IMPROVING STUDENTS' MATHEMATICAL COMMUNICATION SKILLS THROUGH THE THINK PAIR SHARE LEARNING MODEL

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ABSTRACT

This study aims to improve students' mathematical communication skills through the implementation of the Think Pair Share (TPS) learning model. This study uses a Classroom Action Research (CAR) approach which is implemented in two cycles, with the stages of planning, implementation, observation, and reflection. The research subjects were 30 grade X high school students. Data collection techniques include observation to observe student activities, tests to measure mathematical communication skills, and documentation as supporting data. The results of the study show an increase in students' mathematical communication skills, which is indicated by an increase in the average value from cycle I to cycle II and increased student activeness in the learning process. Students become more able to convey ideas, discuss, and write mathematical concepts systematically. Thus, the implementation of the Think Pair Share model is proven to be effective in improving students' mathematical communication skills and creating more active, interactive, and meaningful learning in the classroom.

Keywords: mathematical communication, Think Pair Share, learning outcomes, PTK.

1 INTRODUCTION

Mathematics education plays a strategic role in shaping students' thinking skills, particularly in developing logical, critical, systematic, analytical, and creative thinking. Mathematics serves not only as a calculation tool but also as a means to train reasoning and problem-solving skills in everyday life. In the context of modern education, mathematics is seen as a vehicle for developing mathematical literacy, namely the individual's ability to formulate, apply, and interpret mathematics in various life contexts [1]. Therefore, mathematics learning is expected to be oriented not only toward the final result, but also toward the thinking process and reasoning, as well as students' ability to communicate their mathematical ideas effectively and meaningfully.

Mathematical communication skills are one of the core competencies that must be developed in mathematics learning. These skills encompass various aspects, such as the ability to convey mathematical ideas or concepts verbally and in writing, explain problem-solving processes coherently and logically, use symbols, tables, graphs, or other representations appropriately, and interpret mathematical information in various forms. The National Council of Teachers of Mathematics (NCTM) emphasizes that communication is a standard process in mathematics learning, serving to help students clarify, strengthen, and construct their understanding of mathematical concepts [2].

Furthermore, mathematical communication serves not only as a means of conveying information but also as a tool for thinking. Through communication, students can organize ideas, reflect on their understanding, and develop logical and systematic arguments. Students with good mathematical communication skills tend to be able to explain the rationale for each step in a problem-solving process, relate learned concepts to real-world situations, and express their opinions rationally and structuredly. This aligns with the view that effective mathematics learning must involve speaking, writing, reading, and actively representing mathematical ideas [3].

However, the reality on the ground shows that students' mathematical communication skills are still relatively low. Based on initial observations in 10th grade high school students, it was found that most students had difficulty expressing mathematical ideas clearly and systematically. Students tended to only write the final answer without fully explaining the solution process. In addition, students also experience difficulties in using mathematical symbols correctly and are not yet able to link concepts with appropriate representations, such as graphs or diagrams.

Another significant problem is low student participation in the learning process. Students tend to be passive, lack confidence in expressing their opinions, and are reluctant to ask questions when they encounter difficulties. Classroom interactions are still one-way, with the teacher as the center of information (teacher-centered learning). This situation results in students having less opportunity to optimally develop their mathematical communication skills. Previous research also shows that teacher-centered learning tends to hinder the development of students' communication and critical thinking skills [4].

This low mathematical communication skill directly impacts student learning outcomes. Students who are unable to communicate their mathematical ideas effectively will have difficulty understanding concepts deeply, developing problem-solving strategies, and explaining the rationale for their solutions. Furthermore, a lack of communication skills can also hinder the development of higher-order thinking skills (HOTS), such as analysis, evaluation, and creativity, which are essential for 21st-century learning [5].

In the context of 21st-century learning, students are required to possess the 4C skills: critical thinking, creativity, collaboration, and communication. Mathematical communication skills are an integral part of these skills, particularly in the areas of communication and collaboration. Therefore, mathematics learning needs to be designed in such a way as to develop these four skills in an integrated manner. This requires innovation in learning strategies that encourage active student involvement and provide space for them to interact, discuss, and express ideas freely and responsibly [6].

One alternative solution that can be implemented to address this problem is the Think Pair Share (TPS) cooperative learning model. This model, first introduced by Lyman, is designed to increase student participation in learning through three main stages: think (thinking individually), pair (discussing with a partner), and share (sharing the results of the discussion with a group or class). The TPS model provides students with the opportunity to process information independently, then discuss it with a partner, and finally convey their thoughts to others [7].

The advantage of the TPS model lies in its ability to create active, directed, and meaningful interactions between students. During the think stage, students are given time to understand problems and develop ideas independently, thus practicing critical and reflective thinking skills. In the pair stage, students discuss with their partners to compare, clarify, and improve answers, which can improve collaboration skills and enrich conceptual understanding. Meanwhile, in the share stage, students are trained to convey ideas orally in front of the class, using appropriate mathematical language, and explaining the solution process systematically. This stage is very important in improving students' confidence and mathematical communication skills [8].

Theoretically, the TPS model is based on constructivism theory, which states that knowledge is actively constructed by individuals through experience and social interaction. Effective learning is learning that allows students to be directly involved in the process of discovering and constructing knowledge. Furthermore, the TPS model is supported by Vygotsky's theory of the zone of proximal development (ZPD), which emphasizes that social interaction with peers or teachers can help students achieve higher levels of understanding [9].

Various previous studies have shown that implementing the TPS model has a positive impact on the learning process and outcomes. This model has been proven to significantly increase student engagement, conceptual understanding, and mathematical communication skills. Furthermore, TPS can also create a more interactive, collaborative, and enjoyable learning environment, thus increasing student motivation to learn [10].

Considering the various existing problems, and supported by theoretical studies and previous research findings, improvements are needed in the mathematics learning process that can improve students' mathematical communication skills. The implementation of the Think Pair Share learning model is expected to be an effective solution to address students' low mathematical communication skills while simultaneously improving the quality of classroom learning.

Based on the description, the problem formulation in this study is: how can the application of the Think Pair Share learning model improve the mathematical communication skills of grade X high school students? The purpose of this study is to improve students' mathematical communication skills through the application of the Think Pair Share learning model.

2 RESEARCH METHOD

This study used a Classroom Action Research (CAR) approach aimed at improving students' mathematical communication skills through the implementation of the Think Pair Share (TPS) learning model. CAR was chosen because it is a reflective and participatory research method, in which teachers play a direct role as researchers in efforts to improve classroom learning practices. Through CAR, learning problems can be systematically identified and addressed through planned actions. This approach is highly relevant in the context of mathematics learning, particularly for improving mathematical communication skills, which require active student involvement in the learning process.

This classroom action research was conducted cyclically in two cycles, each consisting of four main stages: planning, acting, observing, and reflecting. Each cycle is designed as a series of interrelated and ongoing activities. The planning stage involves developing a learning strategy appropriate to the problem at hand, while the action stage implements the plan. The observation stage aims to collect data related to the learning process and outcomes, while the reflection stage is used to evaluate the effectiveness of the actions taken and formulate improvements for the next cycle [11].

This research design refers to the spiral model developed by Kemmis and McTaggart, which emphasizes a continuous improvement process through repeated cycles of action. This model allows researchers to adjust learning strategies based on the results of reflection in each cycle, so that the quality of learning can gradually improve until it reaches the predetermined success indicators. Thus, the use of the CAR model in this study is expected to provide an effective and contextual solution to the problem of students' low mathematical communication skills [12].

2.1 Research Subjects and Setting

The study was conducted on 30 tenth-grade high school students with heterogeneous abilities. The study was conducted during the current semester in mathematics. The research setting focused on classroom learning activities that implemented a cooperative learning model to enhance interaction and communication between students.

2.2 Research Procedures

Each cycle in this research includes four stages: planning, implementation, observation, and reflection. In the planning stage, researchers developed a Lesson Implementation Plan (RPP) based on the Think Pair Share (TPS) model, developed Student Worksheets (LKS), developed mathematical communication test instruments, developed student activity observation sheets, and prepared media and teaching materials to support the learning process.

The next stage is implementation, a learning process that applies the Think Pair Share (TPS) syntax. In the think stage, students think independently to understand and solve the given problem. Then, in the pair stage, students discuss with their partners to compare and refine their answers. Afterward, in the share stage, students present the results of their discussions to the entire class.

The observation stage was conducted throughout the learning process to observe student activity, participation in discussions, and their ability to convey mathematical ideas. Observations were conducted using structured observation sheets to ensure a more systematic data collection.

The final stage is reflection, which evaluates the learning outcomes of each cycle. The results of this reflection are used as a basis for improving and refining the implementation of the actions in the next cycle so that learning objectives can be optimally achieved.

2.3 Data Collection Techniques and Instruments

The data collection techniques used in this study included tests, observation, and documentation. Tests were used to measure students' mathematical communication skills in the form of descriptive questions. Indicators measured included the ability to convey mathematical ideas, the ability to write down solution steps systematically, and the ability to use mathematical symbols appropriately.

In addition to tests, observations were used to assess student activity during the learning process. Observation assessments used a scale of 1–4, with a score of 1 indicating very poor, a score of 2 poor, a score of 3 good, and a score of 4 very good. These observations aimed to determine the level of student activity and participation during the learning process.

Documentation techniques were also used to support the research. Documentation in the form of photographs of learning activities and field notes can strengthen the research findings [13]. Before use, the test instrument was first tested for validity through expert judgment to ensure it matched the mathematical communication ability indicators being measured.

2.4 Operational Definition of Variables

The variables in this study consisted of action variables and outcome variables. The action variable was the Think Pair Share (TPS) learning model, a cooperative learning model implemented through three stages: individual thinking (think), pair discussion (pair), and sharing the discussion results with the class (share). This learning model was implemented to increase student engagement in the learning process.

Meanwhile, the outcome variable in this study was students' mathematical communication skills. These skills were measured through several indicators: the ability to convey mathematical ideas verbally, the ability to write down solution steps coherently, and the ability to use mathematical symbols or representations appropriately [14].

2.5 Data Analysis Techniques

Data analysis was carried out descriptively, quantitatively and qualitatively.

A. Quantitative analysis

The average value is calculated using the formula:

$$\bar{X} = \frac{\sum x}{n}$$

The percentage of learning completion is calculated using the formula:

$$P = \frac{n}{N} \times 100\%$$

Learning outcome assessment categories:
85–100 = very good
70–84 = good
55–69 = sufficient
<55 = insufficient

B. Qualitative analysis

Observation data is analyzed through the stages of data reduction, data presentation, and drawing conclusions to describe student activities during learning [15].

2.6 Success Indicators

This research is declared successful if it meets several predetermined criteria. These criteria include at least 75% of students achieving scores above or equal to the Minimum Completion Criteria (KKM), an increase in the average student score from cycle I to cycle II, and student activity during the learning process being at least in the "good" category. By achieving these criteria, the implementation of the Think Pair Share (TPS) learning model is considered capable of improving students' mathematical communication skills.

3 RESULT AND DISCUSSION

3.1 Result

This classroom action research was conducted in two cycles, each consisting of planning, action implementation, observation, and reflection. The main focus of the research was improving students' mathematical communication skills through the implementation of the Think Pair Share (TPS) learning model. Data were obtained through tests, observations, and documentation, which were then analyzed descriptively using quantitative and qualitative methods.

A. Results of Cycle I

In the planning stage of cycle I, researchers developed learning materials in the form of TPS-based lesson plans (RPP), student worksheets (LKS), and mathematical communication test instruments. The materials used were adapted to the 10th grade curriculum and designed to stimulate students' mathematical communication skills.

In the implementation phase, learning began with the presentation of contextual problems. In the think phase, students were asked to understand the problem and formulate solutions independently. However, observations indicated that some students still had difficulty interpreting the problem and organizing mathematical ideas in writing.

In the pair phase, students discussed with their partners. Although interaction began to occur, the discussions were not yet effective. This was evident in the persistence of passive students who tended to rely on their more dominant partners. Furthermore, communication was limited to the final answers, not the solution process.

In the share phase, only a few students dared to present the results of their discussions. Most students remained hesitant and lacked confidence in conveying their ideas in front of the class. This indicates that students' mathematical communication skills, both verbally and in writing, are still low. The results of the mathematical communication skills test in cycle I showed an average score of 68, with classical completeness of 60%.

Table 1 Results of Students' Mathematical Communication Skills in Cycle I

No	Indicators	Percentage (%)
1.	Expressing mathematical ideas orally	58%
2.	Write down the solution steps in sequence	62%
3.	Using mathematical symbols and representations	60%
Rata - Rata		60%

Furthermore, observations of student activity indicated that the level of activity was in the sufficient category, with a percentage of 65%.

Reflection on Cycle I:

Based on the analysis, several obstacles affected learning outcomes, namely:

1. Students were not yet accustomed to the TPS cooperative learning model.
2. Low student confidence in expressing ideas.
3. Lack of student skills in writing solutions systematically.
4. The teacher was not optimal in providing guidance during the discussion.

B. Results of Cycle II

In Cycle II, improvements were made based on the results of the reflections from Cycle I. The teacher provided more detailed explanations of the TPS steps, provided examples of good mathematical communication, and increased the intensity of guidance during the discussion process. Furthermore, the teacher provided motivation and rewards to active students.

In the think phase, students began to show improvement in understanding the problem and developing solutions independently. In the pair phase, discussions became more active and balanced. Students began to ask questions, offer opinions, and correct each other's answers.

In the share phase, there was a significant increase in the number of student participants. Students became more confident in conveying discussion results, both verbally and using mathematical representations such as symbols, diagrams, and sequential solution steps.

Test results in Cycle II showed significant improvement, with an average score of 80 and a classical completion rate of 83%.

Table 2 Results of Students' Mathematical Communication Skills in Cycle II

No	Indicators	Percentage (%)
1.	Expressing mathematical ideas orally	82%
2.	Write down the solution steps in sequence	85%
3.	Using mathematical symbols and representations	83%
Rata - Rata		83%

Observations showed that student activity increased to 85%, which is considered excellent. This indicates that students are more active, enthusiastic, and engaged in learning.

C. Comparison of Results Between Cycles

Table 3 Comparison of Results of Cycle I and Cycle II

Aspect	Cycle I	Cycle II
Average score	68%	80%
Classical completion	60%	83%
Student activity	65%	85%

The data shows a significant increase in all aspects studied

3.2 Discussion

The research results show that the effective implementation of the Think Pair Share (TPS) learning model can improve students' mathematical communication skills. This improvement is not only evident in test results but also in student activity and engagement during the learning process.

In Cycle I, students' mathematical communication skills were still low because they were not yet accustomed to learning that requires active participation. However, after improvements were made in Cycle II, significant improvement occurred. This demonstrates that systematically and sustainably designed learning can have a positive impact on students' abilities.

The TPS model provides students with the opportunity to go through a structured learning process. In the "think" phase, students are trained to think independently and develop ideas. This phase is crucial for building students' initial understanding of the concepts being studied. In the "pair" phase, students discuss with their partners, leading to an exchange of ideas and clarification of concepts. This interaction helps students refine their understanding and improve their communication skills.

The "share" phase is the most important phase in improving mathematical communication skills. In this phase, students are trained to convey ideas verbally in front of the class, using appropriate mathematical language, and explaining the steps to solve problems systematically. This aligns with the NCTM's opinion that communication is a means to clarify and strengthen mathematical understanding.

Furthermore, improvements in mathematical communication skills were also influenced by increased student self-confidence. Students who were initially passive became more active in asking questions and expressing opinions. This demonstrates that cooperative learning can create a more comfortable learning environment and encourage student participation.

The results of this study also align with constructivism theory, which states that knowledge is built through social interaction and learning experiences. Through discussion and collaboration, students can construct deeper understanding.

Furthermore, improvements in each indicator of mathematical communication indicate that:

1. Students are able to convey mathematical ideas more clearly and in a structured manner.
2. Students can write down solution steps coherently and logically.
3. Students are able to use mathematical symbols and representations appropriately.

These findings are also supported by previous research that found the Think Pair Share model effective in improving student communication skills and learning outcomes. Therefore, this model can be used as an innovative and effective learning alternative in mathematics.

Overall, the implementation of the Think Pair Share model has been proven to improve students' mathematical communication skills and create active, collaborative, and meaningful learning.

4 CONCLUSION

Based on the results of classroom action research conducted over two cycles, it can be concluded that the implementation of the Think Pair Share (TPS) learning model can improve the mathematical communication skills of tenth-grade high school students. This improvement is evident in test results, which show an increase in students' average scores from cycle I to cycle II, as well as an increase in the percentage of students achieving learning completion that has reached the established success indicators. Furthermore, observations also indicate increased student activity and participation in the learning process, particularly in expressing ideas, discussing, and systematically writing solutions.

The implementation of the TPS model provides students with opportunities to think independently, discuss with partners, and share their ideas with the group, thus gradually practicing mathematical communication skills. This model has also been shown to increase student self-confidence and create a more active, interactive, and collaborative learning environment.

The implication of this research is that the Think Pair Share learning model can be used as an effective alternative learning strategy to improve students' mathematical communication skills. Therefore, teachers are advised to implement learning models that involve active interaction between students in the mathematics learning process. For further research, it is recommended to develop this research on different materials, other levels of education, or combine the TPS model with learning media or technology to obtain more optimal results.

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