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Improvement of Mathematical Communication Skills of Grade V Elementary School Students Using the Application of the Round-Robin Brainstorming Model

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Abstract
The low mathematical communication skills of grade V students of Kluwut 02 Public Elementary School Malang is the background of this study. In fact, mathematical communication skills are an important component in helping students understand mathematical concepts meaningfully. This research aims to improve students' mathematical communication skills through the application of the round-robin brainstorming learning model. The method used is Class Action Research, which is carried out in two cycles, each consisting of the stages of planning, implementation of actions, observation, and reflection. The research subjects were 16 elementary school grade V students. The data collection technique uses observation and tests in the form of story questions in the Student Worksheet, which are done in groups. The data was analyzed descriptively to determine the improvement of students' mathematical communication skills. The results of the study showed an increase in the percentage of completeness from cycle I by 56.25% to cycle II to 87.5% with the category of good to good. This study fills the gap in the study of the application of round-robin brainstorming at the elementary school level, especially in the development of mathematical communication skills. Although the results showed significant improvement, the study was limited to a small class scope and limited time duration, so further research with a wider scope is needed.

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Introduction

One of the crucial competencies required in the 21st century is mathematical communication skills, which enable students to express, interpret, and justify mathematical ideas clearly and systematically. This aligns with the demands of competency-based learning that emphasizes not only knowledge acquisition but also skill development in problem-solving and reasoning. According to the National Council of Teachers of Mathematics (NCTM, 2020), communication is a fundamental process in mathematics education because it helps students to organize, clarify, and articulate mathematical ideas both orally and in written form. Moreover, the Programme for International Student Assessment (PISA) conducted by the Organisation for Economic Co-operation and Development (OECD, 2019) reported that weak mathematical communication skills significantly contribute to low mathematical literacy, particularly among students in developing countries such as Indonesia. These findings underscore the importance of equipping students with effective communication skills in mathematics from an early age.

In the Indonesian context, mathematics instruction in elementary schools tends to rely heavily on traditional teaching methods that are teacher-centered and emphasize final outcomes rather than the learning process. This pedagogical approach often limits students' opportunities to communicate their mathematical reasoning or engage actively in classroom discourse (Iskandar, 2021). As a result, many students become passive recipients of knowledge and exhibit difficulties in articulating the processes they use to solve problems. Data from the 2022 Minimum Competency Assessment (AKM), as reported by the Center for Education Assessment, reveals that approximately 56% of elementary school students fall within the basic numeracy category, with communication identified as one of the weakest skill indicators (Rahman & Wandini, 2024). This reality has serious implications for students' ability to participate in discussions, explain their problem-solving steps, and construct logical arguments in mathematics.

Preliminary observations conducted in a fifth-grade classroom at Kluwut 02 Public Elementary School Malang, support these national findings. Of the 16 students observed, only six students (37.5%) were able to articulate their problem-solving ideas both orally and in writing during group discussions. The majority of students struggled to explain the steps they took, draw valid conclusions, and present their answers coherently and systematically (Personal Observation, 2025). Similar challenges have been identified in other studies, such as those by Hidayat (2023), Zain and Ahmad (2021), and Muspika (2024), which all found that elementary students generally exhibit poor mathematical communication during collaborative tasks and when explaining their solutions. These recurring findings indicate that the issue is widespread and requires systematic pedagogical intervention.

One potential solution that has shown promise in higher educational levels is the Round-Robin Brainstorming model, a cooperative learning technique that promotes structured turn-taking and collaborative idea generation. While this model has been applied with relative success in junior and senior high schools (Rosita, 2015; Sulestyani, 2016), its effectiveness in the elementary school context remains underexplored. Research that investigates how this model can specifically enhance the mathematical communication skills of younger learners is still very limited. Given the importance of early intervention in the development of mathematical

literacy, there is a pressing need to explore and assess the implementation of this model at the elementary level. Such research could provide insights into its adaptability and impact in nurturing students' communication abilities within mathematics learning environments.

This study holds both theoretical and practical significance. From a theoretical standpoint, it contributes to the expansion of cooperative learning theory by adapting the Round-Robin Brainstorming model to suit the cognitive and communicative characteristics of elementary students. Practically, the findings can inform teachers about the potential benefits of using structured group discussions as a means to foster active participation and encourage students to articulate mathematical ideas with confidence and clarity (Khorurrohimah & Nuryadi, 2025; Rahmadani et al., 2024). Therefore, this study is designed with the specific aim of enhancing the mathematical communication skills of elementary school students through the application of the Round-Robin Brainstorming learning model.

Method

This study employed the Classroom Action Research (CAR) method because it aims to improve classroom learning practices through systematic, reflective, and iterative cycles of planning, action, observation, and reflection (Winarto, 2016). The research was conducted at Kluwut 02 Public Elementary School, Malang Regency, during the odd semester of the 2024/2025 academic year, involving 16 fifth-grade students selected using a total sampling technique (Priambada & Supriatin, 2024). The research design adopted the model developed by Kemmis and McTaggart (1988), which consists of two cycles, each comprising four stages: planning, implementing the action, observing the process, and reflecting on the results. Data were collected through various techniques, including observation of the learning process, interviews with teachers and students, documentation of classroom activities, and mathematical communication ability tests using Student Worksheets (LKPD) in the form of group-based word problems (Arikunto, 2010). All research instruments underwent content validity assessment by two mathematics education experts and one expert in classroom action research to ensure clarity, relevance, and alignment with research objectives, and the instruments were revised based on their input. The data were analyzed using descriptive quantitative methods, where the implementation score was calculated using the formula: score = total score / maximum possible score, while the percentage of students' mathematical communication skills was determined using the formula Pst = (∑T / N) × 100%. The success criteria were established as a minimum of 75% of students achieving the "good" category in mathematical communication, and the learning implementation reaching at least the "good" level (≥76%) as an indicator of instructional effectiveness and the basis for evaluating action improvement.

Results and Discussion

Results

Activities in cycle 1 include planning, implementation of actions, observation of the implementation of learning and observation of the student learning process as well as reflection. Before learning, the teacher first prepares the necessary learning tools during the research process. The learning tools prepared consist of teaching modules using the Round-Robin

Brainstorming model, a learning media that is tailored to the learning material. The researcher also prepared assessment sheets, LKPD, observation sheets, and interviews.

The implementation of the mathematics learning process using the Round-robin Branstroming model in grade V of SD Negeri Kluwut 02 in the first cycle will be carried out in November 2025, and adjusted to the steps of the learning model. Learning activities include 3 stages, namely introductory, core, and closing activities. At the core, the application of the Round-Robin Brainstorming model encourages students' active involvement in group discussions. In this activity, students are divided into groups and form a circular formation to share ideas or information related to solving problems in the LKPD in turns. Each group appoints one student as a recorder who is in charge of documenting the ideas or completion strategies presented by the group members. The ideas are then discussed further in the group discussion. Towards the end of each round of discussion, the teacher will listen to the students' responses and provide additional clarifications or explanations to strengthen their understanding. This activity is carried out repeatedly until all students get an equal opportunity to express their opinions. Through the mechanism of sharing ideas in turn, each student is given a space to speak and contribute to the discussion. (Marjuki, 2020).

Table 1. Results of Observation of the implementation of learning cycle I with *the Round-Robin Brainstorming model*

Observer	Value
Cycle I (1 Meeting)	2,75

In the first cycle stage, students participated well in the activities but there were still a number of who experienced difficulties in learning in the core stage. There are some students who are less active in group discussions, the inactivity of students is due to difficulty in catching the ideas they receive. However, in general, learning activities using the Round-Robin Brainstorming model went smoothly accompanied by an average observation result of all groups of 2.75 with a good predicate.

The results of the observation of students' mathematical communication skills in cycle I are as shown in the following table:

Table 2. Results of Student Mathematical Communication Observations in the Discussion Process of the first cycle

No.	Aspects observed	Value
1	The ability of students to express mathematical ideas through diagrams, tables, or mathematical symbols.	4
2	The ability of students to explain ideas or thoughts and daily situations in writing using pictures.	4
3	The ability of students to associate real objects with symbols, graphs, and tables in mathematical concepts.	4
4	Students' ability to read, listen, interpret, and evaluate mathematical ideas.	2
5	Students' ability to understand and evaluate mathematical ideas in everyday problem solving.	2

6	The ability of students to re-articulate mathematical ideas both orally and in writing.	3
7	The ability of students to communicate conclusions from answers to daily problems.	3
	Average	3,15

Based on the data in Table 4, students' mathematical communication skills showed improvement in cycle I. Students began to be able to turn everyday events into mathematical ideas expressed in the form of story problems, and were able to relate these mathematical ideas into the form of mathematical symbols. Thus, it can be concluded that the implementation of class actions in the first cycle has a positive impact on improving students' mathematical communication skills.

In cycle I, a test was also carried out which functioned not only to assess ability, but also to measure the level of student participation in the development of mathematical communication through group discussion activities using the Round-Robin Brainstorming learning model. The results of this test were used to determine the level of active involvement of students in the learning process and discussion.

Table 3. Student participation in learning and discussion process

Group	Number of Members	Number of Participants	Percentage
Group 1	4	1	25%
Group 2	4	3	75%
Group 3	4	2	50%
Group 4	4	3	75%
		Average	56,25%

The results of table 5 show that the participation of students in groups and discussion processes is 56.25%, of which the number of student activity is less than <75%, It can be concluded that the level of student activity in learning using the Round-Robin Brainstorming model shows positive results, and the achievement of improving students' mathematical communication skills is in the category of sufficient.

Based on the results of the analysis of the implementation of learning in cycle I by applying the Round-Robin Brainstorming model, it can be seen that the learning process has gone quite well. However, the level of student participation shows that there are still several aspects that need to be improved, where of the 16 students who actively participated in learning and completed the test, only 9 students with a percentage of 56.25%. This result has not been achieved because the average student participation in the activeness of the discussion process to solve the questions given using the Round-Robin Brainstorming model is still less than 75%. These results also show that the observation value of mathematical communication skills is only possessed by students who actively participate in learning. The low participation of students in learning is due to students lacking confidence in their abilities and also low understanding of concepts. This makes it difficult for students to grasp ideas and pour them into solving problems.

From the implementation of the first cycle of actions, there are a number of things that are reflections and evaluations of learning, namely: 1) time allocation management in core activities so that all syntax can be implemented, 2) appropriate and regular group position management to facilitate the control of student activities in groups, 3) intensively monitoring discussions during the learning process to ensure that all students actively participate in group discussions, and 4) be more proactive in providing assistance during learning to help students who are experiencing difficulties. Planning activities in cycle II generally have similarities with planning in cycle I. Planning stages in cycle 2 include: preparation of learning modules and preparation of Student Worksheets (LKPD). In addition, it also prepares learning support media, student observation formats, and interviews implementation. The implementation of cycle 2 includes: opening, core, and closing activities.

The implementation of learning in cycle 2 is slightly different from the core activities in cycle I, the goal is so that what is the evaluation of cycle I can be improved. The activities carried out are as follows, 1) providing an introduction to the material that will be the focus of the discussion, 2) dividing the tasks of each group member, such as people to take notes and collect ideas, 3) the teacher gives or gives an open-ended question (has many answers), 4) one of the students in each group takes turns to pour out ideas, 4) then, each group takes notes and discusses to solve the questions given by the teacher, 5) After the whole group is finished, the teacher asks one of the students in each group to express an opinion on the question, 6) After all the groups have their turn to give their opinions, the teacher gives reinforcement and gives points to each group. The activities carried out in the core activities are to guide students to actively participate in learning activities, Brainstorming activities will continue to be carried out until all students have their turn to express ideas. The learning activity ended by giving the LKPD to be done in groups as a test. The researcher will make observations on the learning process and the discussion process. Based on the findings of observations that have been carried out in the learning process of cycle 2, it can be seen that there is an increase in student activity compared to cycle I. Students are seen to be active in group discussions and actively involved in the Round-robin Brainstorming process compared to cycle I, although there are one or two students who are unable to express their opinions because students' understanding of the material is still lacking. Details of the results of students' mathematical communication in cycle 2 can be seen in the following table:

Table 4. Results of Observation of Students' Mathematical Communication in the Discussion Process of Cycle 2

No	Aspects observed	Value
1	The ability of students to express mathematical ideas through diagrams, tables, or mathematical symbols.	4
2	The ability of students to explain ideas or thoughts and daily situations in writing using pictures.	4
3	The ability of students to associate real objects with symbols, graphs, and tables in mathematical concepts.	4
4	Students' ability to read, listen, interpret, and evaluate mathematical ideas.	4

5	Students' ability to understand and evaluate mathematical ideas in everyday problem solving.	3
6	The ability of students to re-articulate mathematical ideas both orally and in writing.	4
7	The ability of students to communicate conclusions from answers to daily problems.	4
	Average	3,85

Table 6 shows that students' mathematical communication skills at cycle 2 meetings have increased significantly. The most notable improvement can be seen in the aspects of students' skills in reading, listening, interpreting, and evaluating mathematical ideas, as well as in their ability to re-express mathematical ideas orally or in writing. In conclusion, the implementation of actions in cycle 2 has been effective in improving students' mathematical communication skills during the learning process, accompanied by an overall average of 3.85% which is categorized as very good.

The implementation of the 2nd cycle test was used to measure student participation in improving mathematical communication skills through group discussion activities applying the Round-Robin Brainstorming learning model. These results are used to see a number of students who are actively involved in the learning and discussion process.

Table 5. Student participation in learning and discussion process

Group	Number of Members	Number of Participants	Percentage
Group 1	4	4	100%
Group 2	4	3	75%
Group 3	4	4	100%
Group 4	4	3	75%
		Average	87,5%

The results of table 7 show that the participation of students in groups and discussion processes is 87.5%, of which the number of student activity is more than >75%, It can be concluded that student involvement in learning through the Round-Robin Brainstorming model takes place actively, and the achievement of improving students' mathematical communication skills is in the very complete category.

Based on the results of observations of student activities, the researcher concluded that the learning in cycle 2 had reached the success indicators set in the research. Observation of student activities during cycle 2 showed a significant increase. In conclusion, the implementation of the action in cycle 2 has met the success criteria. This is in accordance with the standard of success, where learning is considered successful and quality when overall or at least the majority of students (75%) in learning contribute actively physically, socially, or mentally, and show high enthusiasm for learning, enthusiasm, and confidence. (Mulyasa., 2006; Dimyati & Mudjiono, 2006; Sudjana, 2009).

From the results in cycle I and cycle 2, an improvement in mathematical communication skills was obtained by applying the Round-Robin Brainstorming learning model. This can be

seen in the data on student participation and activeness in the group discussion process in cycle I and cycle 2. After an analysis of the learning process with the Round-Robin Brainstorming model, it was found that the participation of student discussions in cycle I, 9 students were able to complete the mathematical communication aspect with a percentage of 56.25% and as many as 7 students could not participate and fulfilled the mathematical communication aspect with a percentage of 43.75%. In cycle 2, there was an increase, 14 students 87.5% actively participated and met the mathematical communication aspect and 2 students 12.5% who could not meet the mathematical communication aspect. The test results in cycle 2 showed achievements that were in accordance with the expectations of the researchers, characterized by an increase in the learning completeness of students who had met the success indicators in this study. The percentage of improvement in students' mathematical communication can be seen in figure 1:

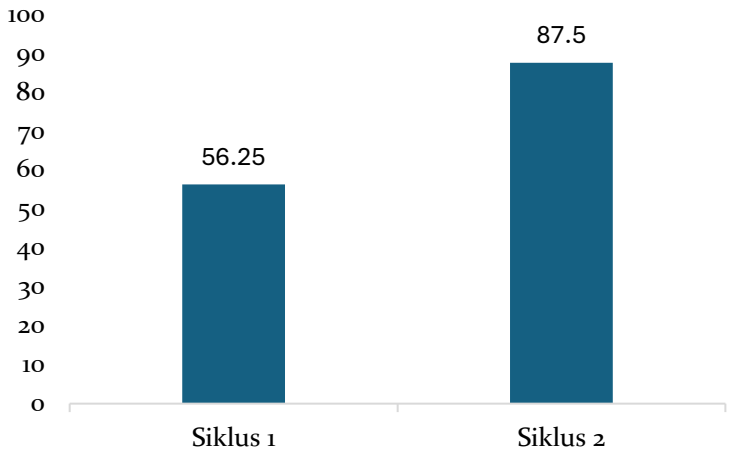

Figure 1. Percentage improvement in students' mathematical communication

Discussion

It takes the application of an effective learning model to foster students' mathematical communication skills. One of the models that has been proven to be able to improve this ability is Round-Robin Brainstorming. Research by Khorurrohimah and Nuryadi (2025) shows that this model is more effective in improving students' mathematical communication skills compared to conventional learning approaches. Similar results were obtained by Jatisunda (2019), who stated that students who were taught through the brainstorming approach showed higher achievement in mathematical communication than students with traditional methods. The Round-Robin Brainstorming model involves students taking turns conveying ideas in group discussion forums, thereby encouraging active involvement and collaboration between students (Kusuma & Rosidah, 2024). Padmadewi (2021) added that this model is effective in developing critical and creative thinking skills, because students are encouraged to think spontaneously and respond to the ideas of their classmates.

The results of the research at SD Negeri Kluwut 02 Malang Regency showed that there was an increase in mathematical communication skills of grade V students through the implementation of Round-Robin Brainstorming. This model provides opportunities for each student to express ideas, combine ideas efficiently, and encourage the participation of students who are less confident so that dominant students do not dominate the discussion (Baiduri,

2021). This condition is important considering the low confidence of students and the understanding of basic mathematical concepts which are the main obstacles in mathematical communication (Wardana, 2018). The discussion process has proven to be a crucial moment in developing mathematical communication skills, because it involves questions and answers, statements, images, and contextual examples in solving problems together (Hartono & Irvandi, 2021).

In the first cycle, the implementation of this model has gone quite well, but the level of student participation is still low. Of the 16 students, only 9 students (56.25%) actively participated in the discussion and solved the questions. This condition is caused by a lack of confidence and limited understanding of concepts, so that students have difficulty pouring out ideas and expressing their mathematical ideas. Students who lack confidence tend to be passive, afraid of making mistakes, and reluctant to engage in group discussions (Kinanti et al., 2025; Kristina et al., 2023). As a result, they are more likely to be listeners than active participants in learning, which has an impact on low academic attainment and social development (Srijayami et al., 2024).

In the implementation of cycle II, there was a significant increase in both participation and mathematical communication skills of students, reaching 87.5%. Students are more active in discussing, asking questions, and interacting, although some still use everyday language. However, this process is actually an important first step in helping students develop the ability to convey mathematical ideas in a clearer, more structured, and critical way (Kusumawati, 2016). This model has been proven to have a positive influence on students' communication skills because it is able to facilitate the courage and activities of asking questions, opinions, and analyzing problem-solving strategies with peers and teachers.

However, the implementation of this model has limitations. First, the study was conducted in a small class of 16 students, which was relatively easier to control in group discussions. In the context of large classrooms, the effectiveness of Round-Robin Brainstorming can face different challenges, such as difficulty arranging turns, limited discussion time, or more diverse student character differences. Second, the action process is carried out by the teacher-researcher himself, so that the potential for subjective bias in observation and action decision-making is very likely to occur, especially in determining the success of the cycle. As revealed by Kinanti et al. (2025), the direct involvement of teachers-researchers can affect the objectivity of evaluating action results.

In addition, the use of learning media in this study is still limited to printed LKPD, without the integration of technology or interactive digital media. In fact, the use of more varied digital media can increase the effectiveness of the Round-Robin Brainstorming model in building students' mathematical communication in a more optimal and attractive manner. For this reason, further research is recommended to integrate interactive digital media in the discussion process so that the learning atmosphere is more dynamic, while expanding the space for interaction between students. An expansion of the research focus can also be directed to test the influence of this model on other aspects of students' mathematical competence, such as critical thinking skills, problem-solving, and mathematical representation.

Conclusion

Based on the results of the research and analysis that has been carried out, the implementation of the Round-Robin Brainstorming learning model in mathematics learning shows positive potential in improving the mathematical communication skills of grade V students of SD Negeri Kluwut 02 Malang Regency. The data showed an increase from cycle I to cycle II, with students' average mathematical communication scores rising from 3.15 to 3.85, and active participation in group discussions increasing from 56.25% to 87.5%. This research not only makes a practical contribution to strengthening discussion-based collaborative learning in elementary schools, but also contributes to enriching the literature on the effectiveness of the Round-Robin Brainstorming cooperative discussion model at the elementary school level, especially in the context of developing mathematical communication skills. However, the results of this study are contextual because they are carried out in one class with a limited number of students and certain materials. Therefore, further research is recommended to be applied to classes with larger student numbers and more varied coverage of mathematics material, in order to obtain stronger generalizations of results and test the potential of this model against other aspects of mathematical competencies such as critical thinking, problem-solving, and mathematical representation.

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Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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