Ability.

The normalized gain scores for the experimental class and control class were found to be normally distributed based on the findings of the conducted normality test. In the meantime, the homogeneity test demonstrates that there is homogeneity in the variance of the normalized gain scores between the two groups. Therefore, a test of the difference in the average normalized gain scores was conducted using the t-test in order to demonstrate that the normalized gain scores of students' mathematical communication abilities in the experimental class were different from those in the control class.

The test results for the difference in average normalized gain scores at the significance level $\alpha = 0.05$ are summarized as follows.

Table 1

Results of Test Data for Differences in Average Normalized Gain Scores for Mathematical Communication Ability

t-test			Conclusion
t	*df*	*Sig.* (2-tail)	
3,549	60	0,001	H_0 Rejected

Table 1 With df = 60, t_{table} value = 2.00, and t_{count} = 3.549 for $\alpha = 0.05$, Table 1 above indicates that t_{count} is in the H_0 rejection area, or a significant value of $0.001 < \alpha = 0.05$, indicating that H_0 is rejected and H_a is accepted. This indicates that there is a significant difference between students who receive conventional learning and those who receive reciprocal teaching and learning in terms of their increased mathematical communication skills. Therefore, students who receive reciprocal teaching learning outperform those who receive traditional learning in terms of their increased mathematical communication skills.

b. Test of Differences in Mean Normalized Gain Scores for Problem Solving Ability

The normalized gain scores for the traditional class and the reciprocal teaching class had a normal distribution, according to the results of the prior normality test. The homogeneity test, on the other hand, demonstrates that the variance of the normalized gain scores in the two groups' capacity to solve mathematical problems is homogeneous. Therefore, a test of the difference in the average normalized gain score was conducted using the t-test in order to demonstrate that the normalized gain score of students' mathematical problem solving abilities in the reciprocal teaching class differs from the traditional class.

Students who receive reciprocal teaching learning have greater increases in their ability to solve mathematical problems than those who receive conventional learning.

The following is an overview of the test findings at the significance level of $\alpha = 0.05$ for the variation in average normalized gain scores.

Table 2

Comparison of Average Normalized Gain Scores for Problem Solving Ability Across Test Results

t	*df*	*Sig.* (2-tail)	Conclusion
4,623	60	0,000	H_0 Rejected

H0 is rejected because tcount is in the H_0 rejection area, or a significant value of $0.000 < \alpha = 0.05$, as Table 2 above demonstrates $t_{count} = 4.623$ for $\alpha = 0.05$ with df = 60, t_{table} value = 2.00. What happens to pupils who receive reciprocal education in terms of their increased ability to solve mathematical problems varies significantly. As a result, pupils who receive reciprocal teaching surpass those who receive traditional learning in their progress in mathematical problem-solving skills.

c. Correlation in Reciprocal Teaching Classrooms between Mathematical Problem Solving and Communication Skills

Pearson's r correlation is used to determine whether or not there is a relationship between the ability to communicate and the ability to solve mathematical problems.

Hypothesis:

To see whether or not Mathematical problem solving and communication abilities are correlated, Pearson's r correlation is used.

Hypothesis:

" There is a connection between pupils' ability to communicate and solve mathematical problems in classes that use reciprocal teaching."

Hypothesis testing criteria:

H0: There is no significant correlation between communication skills and mathematical problem solving.

Ha: There is a significant correlation between communication skills and mathematical problem solving.

Table 3

Correlation Test Results of Communication Ability and Mathematical Problem Solving

Pearson's r correlation	*Sig.*	Conclusion
0,801	0,000	H_0 Rejected

The Sig value is derived using Table 3 above. That is, H_0 is rejected because 0.000. This demonstrates the strong relationship between mathematical problem solving and communication abilities. The size of the correlation 0.801 between mathematical problem solving and communication skills is indicated by the Pearson r coefficient value. According to this coefficient, there is a positive and substantial correlation between a student's ability to solve mathematical problems and their score on the mathematical communication skill scale.

4. CONCLUSIONS

The following conclusions were drawn after data processing, analysis, findings, and discussion: (1) Students who receive instruction through reciprocal teaching demonstrate more progress in their mathematics communication skills than students who get traditional instruction. It has been observed that students who get instruction through reciprocal teaching are more adept at solving problems than students who receive traditional instruction. (3) In courses that get reciprocal education, there is a strong association between problem-solving capabilities and mathematical communication abilities.

AUTHORS' CONTRIBUTIONS

1. Junaidi: Junaidi was the primary conceptor of this research. He designed the research framework, collected data through field surveys, and conducted statistical data analysis. Additionally, John was responsible for writing the manuscript of this report.
2. Taufiq: Taufiq played a role in developing the research methodology, assisted in data collection by conducting structured interviews, and contributed to data analysis. She also played a part in writing and editing the manuscript, Taufiq assisted in field data collection and made a special contribution to qualitative analysis.
3. Mirunnisa: Mirunnisa led the research team and secured funding sources for this project. Furthermore, he provided crucial guidance in planning and executing the research, Mirunnisa offered valuable statistical consultation in data analysis. She also contributed to the preparation of tables and graphs used in the report.

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