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Analysis of mathematical communication skills in the discussion process of grade V elementary school students

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Abstract: Mathematical communication skills help students in improving their understanding of mathematics lessons and help students in solving mathematical problems. Students with low mathematical communication have difficulty understanding and solving mathematical problems. This study aims to describe mathematical communication skills in the discussion process of grade V elementary school students. The type of research used is descriptive qualitative research. The data collection methods used were observation, tests and interviews. The data obtained were then analyzed through data reduction steps, data presentation, and conclusion drawing. Based on the results of the data analysis, it was found that students' mathematical communication skills during the discussion process were still relatively low. Most students did not meet the indicators of mathematical communication during the discussion process. Students' skills in reading, listening, interpreting, and evaluating mathematical ideas were not evident during the discussion. This was evidenced by the results of observations during the discussion process: several students were not actively involved in expressing their opinions during the discussion due to difficulties in understanding the problems and problem-solving strategies; students also had difficulty communicating the solutions reflected in their answers.

Keywords: mathematics; mathematical communication; discussion; elementary school

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INTRODUCTION

Mathematical communication skills are very important for students to improve their understanding of mathematics. In learning, students have difficulty exploring mathematical understanding because learning is considered difficult, monotonous, lack of activities that strengthen students' mathematical skills and without innovation in implementation. Mathematics learning is learning that has a lot of theory, memorizing formulas, numbers, and seems complicated (Qoyyimah et al., 2022). From this, it has an impact on students who have not been able to explain the steps of solving problems using the correct mathematical language. An ability is needed that helps students to connect symbols or symbols in problem solving steps and understanding mathematical concepts. This ability is mathematical communication ability. Communication plays a very important role in helping students not only to build concepts but to build links between ideas and abstract language with mathematical symbols (Astuti & Leonard, 2015). Communication skills are an understanding of what is communicated by using mathematical language, such as mathematical symbols, or by referring to the realities of everyday life, such as pictures, graphs, real objects, and tables (Yulyantika et al., 2019). According to Greenes and Schulman (1996, as cited in Ansari, 2018), mathematical communication skills are the ability of students to 1) express mathematical ideas through language, writing, demonstration, and visuals in various forms, and 2) communicate ideas presented in written, oral, or visual formats, interpret and evaluate, 3) build, interpret and connect diverse expressions of ideas and their relationships. Based on this opinion, mathematical communication ability is the ability to convey an idea with mathematical language both orally and in writing. Mathematical communication skills are fundamental skills that students need when learning mathematics. The communication process helps students to deepen their understanding of mathematical concepts and facilitate their understanding. Thus, mathematical communication skills are very necessary and important to be developed by teachers for students in learning mathematics to help students solve and solve problems during the learning process.

Mathematical communication skills can encourage students to build understanding of problem solving, students' mathematical communication skills can be fostered by collaborative activities between friends in the form of discussions or project collaboration. These activities can encourage their communication skills naturally. Students' communication skills do not occur because students in expressing ideas to other friends are not confident in sharing ideas with their peers and students do not understand the basic concepts of mathematics (Wardhana & Lutfianto, 2018). Thus, a constructive activity is needed between students to develop mathematical communication. The discussion process in the classroom is a crucial moment to develop students' mathematical communication skills. Through discussion, students not only learn to express their opinions, but also practice listening and responding to their friends' arguments. This is important to build a deeper understanding of mathematical concepts.

The discussion process involves asking and answering questions, using statements, images, and real-life examples to explain solutions that can be achieved together (Hartono & Irvandi, 2021). Learning occurs both in interactions between individuals, where individuals share ideas, knowledge, experiences, and information in groups to solve problems, as well as in interactions between groups, where each group provides alternative solutions to problems in a connected manner and all students participate actively (Mulyatna, 2022). Through group discussions, students have a tendency not to hesitate to ask questions if there are things that are lacking or even not understood. Thus, the group discussion method not only helps improve understanding of mathematical concepts, but also develops students' social and collaborative skills (Sholihah & Amaliyah, 2022). At the elementary school level, especially in learning mathematics, group discussions can improve students' ability to communicate mathematically, because in discussions there is a process where students work together and exchange ideas to solve problems. In the explanation

above, group discussion activities can encourage students' mathematical communication skills.

Based on the results of preliminary observations conducted at an elementary school in Malang Regency, it was found that students' mathematical communication skills during discussions have not yet developed optimally. This was evident in the difficulties some students faced in determining the initial steps to solve problems, analyzing the available information, and understanding the problems presented. Some students also appeared confused and repeatedly asked the teacher or their peers to re-explain the steps for solving the problems. This situation indicates that the students' difficulties are not only related to their understanding of mathematical problems but also to their ability to express and communicate mathematical thinking during the discussion process.

A number of previous studies have examined the mathematical communication skills of elementary school students, with varying focuses and findings. A study by Hidayat *et al*. (2023) involving six third-grade elementary school students revealed differences in the levels of mathematical communication skills among students. Students in the low category were unable to present answers orally, through drawings, or in the form of conclusions, while students in the intermediate category still needed to improve their ability to express ideas orally. Furthermore, a study by Zain and Ahmad (2021) found that students' mathematical communication skills remained low, as evidenced by a tendency for students to fail to understand problems first, adopt a passive attitude, and immediately write down answers without going through a systematic problem-solving process. Meanwhile, a study by Muspika *et al*. (2024) involving 20 fourth-grade elementary school students, conducted through written tests and interviews, showed that students still face difficulties in explaining mathematical ideas to solve problems and in drawing conclusions for math problems involving the division of three numbers. These findings indicate that previous research has identified various forms of students' mathematical communication difficulties, whether in conveying ideas, representing their thinking, explaining the problem-solving process, or deriving mathematical answers. Nevertheless, these findings do not, on their own, fully explain how students' mathematical communication skills are demonstrated in interactions during the discussion process—particularly when students attempt to understand information, determine initial steps toward a solution, articulate ideas, and engage in collaborative problem-solving. This aspect is important to examine because mathematical communication in discussions is not only related to the ability to produce correct answers but also encompasses the process of expressing, explaining, and responding to mathematical ideas. Phenomena observed in initial observations indicate that some students struggle to understand problems and tend to rely on explanations from teachers or peers, thereby limiting their participation in discussions. Therefore, this study focuses on analyzing the mathematical communication skills of elementary school students during discussions to obtain a more detailed picture of the characteristics of the skills demonstrated by students based on the mathematical communication indicators used. The results of this study are expected to provide a deeper understanding of the forms of students' mathematical communication skills during discussions, while also serving as a basis for designing instruction that encourages active engagement and the development of students' mathematical communication skills.

METHODS

Research Design

This research uses qualitative research with the type of descriptive qualitative research method. This research aims to describe students' mathematical communication skills in the discussion process.

TABLE 1. *Group division*

Group	Member name	Description
Group 1	IMNF (Female)	Student 1 (S1)
	RDS (Male)	Student 2 (S2)
	MAL (Male)	Student 3 (S3)
	ZEOD (Male)	Student 4 (S4)
	VM (Female)	Student 5 (S5)
Group 2	KNFS (Female)	Student 1 (S1)
	ARA (Male)	Student 2 (S2)
	DEP (Male)	Student 3 (S3)
	AFEP (Male)	Student 4 (S4)
	JDP (Male)	Student 5 (S5)
	MHA (Male)	Student 6 (S6)
Group 3	FAF (Male)	Student 1 (S1)
	BHJ (Male)	Student 2 (S2)
	MIA (Male)	Student 3 (S3)
	SASA (Female)	Student 4 (S4)
	FMR (Male)	Student 5 (S5)

Participants

The subjects involved and the main source of data are fifth grade students in one of the elementary schools in Malang district with an average age of 11 years. At the time of the initial observation, the subjects of this study amounted to 20 students, but when the test was carried out there were 4 students who were absent so, there were only 16 students (12 male and 4 female) who carried out the test. The data collection technique was carried out by giving test questions to class V students which were completed in groups or by discussing. The students were divided into three groups of five to six students each.

The group formation is based on heterogeneous division, in one group formed consisting of students with low, medium, and high mathematical abilities. The determination and division of group members was carried out by the researcher on the basis of discussions with the class teacher based on the average student mathematics scores obtained during learning.

Instrument

The instruments used in this study consisted of test questions that had to be completed through group discussions. The test results were used to determine students' achievement in meeting the indicators of mathematical communication skills; the researcher then observed the group discussions and interviewed several students, asking questions related to the problems they had worked on. The observation activities were rated on a 1–4 scale based on seven aspects of mathematical communication indicators. The test questions and interview guidelines were developed based on these mathematical communication indicators. The analysis was conducted based on the aspects or indicators of mathematical communication skills (MCI) (Dianti et al., 2022).

TABLE 2. *Indicators of mathematical communication ability*

Indicator of mathematical communication ability	Code	Implementation on the problem
Students' ability to express mathematical ideas in the form of diagrams, tables and or mathematical symbols.	MCI 1	1. Lukas has $^1/_3$ paper, then, Komang gives Lukas $^4/_6$ more paper. If the two pieces of paper are combined, can you name the fraction of the combined paper?
Students' ability to explain ideas/thoughts and everyday situations in writing using pictures	MCI 2	
Students' ability to connect real objects, symbols, graphs and tables in mathematical ideas.	MCI 3	2. Ana and Budi have a chocolate bar. Ana eats $^1/_4$ of the chocolate bar, and Budi eats $^1/_3$ of the chocolate bar. Find the total amount of chocolate they ate together, and explain using a picture of a chocolate bar divided into fractions!
Students' ability to use the skills of reading, listening, interpreting, and evaluating mathematical ideas	MCI 4	3. Edo and Sinta share a chocolate bar. Edo ate $^3/_8$ part, and Sinta ate $^5/_8$ part of the chocolate. How much chocolate is left after Edo and Sinta eat?
Students' ability to understand and evaluate mathematical ideas in solving everyday problems.	MCI 5	
Students' ability to re-explain mathematical ideas in oral and written form.	MCI 6	4. Bayu has $^3/_5$ from a cake. Then he adds $^1/_4$ from another cake of the same size. Determine how many cakes Bayu has after the addition and explain the process of solving the problem in writing!
Students' ability to communicate the conclusion of the answer to everyday problems.	MCI 7	

Procedure

The assessment of mathematical communication skills was based on the fulfillment of mathematical communication indicators during test-taking, observations, and interviews. This study began by administering a test to be completed in groups based on pre-established groupings. The test consisted of four word problems related to fractions. During the test-taking process, observations were also conducted to directly assess the students' mathematical abilities in solving the test questions. The study continued with interviews to explore the students' mathematical communication skills in greater depth. The interviews involved asking questions about the problems the students had worked on, as well as questions regarding the students' approaches to solving those problems.

Data Analysis

The data analysis technique in this study refers to the Miles and Huberman model (Sugiyono, 2015); the data analysis was done by data reduction, data presentation, and conclusion drawing. 1) Reduction, Data reduction is carried out by correcting student test results in working on problems in groups, then reducing data from the discussion process and also reducing data from student interviews; 2) data presentation is used to provide the possibility of taking action, drawing conclusions, and finding meaningful data. The data in this study is presented by systematically describing each data related to the focus of the research; 3) Drawing conclusions is the final stage in the research to conclude students' mathematical communication skills from the results of the discussion process. Then

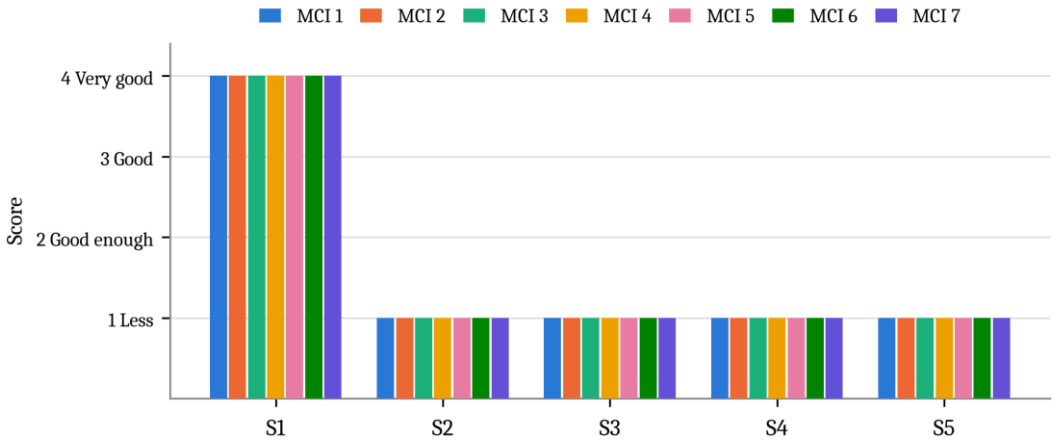


FIGURE 1. *Observation results of mathematical communication skills in the discussion process*

Description

MCI = Mathematical Communication Indicator

1 = Less 3 = Good

2 = Good enough 4 = Very Good

checking the validity of the research results using credibility test with method triangulation technique, namely data collection with interview, observation and test techniques.

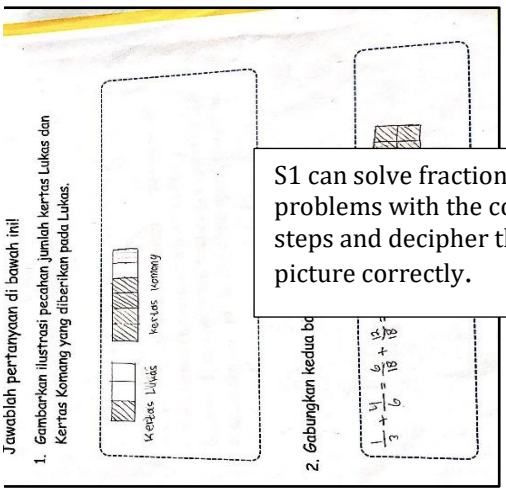
RESULTS

The following is the presentation of students' mathematical communication results in this study:

Analysis of Mathematical Communication Ability of Group 1

Based on the observation of group 1 in solving the test questions, not all group members fulfill the indicators of mathematical communication ability. Group 1 consists of 5 students, of the five students only S1 actively participated in solving the problem and fulfilled MCI 1, MCI 2, MCI 3, MCI 4, MCI 5, MCI 6 and MCI 7. Mathematical communication skills can help students in analyzing and solving problems. Through mathematical communication can help students understand mathematics (Pertiwi et al., 2020). Lack of participation in the discussion process can be caused by low student mathematical communication and low understanding of concepts. Low understanding of mathematical concepts can make it difficult for students to answer questions correctly (Zakia & Marwahanif, 2024). The following is a graph of the results of the analysis of mathematical communication skills in the discussion process of group 1 students, where in the graph S1 plays an active role in solving the test questions given, while other students do not play a role in the discussion process.

The graph shows that S1 achieved and fulfilled all indicators of mathematical communication. S1's mathematical communication skills are very good so that S1 can solve the problem correctly. Based on the graph shown, it can be seen that in the group discussion process, only one student (S1) was able to achieve all indicators of mathematical communication (MCI 1 to MCI 7) with the maximum score. Meanwhile, other students in the group (S2, S3, S4, and S5) did not achieve these indicators or showed much lower results. This shows that the mathematical communication ability in the group is dominated by one



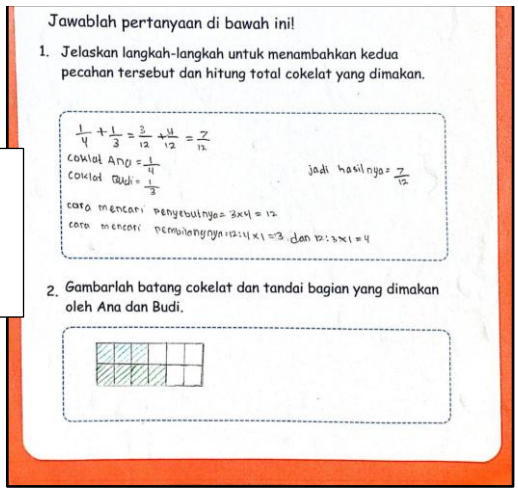


FIGURE 2. *Group 1 answers to the first test* **FIGURE 3.** *Group 1 answers to the second test*

individual, while the contribution of other members is less than optimal. This finding may indicate an imbalance of participation in the discussion, where only one student actively conveys ideas, arguments, or solutions, while the others have not utilized the discussion opportunity to develop their mathematical communication skills.

Based on the observation, the discussion process of group 1 in solving problems with indicators MCI 1 and MCI 2 is still classified as passive. Not all group 1 students achieved these indicators, because they did not communicate with each other to complete the task. From the recording of the discussion, it can be seen that only S1 is active in solving the problem, while other students do not help and do not express opinions about the steps to solve the problem. Analysis of the test answers showed that S1 could solve the problem correctly. S1 can analyze the problem and write mathematical ideas in the form of mathematical symbols and images, S1 has fulfilled MCI 1 and MCI 2. In addition, the results of the interview with S1 show that he can answer questions and questions from researchers smoothly. In answering S1 also did not encounter difficulties in explaining the solution steps, S1 could answer the questions and write the solution steps correctly. S1's communication skills can help students solve mathematical problems. S1's mathematical communication skills can help in solving mathematical problems because communication allows students to organize thoughts, explain problem solving steps, and share ideas more clearly. This is in line with the opinion of NCTM (2000), which emphasizes that mathematical communication is one of the important standards in mathematics learning. This ability encourages students to convey mathematical ideas in writing and orally, which in turn improves their understanding and problem solving ability (Siregar, 2018). Whereas S2, S3, S4 and S5 could not fulfill MCI 1 and MCI 2 because they did not help solve and only copied the answers from S1, they chatted and did other activities in the discussion process. The low mathematical communication ability of students is due to students' confusion in presenting ideas or ideas in the form of symbols, graphs, tables or others to clarify mathematical problems (Sopiah et al., 2022). While from the recording of the discussion, other students did not actively participate, they could not help solve the problem. Low understanding of mathematical concepts makes students unable to solve the problems given and causes some students in group 1 not to achieve MCI 1 and MCI 2.

After the test was completed, the researcher dug deeper into the mathematical communication data by conducting an interview with one of the members of group 1. The interview was conducted by giving the same questions on the discussion test questions. By conducting interviews, researchers can find out students' mathematical communication from the way students solve problems.

The dialog between the researcher and student 1 of group 1 is as follows:

R: From the following problems try to answer and solve according to your ability, Lukas has $\frac{1}{3}$ paper. Then, Komang gave Lukas $\frac{4}{6}$ more paper. If the two pieces of paper are combined, can you mention the fraction of the combined paper in the form of a picture?

R: How do you find the denominator?

S1 G1: To find the denominator by multiplying 3 and 6 (3x6).

R: If you are looking for the numerator?

S1 G1: The first numerator is 18 divided by 3 then multiplied by 1 equals $\frac{6}{18}$, the second numerator is 18 divided by 6 then multiplied by 4 equals $\frac{12}{18}$. Then added and the result is $\frac{18}{18}$

R: How do you draw the result of the fraction?

S1 G1: Made 18 squares then shaded them all because the result of the fraction is $\frac{18}{18}$

The dialog shows that the researcher gave a fraction problem that must be solved and explained in the form of a picture. The researcher gave a trigger to students so that students could understand the steps to solve the problem. S1 G1 can understand and solve fraction problems and can decompose fractions into pictures. S1 G1 can understand the problem and understand the way or steps to solve the problem. In the second problem, the one who can solve the problem is S1, S1 has the ability to connect contextual problems in mathematical ideas. Having mathematical communication skills can help connect contextual problems into mathematical ideas is also reinforced by previous research, the research shows that students with high mathematical communication skills tend to be more able to make connections of mathematical ideas and solve contextual problems well (Aviyanti & Setianingsih, 2020). As for the second problem that represents MCI 3 (students' ability to connect real objects into mathematical ideas), S1 can fulfill it. S1 can explain the steps to add fractions in the problem and write the combined fractions in the form of a picture. Having mathematical communication skills can help S1 to be able to connect symbols into mathematical ideas. However, there is still an evaluation of S1's answer where the description or sentence of the fraction written is not in accordance with the instructions of the problem. The question given instructed that students must find the total part of chocolate eaten by Ana and Budi and describe the part of chocolate eaten by both. However, the information written by S1 is not in accordance with the question instructions, and students do not provide information on the picture presented. While S2, S3, S4, and S5 were also unable to complete the second test question, they did not participate in completing the test question. They did not understand the concept of fractions in the problem and they could not analyze the problem and find a solution. Students with low ability often have difficulty connecting mathematical ideas to solve the problem (Aviyanti & Setianingsih, 2020).

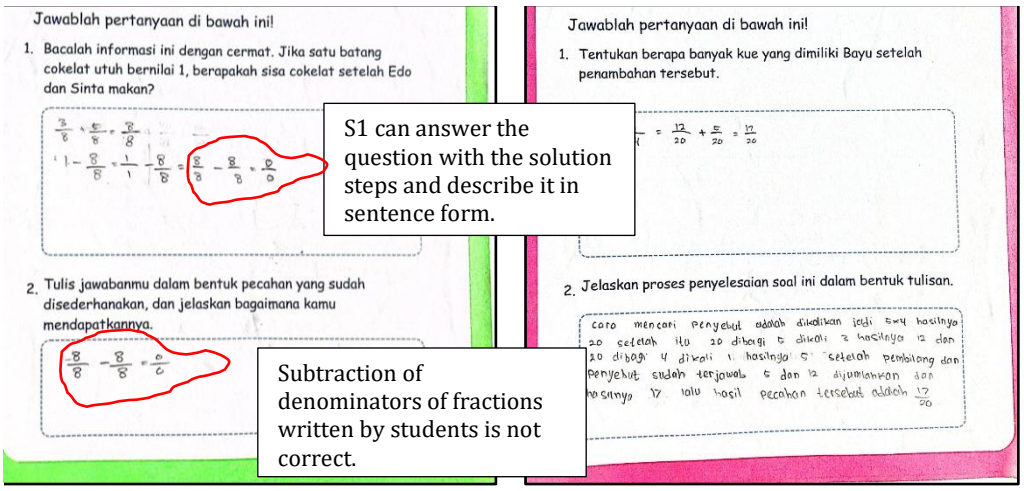


FIGURE 4. *Group 1's answer to the third test* **FIGURE 5.** *Group 1's answer to the fourth test*

Following the answers of group 1, the third test question activity is intended to measure MCI 4 and MCI 5, namely the ability of students to use the skills of reading, listening, interpreting, and evaluating mathematical ideas and the ability of students to understand and evaluate mathematical ideas in solving everyday problems. Based on the observation of the discussion process to solve the problem, S1 played an active role in solving the problem. Analysis of the written answers showed that S1 solution steps for the second problem were correct. To find the final result or the remaining part of the chocolate, the first solution step is to add the fractions then subtract the total of all parts. However, there was an error in the fraction reduction at the end. In addition, the recording of the group discussion showed that S1 tried to explain her thinking to other members, although not all members were actively involved in the discussion. Thus, from observations, analysis of written answers, and recorded discussions, it shows that S1 has a good understanding in interpreting mathematical ideas into answers, but still has problems in the fraction reduction operation. Good reading skills allow students to understand the content of the problem well, which is the first step in solving mathematical problems (Heriyati & Pratiwi, 2021). On the other hand, S2, S3, S4, and S5 in MCI 4 and MCI 5 had no improvement from the previous test. The concept understanding of S2, S3, S4, and S5 is low, this makes students not participate in discussions and solve problems.

In the process of group 1 discussion to solve the fourth test problem, the observation results show that group participation is still low, not all members can understand the problem and how to solve it so, they choose to do other activities and not help each other solve the problem. Based on the analysis of the written answers, the one who solved the problem was S1. S1 can solve the problem correctly, organize the steps, and write it in the form of sentences that are in accordance with MCI 6 and MCI 7, namely the ability of students to communicate everyday problems and explain mathematical ideas in writing, the results of S1's answers meet these criteria. S1 can solve the questions in the problem by adding fractions, S1 can also find ways to add fractions and write the steps in writing or sentences. The recording of the discussion process showed that other students in group 1 were not active in the discussion to find solutions to the problem, so that other students, namely S2, S3, S4, and S5 did not fulfill MCI 6 and MCI 7.

Analysis of Mathematical Communication Ability of Group 2

Similar to group 1, some students in group 2 did not fulfill MCI 1, MCI 2, MCI 3, MCI 4, MCI 5, MCI 6 and MCI 7. In group 2 which consisted of 6 students, three of them had low mathematical communication skills. Lack of participation in the discussion resulted in students not understanding how to solve the problem**.** Only certain students who have high

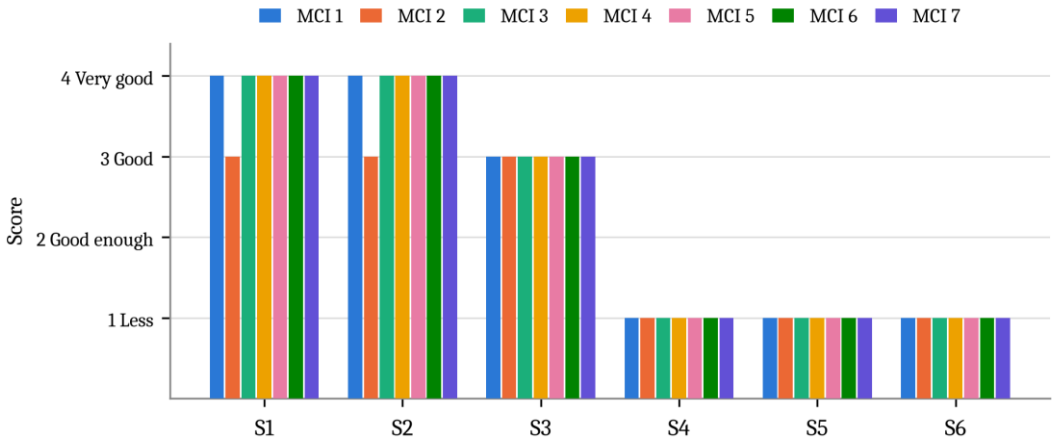


FIGURE 6. *Observation results of mathematical communication ability in group discussion process*

Description

MCI = Mathematical Communication ability indicator

1 = Less 3 = Good

2 = Good enough 4 = Very Good

mathematical understanding do and complete the task, while students who have low understanding will be passive in the discussion (Sulastri & Rakhmawati, 2024)

Based on the graph shown, it can be seen that in the group discussion process, there are several students (S1, S2 and S3) who managed to achieve almost all indicators of mathematical communication (MCI 1 to MCI 7). These three students showed consistent scores on each indicator. However, the other students in the group (S4, S5, and S6) had much lower achievements. S3 achieved some of the indicators, while S4, S5, and S6 only had very low scores for all indicators. This shows an imbalance in mathematical communication skills within the group. Some group members, namely S1, S2 and S3, dominated the discussion process with high achievement. Meanwhile, S4, S5 and S6 did not seem to contribute maximally in mathematical communication, so their role in the discussion was more passive. The discussion process in the group was dominated by some members who had high mathematical abilities, while other members played a passive role. This resulted in a lack of interaction and collaboration in the discussion, which had the effect of hampering the potential for improving mathematical communication skills (Salmiah, 2022)

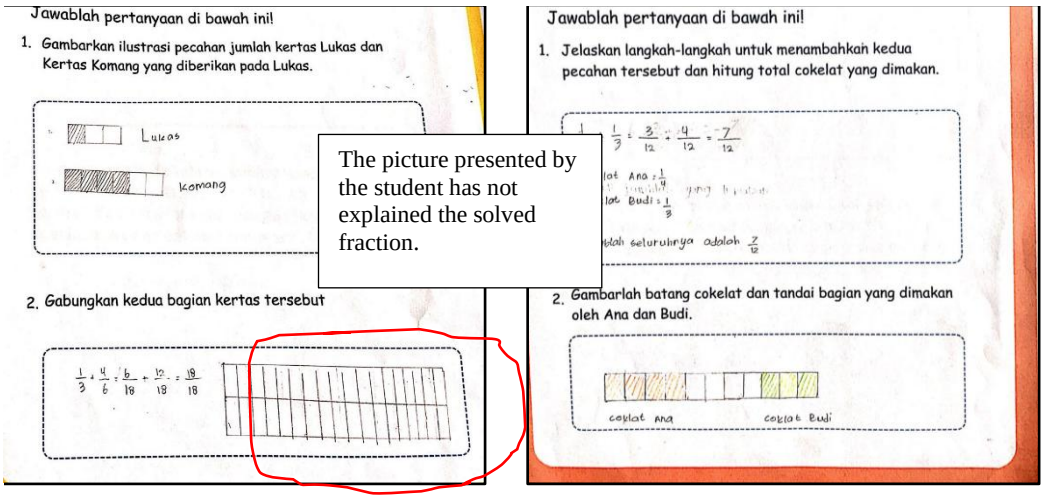


FIGURE 7. *Group 2 answers to the first test* **FIGURE 8.** *Group 2's answers to the second test*

Based on the observation of the group 2 discussion process, S1, S2 and S3 communicated and discussed with each other. However, during the discussion process the three students still seemed to have difficulty in understanding and identifying problems and solving steps. Students who cannot understand the meaning of the problem given result in confusion in determining important information and the right solution steps. This is due to a lack of understanding of the concepts needed to solve the problem (Islami et al., 2019) . It can be seen from the answer to the first problem that S1, S2 and S3 can solve the problem by adding fractions and then expressing the fractions $\frac{1}{3}$ and $\frac{4}{6}$ in the form of pictures with the correct shading, but in the second instruction the picture presented does not represent the fraction result, there is no shading in the second picture which states that the picture is a picture of the fraction $\frac{18}{18}$. So that S1, S2 and S3 are not perfect in achieving MCI 1 and MCI 2 or it can be said that the mathematical communication skills of students are at a moderate level. Because in MCI 1 and MCI 2 with the fulfillment of students being able to express mathematical ideas in the form of mathematical symbols and the ability of students to explain mathematical ideas in writing using images. From the answers of S1, S2 and S3, they are able to express mathematical ideas in mathematical symbols, but it is not appropriate to explain in the form of images. These results are in line with previous research that elementary students are able to express mathematical ideas in the form of symbols, but have difficulty when asked to change visual representations, such as images (Ariani, 2018). According to NCTM (2000), mathematical communication skills include organizing and conveying mathematical ideas clearly, but many students still tend to recite the solution steps without understanding the concept. On the other hand, S4, S5, and S6 were passive in the discussion. S4, S5, and S6 have a low understanding of mathematics so they cannot give opinions or help solve test questions.

Then the researcher conducted an interview with S3, the interview was conducted to explore data information on mathematical communication skills and students' understanding of the problem solving that had been done more deeply.

Researcher's interview dialog to student 3 of group 2:

R: Lukas has $\frac{1}{2}$ paper. Then, Komang gave Lukas $\frac{4}{6}$ more paper. If the two pieces of paper are combined, can you tell the fraction of the combined paper in picture form? How do you solve it?

S3 G2: I can't mom

R: Write first from the problem how to solve it in the form of adding up.

S3 G2: $\frac{1}{2} + \frac{4}{6}$

R: Yes, so that you can add them up first find the denominator, how do you find the denominator?

S3 G2: 6 divided by 3 bu

R: Sure it's divided, is it multiplied?

S3 G2: multiplied by mom, $\frac{}{18}$ $\frac{}{18}$ $\frac{}{18}$

R: How was the sign of the number operation?

S3 G2: $\frac{}{18} + \frac{}{18} = \frac{}{18}$Then multiply it by 1, right ma'am?

R: What do you want to find from multiplied by 1?

S3 G2: The numerator here ma'am (while pointing to the part in question)

R: How do you do that? Try to divide it first, don't multiply it directly

S3 G2: 18 divided by 3 is equal to 6, then multiplied by 1 is equal to 6.

R: Yes, then how else? 18 divided by 6

S3 G2: 18 divided by 6 equals 3 mom

R: The result multiplied by 4

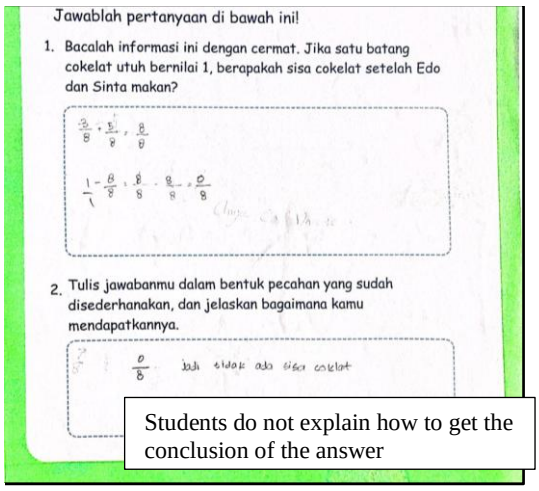
S3 G2: 12 bu $\frac{6}{18} + \frac{12}{18} = \frac{}{18}$

R: Yes, keep adding

S3 G2: The result is $\frac{18}{18}$ mom.

In the interview dialog, the researcher gave a trigger to S3 so that students could understand and complete the steps of the problem, but several times students hesitated and answered the questions incorrectly so that the researcher had to provide a deeper trigger so that students could solve the problem. Based on the interview excerpts above, it can be found that S3 has low mathematical communication skills in MCI 1 and MCI 2 indicators, this can be seen from the way students answer questions still contain errors and doubts, as well as their inability to answer questions with the correct steps independently without guidance from researchers or teachers. Observations showed that although S3 participated in discussions with S1 and S2, she still had difficulty in expressing mathematical ideas. Analysis of the answers of S1, S2 and S3 in solving problems with MCI 1 and MCI 2, the three students had doubts in expressing mathematical ideas in the form of drawings so that the answers given were still not correct.

Based on observations, in the process of discussing the activities of the second test question, S1, S2 and S3 of group 2 still looked confused and had difficulty identifying the



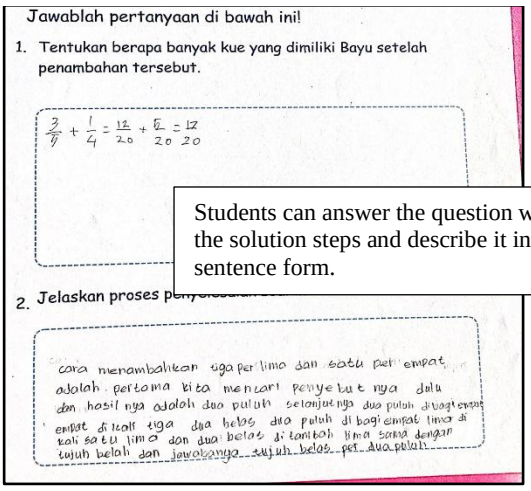


FIGURE 9. *Group 2 answers to the third test* **FIGURE 10**. *Group 2's answers to the fourth test*

steps to solve the problem. Students have difficulty in reading and interpreting the sentences in the problem, these difficulties result in they cannot identify what is known and what is asked. This inability makes students unable to convert the problem into the form of mathematical ideas (Anturichana et al., 2021). Despite the difficulty in analyzing the problem, the results of the analysis of S1, S2 and S3's answers in the second problem have met MCI 3, students can relate real objects or contextual problems to mathematical ideas. From the answers to the second problem, students can solve by adding fractions to find the total part of chocolate eaten and can describe the fraction correctly. The mathematical communication skills possessed by S1, S2 and S3 in the second activity are quite good, so that they can help to solve the test questions. Unlike the other 3 group members, S4, S5, and S6 in this second activity were not involved in the discussion and problem solving process. The non-involvement of S4, S5, and S6 was due to the low concept of mathematics, especially fraction material.

In the third discussion activity, the results of the group discussion process in this third activity can fulfill MCI 4 and MCI 5, although in reading and interpreting the problem there are still difficulties. Good reading skills allow students to understand the contents of the problem well, which is the first step in solving mathematical problems (Heriyati & Pratiwi, 2021). To be able to understand the problem, students in group 2 had to be given instructions for solving the problem, when the instructions are finished, only S1, S2 and S3 understand the solution steps. The ability to listen and understand S1, S2 and S3 is quite good, so that after listening to the instructions they can solve the test questions and students can answer the questions correctly. Students can find the solution to the third problem with the addition and subtraction of fractions. However, other students in group 2, namely S4, S5, and S6 still could not understand the problem, the ability to listen and understand S4, S5, and S6 was still low so that students could not interpret the solution to the problem.

Based on the observation, S1, S2 and S3 discussed with each other to solve problems with MCI 5 and MCI 6 indicators, the results of this observation were reinforced by the analysis of the answers written, where the answers had fulfilled these indicators, namely students can communicate mathematical ideas and explain the process in writing. Students can solve problems with the correct fraction addition steps and they can interpret through detailed sentences or writing. Mathematical communication skills help students solve fraction addition problems correctly and interpret the results. Through mathematical communication activities and discussions, students can develop the ability to explain and discuss their thinking process. In the mathematical communication skills possessed by each member of group 2, S4, S5, and S6 are still low. Every activity of the discussion process, S4, S5, and S6 could not actively participate and complete the test questions. Their passivity makes students not understand the problems that are done together, and the absence of

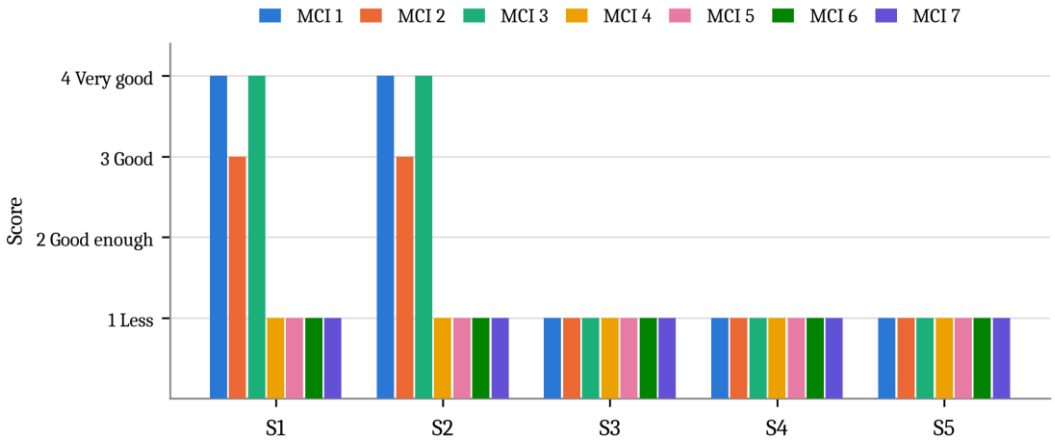


FIGURE 11. *Observation results of mathematical communication skills in the process*

Description

MCI = Mathematical Communication Ability Indicator

1 = Less 3 = Good

2 = Good enough 4 = Very good

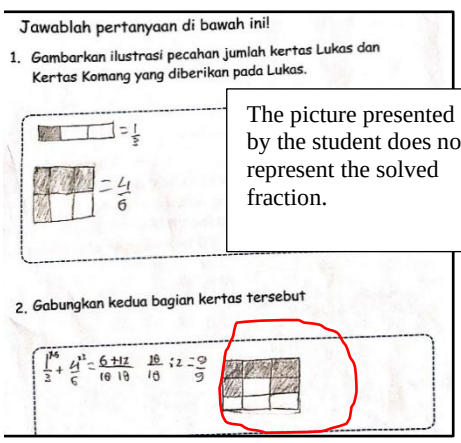
effort to participate makes students unable to develop. The factors that influence students' mathematical communication skills are difficult to develop include: 1) Lack of cooperation and participation of students when discussing, not cooperative when discussing. 2) Lack of maximizing potential when speaking in front of friends and teachers because they are not confident. 3) If there is material that is not understood, students are embarrassed to ask or do not dare to ask. 4) Take for granted the opinions of friends or teachers without proposing comparative ideas and. 5) Rarely interpret contextual problems into mathematical models, if this is left without a solution, the ability of students to communicate mathematics will decrease (Pratama et al., 2024).

Analysis of Mathematical Communication Ability of Group 3

From the observations that have been made, it is found that MCI 1 and MCI 2 of group 3 are still low and moderate, many students in group 3 are still confused about the results that must be obtained and lack of confidence in the answers. Lack of student confidence in analyzing questions makes students feel confused about the results that must be obtained (Zakia & Marwahanif, 2024).

The following graph illustrates the achievement of mathematical communication indicators in the group 3 discussion process.

Based on the graph shown, it can be seen that in one discussion group, only a few students (S1 and S2) were able to achieve mathematical communication indicators (MCI) significantly, especially in certain indicators (MCI 1, MCI 2, and MCI 3) with the maximum score. Meanwhile, the other students in the group (S3, S4, and S5) had much lower achievements and were relatively evenly distributed across the indicators, without showing notable success. This reflects the inequality in mathematical communication skills among group members. Some students showed outstanding mathematical communication skills, while others seemed less active or unable to achieve the indicators well.



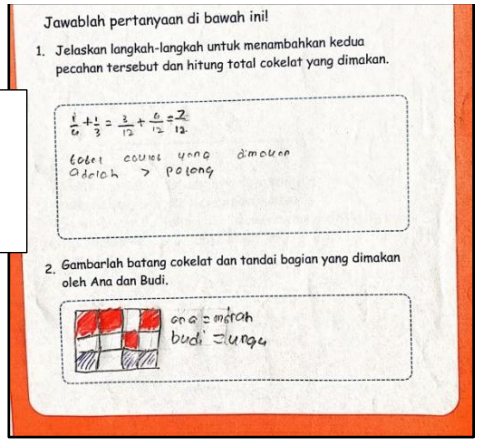


FIGURE 12. *Group 3 answers to the first test* **FIGURE 13.** *Group 3's answers to the second test*

Similar to the previous group, in group 3 also not all members actively participated in the discussion process. S3, S4, and S5 with a low understanding of mathematical concepts could not answer the questions, making it difficult for students and less active participation. Only certain students who have high mathematical understanding do and complete the task, while students who have low understanding will be passive in the discussion (Sulastri & Rakhmawati, 2024). While S1 and S2 with a better understanding of the concept in the discussion they seemed less confident in analyzing the problem, so they had difficulty in recognizing the relationship of the concept of fractions and difficulty in interpreting the answers in the form of images, seen from the second instruction, the images presented did not represent fractions. In MCI 1 and MCI 2 in Figure 12, S1 and S2 can express mathematical ideas in mathematical symbols, but have not been able to explain mathematical ideas in the form of images well. The ability to describe mathematical ideas in the form of images requires good visualization skills. In accordance with research (Sulistiani et al., 2021) students cannot explain mathematical ideas in the form of images because students have not been trained to think visually or use images as a tool to understand and explain mathematical concepts.

To dig deeper into the data for group 3 students, the researcher conducted an interview with student 2 of group 3. Dialogue of the researcher's interview with student 2 of group 3:

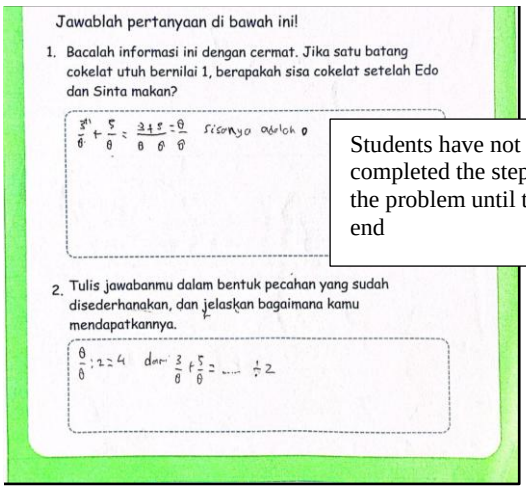
R: From the following problems try to answer and solve according to your ability, Lukas has $\frac{1}{2}$ paper. Then, Komang gave Lukas $\frac{4}{6}$ more paper. If the two pieces of paper are combined, can you mention the fraction of the combined paper in the form of a picture? How do you solve it?

S2 G3: In addition mom

R: Yes, try to do it

S2 G3: $\frac{1}{2} + \frac{4}{6}$ for the denominator 3 times 6 equals 18. The numerator is 18 divided by 3 equals 6 then multiplied by 1 equals 6, 18 divided by 6 equals 3 multiplied by 4 equals 12. $\frac{6}{18} + \frac{12}{18} = \frac{18}{18}$, right ma'am?

The interview process was carried out after the students finished working on the problem in their groups, the researcher conducted an interview with S2 in group 3. The results of the student's answers were better than the answers during the test questions. In



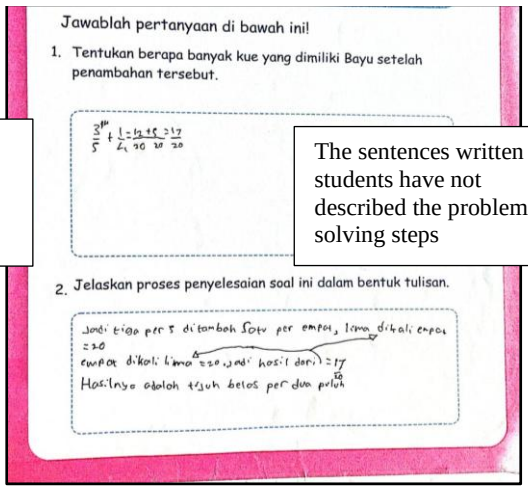


FIGURE 14. *Group 3 answers to the third test* **FIGURE 15.** *Group 3's answers to the fourth test*

the interview dialog, the researcher did not give much triggers to S2 G3 in solving the interview questions, but S2 could complete the steps correctly. Based on the results of observations in solving problems with indicators MCI 1 and MCI 2, the discussion process of group 3 is classified as passive. The recording of the discussion showed that not all students actively participated in solving the problem. Only S1 and S2 communicated with each other to answer the questions, while S3, S4, and S5 were not involved in the discussion. S1 and S2 had good communication skills, the results of the interview with S2 confirmed that he could answer the questions given smoothly and the answers were correct. However, the analysis of the written answers of S1 and S2 showed that they did not fulfill MCI 1 and MCI 2, S1 and S2 had difficulties and doubts in explaining mathematical ideas in the form of drawings.

In the second problem representing MCI 3, the observation of group 3's discussion process in solving the problem showed that only S1 and S2 were active in solving the problem, while S3, S4, and S5 did not participate and were passive in the discussion. The recording of the discussion confirmed that S1 and S2 communicated with each other in answering the questions, while S3, S4, and S5 were mostly silent and did not contribute to the solution. Based on the analysis of the written answers of S1 and S2, they can solve the problem correctly. Students can solve the problem of finding the number of parts of chocolate eaten by adding fractions and drawing and marking fraction shading with the correct answer, from these answers show S1 and S2 achieve mathematical communication skills indicator 3. S1 and S2 have the ability to connect real objects or contextual problems in mathematical ideas, this ability allows students to understand mathematical concepts well. According to Sumarmo (2006) mathematical communication skills include the ability of students to connect real objects, images, and diagrams into mathematical ideas. On the other hand, S3, S4, and S5 did not have the ability in MCI 3, so students had difficulty in solving the problems given. Mathematical communication covers various aspects, including the ability to explain mathematical ideas. Students who are less skilled in mathematical communication tend to have difficulty in organizing and conveying their thoughts, which will affect their ability to solve mathematical problems well (Lubis & Rahayu, 2023).

In the discussion process of solving the third test problem, group 3 students had difficulty reading, understanding, and interpreting the instructions or questions given. Group 3 students were unable to understand the problem well, seen from the first problem, namely with the command, read the information carefully. If one whole chocolate bar is worth 1, how much chocolate is left after Edo and Sinta eat? The problem explained the value of chocolate and the command to find the remaining part, which after adding the fractions of

the chocolate eaten by Edo and Sinta, the students were instructed to find the rest by subtracting the value of the whole chocolate. However, students in group 3 could not understand this step, so the answers written were not correct. S1 and S2 answered the third test question by adding up the known fractions, namely the part of the chocolate eaten by Edo and Shinta, they did not take the next step which was to find the remaining part of the chocolate by subtracting the fractions from the sum that had been found.

DISCUSSION

Errors experienced by students can occur because students often have not made a clear and complete solution plan, so they have difficulty in carrying out the steps of solving (Aliah & Bernard, 2020). Students are often unable to understand and apply the information contained in story problems, which results in difficulties in solving problems (Agnesti & Amelia, 2021). Then the second problem, Write down the simplification of fractions and explain how to get it. If the first problem is wrong, then the first answer will affect the second answer. Seen from the answers of group 3 students in Figure 14, the second answer is also still not right. Group 3 students in the discussion process are not all actively working and communicating, so that if one student cannot solve the problem, other members cannot help either. Low mathematical communication skills will affect students in solving problems, because having mathematical communication skills can help students understand problems and solve problems. Mathematical communication skills are very important for students to improve their understanding of mathematics lessons. Communication skills are an understanding of what is communicated by using mathematical language, such as mathematical symbols, or by referring to the realities of everyday life, such as pictures, graphs, real objects, and tables (Yulyantika et al., 2019).

MCI 6 and MCI 7 contained in the discussion activity to solve the fourth problem, group 3 is also still not achieved (low). In the recording of the discussion process, those who played a role in solving this fourth problem were S1 and S2, while S3, S4, and S5 only copied the answers written by their friends without contributing to the discussion. Observations during the discussion also showed that S3, S4, and S5 did not actively ask questions or try to understand the solution of the problem independently. The results of the analysis of the answers written by S1 and S2 were able to solve the problem with the steps of solving the problem in the form of mathematical symbols (addition of fractions) correctly. However, the results of S1 and S2's subsequent written answers did not explain the problem solving in the form of writing/sentences. S1 and S2 are able to understand concepts procedurally, they still have problems communicating mathematical ideas in writing. To achieve MCI 6 and MCI 7 students must have the ability to be able to re-explain mathematical ideas in writing. Explaining mathematical ideas in writing is one of the important components of mathematical communication skills for students. According to Prayitno (as cited in Alfath & Delvia, 2023), mathematical communication includes the ability of students to express and interpret mathematical ideas orally and in writing. Whereas S3, S4, and S5 did not understand how to solve the problem and had a low understanding of the concept, so S3, S4, and S5 also could not help their friends to solve the problem. This shows a lack of understanding of the basic concepts of fractions so that students have difficulty in solving the problem (Yulianti & Wardana, 2024). Lack of understanding of the material is an important factor that affects mathematical communication skill (Nashihah, 2020).

Low mathematical communication skills make students have difficulty in understanding mathematical concepts, which affects their ability to communicate mathematical ideas (Ikhsan & Afriansyah, 2023). Lack of confidence also affects mathematical communication skills. Low self-confidence, discomfort in communicating, and an unsupportive learning atmosphere can affect students' ability to actively participate in the discussion process (Suryawati et al., 2023). Low mathematical communication skills can have an impact on student learning outcomes in mathematics and also hinder the development of a deeper understanding of concepts. This can potentially happen to

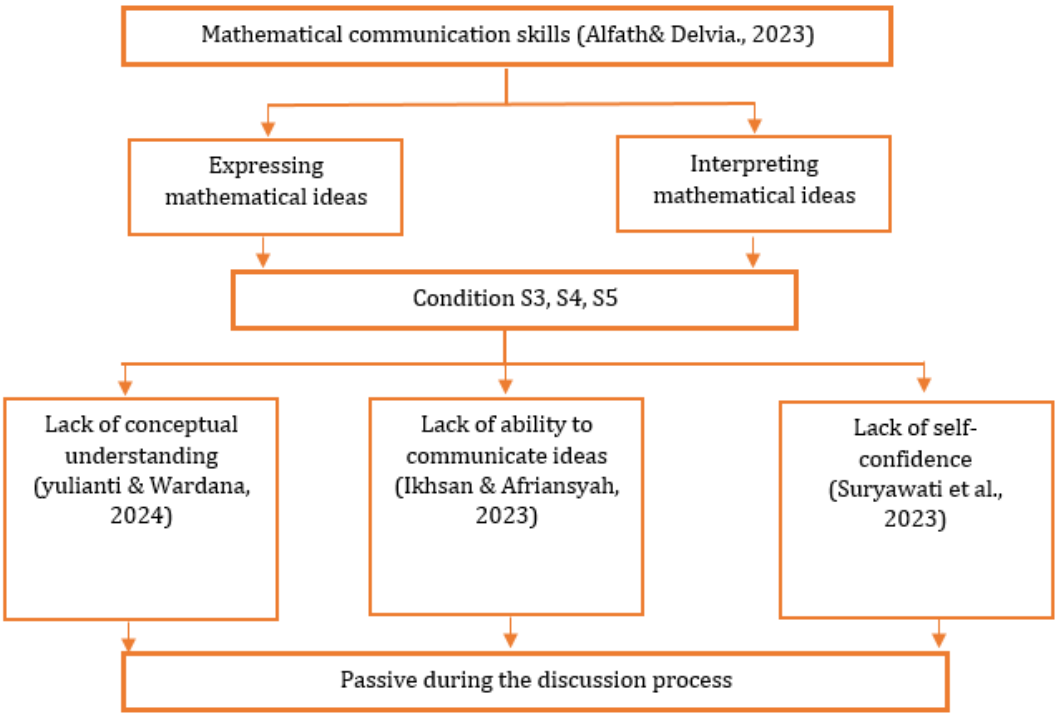


FIGURE 16. *Research results schema*

students, where students find it difficult to solve problems and lack confidence in the discussion process.

The results of the study can be illustrated in the following scheme:

The results of the discussion process to solve the math test questions by all groups, obtained diverse mathematical communication skills of students in each group. Of the three groups, not all members in the group had good/high mathematical communication skills. In each group only one to two students had high mathematical communication skills. Mathematical communication ability can be seen from students' activeness during the discussion process. Students with high mathematical communication skills are more dominant in solving problems, this is due to their ability to analyze and understand the problem in depth, as well as being able to write the solution correctly (Khoirunnisya et al., 2024). Students who are active and more dominant in solving problems, they have good mathematical communication skills, which help students in analyzing problems, understanding concepts, and writing solutions into mathematical ideas. By having mathematical communication skills, students are able to understand, interpret, describe relationships and solve contextual problems into mathematical models orally and in writing (Lubis & Rahayu, 2023).

Whereas students with low mathematical communication tend to be passive in the discussion process and cannot give opinions or solve problems. their mathematical communication skills are low. Students cannot analyze problems and find solutions to the problems given. The difficulties experienced in solving problems can be caused by several factors, namely, lack of concept understanding, lack of confidence, and lack of focus or concentration of students during the discussion process. The low ability of students to understand the meaning of the problem and the low understanding of mathematical concepts make students unable to solve the problems given (Febriana & Mairing, 2023). Students feel afraid of being wrong with their ideas so that this can hinder students' mathematical communication skills. They are not confident in themselves and their abilities so that students are less able to communicate mathematical ideas in learning mathematics (Mulyani, 2017).

CONCLUSION

Mathematical communication skills in the discussion process of grade V students in this study were still low, although there were some students who had quite good mathematical communication skills. This can be seen from the number of students who did not actively participate in the discussion process. The students' disengagement and passivity is because they cannot solve fraction problems and do not understand the form of mathematical sentences, symbols, and conclusions requested in the problem. Based on the results of students' abilities, it can be concluded that students' mathematical abilities are still low, especially in each indicator of mathematical communication ability that is not achieved. Some of the difficulties often faced by students in mathematical communication include a lack of in-depth understanding of mathematical concepts, complicated mathematical language, lack of communication skills, low self-confidence, and lack of practice in conveying mathematical ideas. These results represent a limitation of this study, future research can explore various learning methods and can also test the effectiveness of using more interactive media to see the impact on students' mathematical communication. For teachers in improving students' mathematical communication skills, they can increase their role by facilitating students during the discussion process. Teachers can also apply effective learning strategies or methods to improve students' concept understanding and confidence in involvement during the discussion process.

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DECLARATIONS

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethics Approval and Consent to Participate

This research has been approved by the Dean of the Faculty of Education and the Head of the Primary School Teacher Education (PGSD) Study Program at Universitas PGRI Kanjuruhan Malang, under reference number 215/II.A5/FIP/Uk-Ml/XI.2024, dated November 18, 2024. Written informed consent was obtained from all participants and from the parents/guardians of all participating students. Consent for publication of anonymised data was obtained.

Availability of Data and Materials

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

Dyah Triwahyuningtyas: Writing – review, Formal analysis, Validation.
Jamilatul Nur Azizah: Writing – original draft & editing.
Nyamik Rahayu Sesanti: Conceptualization, Methodology, Supervision, Validation.
All authors have read and approved the final version of the manuscript.

Declaration of Generative AI and AI-Assisted Technologies in the Manuscript Preparation Process

During the preparation of this work, the authors used GPT-4o (OpenAI) to improve the language and readability of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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