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STUDENTS' MATHEMATICAL COMMUNICATION SKILLS IN SOLVING DATA PRESENTATION PROBLEMS

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ABSTRACT
Mathematical communication skills are an essential competency in mathematics learning because they help students organize information, represent data, and communicate ideas and problem-solving processes accurately. However, in data presentation topics, students still encounter difficulties in explaining solution procedures, creating visual representations, and using mathematical expressions correctly. This study aimed to analyze students' mathematical communication skills in solving data presentation problems based on the indicators of written text, drawing, and mathematical expression. This research employed a qualitative descriptive approach. The subjects were seventh-grade students of MTs Mamba'ul 'Ulum, selected based on high, moderate, and low levels of mathematical communication skills. Data were collected through essay tests and semi-structured interviews and were analyzed using the Miles and Huberman model, which includes data reduction, data display, and conclusion drawing. The results showed that students in the high category were able to identify information, present data in tables and diagrams, and use mathematical expressions systematically and accurately. Students in the moderate category were able to communicate mathematical ideas fairly well, although they still made errors in representations and calculations. Meanwhile, students in the low category experienced difficulties in explaining procedures, presenting data visually, and constructing appropriate mathematical models. These findings indicate differences in mathematical communication skills across student categories, which influence the quality of mathematical problem-solving.
Keywords: data presentation; mathematical communication skills; mathematical expression; qualitative analysis; visual representation; written text.

ABSTRAK
Kemampuan komunikasi matematis merupakan kompetensi penting dalam pembelajaran matematika karena membantu siswa mengorganisasi informasi, merepresentasikan data, serta mengomunikasikan ide dan proses penyelesaian masalah secara tepat. Namun, pada materi penyajian data masih ditemukan siswa yang mengalami kesulitan dalam menjelaskan langkah penyelesaian, membuat representasi visual, dan menggunakan ekspresi matematis secara benar. Penelitian ini bertujuan untuk menganalisis kemampuan komunikasi matematis siswa dalam menyelesaikan soal penyajian data berdasarkan indikator written text, drawing, dan mathematical expression. Penelitian menggunakan pendekatan deskriptif kualitatif. Subjek penelitian adalah siswa kelas VII MTs Mamba'ul 'Ulum yang dipilih berdasarkan kategori kemampuan komunikasi matematis tinggi, sedang, dan rendah. Data dikumpulkan melalui tes uraian dan wawancara semi-terstruktur, kemudian dianalisis menggunakan model Miles dan Huberman yang meliputi reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa siswa kategori tinggi mampu mengidentifikasi informasi, menyajikan data dalam bentuk tabel dan diagram, serta menggunakan ekspresi matematis secara sistematis dan tepat. Siswa kategori sedang mampu mengomunikasikan ide matematika dengan cukup baik, meskipun masih melakukan kesalahan pada representasi dan perhitungan. Sementara itu, siswa

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kategori rendah mengalami kesulitan dalam menjelaskan prosedur, menyajikan data secara visual, dan menyusun model matematika. Temuan ini menunjukkan adanya perbedaan kemampuan komunikasi matematis yang memengaruhi kualitas pemecahan masalah matematika.
Kata kunci*: ekspresi matematis; penyajian data; representasi visual; analisis kualitatif; kemampuan komunikasi matematis; teks tertulis.*

Introduction

Despite the recognized importance of mathematical communication skills, numerous studies have reported that students continue to experience difficulties in expressing mathematical ideas, constructing mathematical representations, and explaining problem-solving procedures systematically. Minister of National Education Regulation No. 22 of 2006 explains that mathematics lessons aim to enable students to solve problems, which includes the ability to understand problems, design mathematical models, solve models, and interpret the obtained solutions (Komariya et al., 2018). For instance, Sibarani et al. (2022) and Hariati et al. (2022) found that many junior secondary school students encounter obstacles in using mathematical symbols, developing mathematical models, and communicating reasoning effectively. Similarly, Ikhsan and Afriansyah (2023) as well as Sulisti et al. (2022) reported that students' mathematical communication skills remain at a moderate level, indicating that students are often unable to provide complete, accurate, and coherent mathematical explanations.

Several studies have investigated factors influencing mathematical communication skills and strategies for improving them. Aulia et al. (2021) and Jusniani et al. (2025) revealed that self-confidence positively contributes to students' mathematical communication performance. Furthermore, Palinussa et al. (2021) demonstrated that the Realistic Mathematics Education (RME) approach enhances students' communication skills through contextual problem-solving activities, while Pasani and Amelia (2025) reported that interactive mobile technology can improve students' communication skills, conceptual understanding, and learning engagement. These findings indicate that mathematical communication skills can be developed through appropriate learning environments and instructional strategies. A good question is a question that complies with the rules for writing questions, can reveal students' learning outcomes, and provide an overview of the students' abilities (Vahlia et al., 2022).

However, existing studies predominantly focus on improving mathematical communication skills or examining their relationship with other variables, such as self-confidence, learning models, and technology integration. Only limited studies have qualitatively explored how students communicate mathematical ideas when solving specific mathematical topics, particularly data presentation problems. Moreover, previous studies rarely provide a comprehensive description of students' mathematical communication skills across different ability levels based on the indicators of *written text*, *drawing*, and *mathematical expression*. Consequently, little is known about the distinctive communication patterns and difficulties experienced

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by students with high, moderate, and low mathematical communication abilities when solving data presentation tasks.

This gap is particularly important because data presentation is a mathematical topic that requires students not only to perform calculations but also to organize information, construct tables and diagrams, interpret data, and communicate conclusions appropriately. Previous research has shown that students' problem-solving performance is closely related to their ability to represent information and communicate mathematical reasoning (Siregar et al., 2022; Siregar et al., 2025). In addition, recent studies have reported that students continue to experience difficulties in understanding problems, selecting solution strategies, and presenting mathematical reasoning accurately (Erliananda et al., 2025; Sakdiah & Siregar, 2025). These findings suggest that a more in-depth analysis of students' mathematical communication skills is necessary to identify the specific difficulties encountered during problem-solving processes.

Preliminary observations conducted at MTs Mamba'ul 'Ulum support these findings. Several seventh-grade students experienced difficulties in organizing known and required information, constructing tables and diagrams, and expressing mathematical ideas using appropriate symbols and mathematical expressions when solving data presentation problems. These difficulties indicate that students' mathematical communication skills require further investigation based on specific communication indicators.

Therefore, the novelty of this study lies in its qualitative analysis of students' mathematical communication skills in data presentation problem-solving across three ability categories (high, moderate, and low) using the indicators of *written text*, *drawing*, and *mathematical expression*. By combining written tests and semi-structured interviews, this study seeks to provide a comprehensive understanding of students' communication patterns and difficulties in each ability category. The findings are expected to contribute to the development of mathematics instruction that better supports students' written explanations, visual representations, and mathematical expressions in problem-solving activities.

Research Methods

Research Design

This study employed a descriptive qualitative approach to investigate students' mathematical communication skills in solving data presentation problems. A qualitative design was considered appropriate because the study focused on obtaining an in-depth understanding of students' communication processes rather than examining the effect of a particular treatment or instructional intervention. The analysis focused on three indicators of mathematical communication skills: *written text*, *drawing*, and *mathematical expression*. These indicators were used to examine how students expressed mathematical ideas, constructed visual representations, and utilized mathematical symbols and models in problem-solving activities (Creswell & Poth, 2018).

The research was conducted through several operational stages. First, research instruments, including a mathematical communication skills test, interview protocol, and scoring rubric, were developed. Second, all instruments were validated through expert judgment and revised based on the experts'

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recommendations. Third, the validated instruments were piloted with students outside the research participants to ensure readability and appropriateness. Fourth, the mathematical communication skills test was administered to all participants. Fifth, students' responses were scored and classified into high, moderate, and low ability categories. Sixth, representative students from each category were selected as interview participants. Finally, the collected data were analyzed, interpreted, and synthesized to draw conclusions regarding students' mathematical communication skills.

Research Site and Participants

The study was conducted at MTs Mamba'ul 'Ulum, located in Janji Lobi Hamlet, Lingga Tiga Village, Bilah Hulu District, Labuhanbatu Regency, North Sumatra, Indonesia, during the second semester of the 2025/2026 academic year (March–April 2026). The participants consisted of 24 seventh-grade students. All students completed the mathematical communication skills test. Based on the test scores, students were categorized into three levels of mathematical communication ability: high (5 students), moderate (14 students), and low (5 students). Subsequently, six students were purposively selected as the main research subjects, consisting of two students from each ability category. The selected participants were coded as H1 and H2 (high category), M1 and M2 (moderate category), and L1 and L2 (low category).

Research Instruments

The instruments used in this study consisted of a mathematical communication skills test, an interview guide, an assessment rubric, and documentation sheets. The mathematical communication skills test was used to obtain data on students' written mathematical communication in solving data presentation problems. The test was designed in the form of essay questions because essay questions allow students to show their reasoning, write solution steps, construct representations, and use mathematical expressions. The test items were developed based on the data presentation material taught in seventh grade and adjusted to the indicators of mathematical communication skills.

The test measured three indicators of mathematical communication skills. The first indicator was written text, which measured students' ability to write known and asked information, explain solution procedures, and present mathematical reasoning in written form. The second indicator was drawing, which measured students' ability to present data in tables, diagrams, graphs, or other visual representations that were appropriate to the problem. The third indicator was mathematical expression, which measured students' ability to construct mathematical models, use mathematical symbols, perform calculations, and determine conclusions accurately. These indicators were used as the basis for developing test items, scoring students' answers, and analyzing research findings.

One example of the test item used in this study was as follows: "The following data show the mathematics scores of several students: 70, 80, 75, 85, 90, 80, 75, 70, 85, and 90. Present the data in a frequency table, determine the frequency of each score, and explain the conclusion based on the data." This item required students to identify the given data, organize the data into a frequency table, determine the frequency of each score, and write a conclusion based on the data presentation. Through this item, the researcher could analyze students' ability to communicate mathematical ideas through written explanation, visual representation, and mathematical expression.

The interview guide was used to obtain deeper information about students' thinking processes in solving the test items. The interview questions were semi-structured, meaning that the researcher prepared main questions but allowed follow-up questions based on students' responses. The interview focused on how students understood the problem, identified relevant information, determined the solution strategy, constructed tables or diagrams, used mathematical symbols, performed calculations, and explained the final answer. Students feel that the answers they have written are correct so they do not recheck the answers they have written (Setiani et al., 2020). The interview guide also helped the researcher clarify students' written answers, especially when students' answer sheets did not clearly show their reasoning process.

The assessment rubric was used to score students' mathematical communication skills based on the three indicators. Each indicator had scoring criteria that described the quality of students' answers. The written text indicator assessed the completeness, clarity, accuracy, and systematic nature of students' written explanations. The drawing indicator assessed the accuracy, completeness, and suitability of visual representations. The mathematical expression indicator assessed the appropriateness of mathematical models, the correctness of symbols, calculation accuracy, and the relevance of conclusions. Documentation sheets were used to record supporting data, such as students' answer sheets, interview notes, scoring results, and research field notes.

Instrument Validation

Before the instruments were used in the research, the mathematical communication skills test, interview guide, and assessment rubric were validated through expert judgment. The validation involved two experts in mathematics education who had experience in mathematics learning, assessment, and mathematical communication skills. The purpose of the validation was to ensure that the instruments were appropriate for measuring students' mathematical communication skills on data presentation material.

The validation process covered several aspects. First, the experts examined the suitability of each test item with the indicators of mathematical communication skills. Second, the experts reviewed the relevance of the test items to the data presentation material at the seventh-grade level. Third, the experts evaluated the clarity of language, instructions, and mathematical information presented in each item. Fourth, the experts reviewed the accuracy of mathematical concepts and the appropriateness of the scoring rubric. Fifth, the experts assessed whether the interview questions were able to explore students' reasoning and communication processes.

The experts provided several suggestions for improving the instruments, including revising the wording of several questions, clarifying the instructions for students, adjusting the difficulty level of the items, and strengthening the alignment between the test items and the indicators. After the instruments were revised based on expert suggestions, the test items were tried out on students outside the main research subjects. The try-out was conducted to determine whether the questions were understandable, whether the instructions were clear, and whether the time allocation was appropriate. The results of the try-out were used to make final improvements before the instruments were administered to the research participants.

Data Collection Techniques

Data were collected using mathematical communication skills tests, interviews, and documentation. The mathematical communication skills test was administered to all seventh-grade students who participated in the study. The students were asked to solve essay questions individually within the allocated time. During the test, students were instructed to write complete solution steps, present data in appropriate representations, and provide conclusions based on their answers. The test results became the primary data for identifying students' mathematical communication skills.

After the test was completed, students' answer sheets were collected and scored using the assessment rubric. The scores were then used to classify students into high, moderate, and low mathematical communication ability categories. From each category, two students were selected as interview subjects. The interviews were conducted after the test to clarify the students' written answers and to explore their reasoning in solving data presentation problems. The interviews were conducted individually so that each student could explain their thinking process more freely and clearly.

Documentation was used to support the data obtained from tests and interviews. The documentation included students' answer sheets, scoring results, interview notes, validation sheets, and other relevant research records. The use of documentation was important to ensure that the data analysis was based on concrete evidence. In addition, documentation helped the researcher review students' written responses and compare them with the interview results.

Scoring and Ability Classification

Students' mathematical communication skills were scored based on three indicators: written text, drawing, and mathematical expression. Each indicator was assessed using a rubric that described the quality of students' answers. The written text indicator was scored based on the extent to which students could write known and asked information, explain solution procedures, and present mathematical reasoning coherently. The drawing indicator was scored based on the accuracy and completeness of students' tables, diagrams, or other visual representations. The mathematical expression indicator was scored based on students' ability to construct mathematical models, use symbols correctly, perform calculations accurately, and draw appropriate conclusions.

Furthermore, the scores obtained by the students were classified into three categories of ability, namely high, moderate, and low. The classification referred to the guidelines proposed by Sudijono (2010). The criteria used to classify the students' ability levels are presented in Table 1.

Table 1. Criteria for Grouping Students' Ability Levels

Ability Group	**Criteria**
High	Students who obtained scores $\geq \bar{x} + s$
Moderate	Students who obtained scores between $\bar{x} - s$ and $\bar{x} + s$
Low	Students who obtained scores $\leq \bar{x} - s$

Notes:
$\bar{x}$ = Mean score
s = Standard deviation

Based on Table 1, the majority of students were categorized as having moderate mathematical communication skills. This finding indicates that most students were able to communicate basic mathematical ideas; however, they still required further support in explaining solution procedures, constructing visual representations, and using mathematical expressions accurately. This condition suggests that students' mathematical communication skills have not yet developed optimally across all indicators examined in this study.

Subsequently, two students were randomly selected from each ability group (high, moderate, and low) to analyze their answers and to conduct interviews regarding their processes in solving the mathematical communication skills test. The obtained data were validated through source triangulation and data triangulation. Afterward, the data were analyzed, systematically presented, and conclusions were drawn based on the research findings. This classification was used to identify the differences in students' mathematical communication skills across ability levels and to determine the students selected for interviews.

Data Analysis Technique

The data were analyzed using the interactive model proposed by Miles, Huberman, and Saldaña (2014), which consists of data reduction, data display, and conclusion drawing.

During the data reduction stage, students' written responses and interview transcripts were reviewed, coded, and organized according to the indicators of mathematical communication skills (*written text, drawing,* and *mathematical expression*). Irrelevant information was removed, while significant information was categorized based on students' ability levels.

During the data display stage, the reduced data were presented in the form of descriptive narratives, tables, excerpts from students' responses, and interview quotations. The data were organized according to the high, moderate, and low ability categories to facilitate comparison.

During the conclusion drawing and verification stage, patterns and relationships among the findings were interpreted. The consistency of evidence obtained from tests, interviews, and documentation was examined before final conclusions were formulated regarding students' mathematical communication skills in solving data presentation problems.

Results and Discussion

Students' Mathematical Communication Skills Based on Ability Categories

The analysis of students' mathematical communication skills in solving data presentation problems was conducted based on three indicators, namely written text, drawing, and mathematical expression. Students' written answers were first scored using the mathematical communication skills assessment rubric, and the total scores were then used to classify students into high, moderate, and low ability categories. This classification was carried out to obtain a clearer description of how students with different ability levels communicated mathematical ideas when solving data presentation problems. The classification also became the basis for selecting representative subjects from each category to be analyzed more deeply through interviews. The distribution of students across these categories, along with the selected representative subjects for further interview analysis, is presented in Table 2.

Table 2. Classification of Students' Mathematical Communication Skills

Ability Category	**Criteria**	**Number of Students**	**Selected Subjects**
High	Score $\geq \bar{x} + s$	5 students	H1, H2
Moderate	$\bar{x} - s <$ Score $< \bar{x} + s$	14 students	M1, M2
Low	Score $\leq \bar{x} - s$	5 students	L1, L2

Based on Table 2, the *written text* indicator achieved the highest score among the three indicators of mathematical communication skills. This result suggests that students were relatively more proficient in expressing mathematical ideas and explaining solution procedures in written form than in presenting information through visual representations or mathematical expressions. In contrast, the lower achievement on the *mathematical expression* indicator indicates that students still encountered difficulties in translating problem situations into appropriate mathematical models and symbolic representations.

Table 2 shows that students' mathematical communication skills were distributed into three ability categories. There were 5 students in the high category, 14 students in the moderate category, and 5 students in the low category. The largest number of students was found in the moderate category, indicating that most students had begun to communicate mathematical ideas but still needed improvement in presenting complete explanations, accurate representations, and appropriate mathematical expressions. Meanwhile, the high and low categories had the same number of students. This distribution shows that although some students had demonstrated strong mathematical communication skills, there were still students who experienced difficulties in communicating mathematical ideas through written explanations, visual representations, and mathematical symbols.

Students in the high ability category obtained scores greater than or equal to the mean score plus one standard deviation. This indicates that they had better mathematical communication skills than most students in the class. In general, students in this category were able to identify the information contained in the problem, write the known and asked information clearly, present data in appropriate visual forms, use mathematical symbols accurately, and explain the solution process coherently. Two students from this category, coded as H1 and H2, were selected as research subjects because their answers represented the characteristics of students with high mathematical communication skills.

Students in the moderate ability category obtained scores between the mean score minus one standard deviation and the mean score plus one standard deviation. This category consisted of 14 students and represented the dominant ability level in the class. Students in this category were generally able to understand the problems and communicate some mathematical ideas, but their explanations and representations were not always complete. Some students were able to determine

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the correct procedure but still made errors in writing explanations, constructing tables or diagrams, or performing calculations. Two students from this category, coded as M1 and M2, were selected for further analysis and interviews to provide a deeper description of students with moderate mathematical communication skills.

Meanwhile, students in the low ability category obtained scores less than or equal to the mean score minus one standard deviation. This category consisted of 5 students who tended to experience difficulties in identifying relevant information, explaining problem-solving procedures, presenting data in visual forms, and constructing mathematical expressions correctly. Two students from this category, coded as L1 and L2, were selected as research subjects to describe the difficulties experienced by students with low mathematical communication skills. The selection of two students from each category was not intended for statistical generalization, but to obtain an in-depth qualitative description of students' written answers and reasoning processes.

a. *Results of Students' Mathematical Communication Skills in the High Ability Category*

Students with high mathematical communication skills were able to communicate mathematical ideas effectively in written form. They could present the known and asked information clearly, explain the problem-solving procedures logically and systematically, and use mathematical symbols and notation appropriately. The interview results indicated that the students understood the problems well and were able to consistently re-explain the solution process. These findings demonstrate that the students possessed strong abilities in conveying and representing mathematical ideas in written form in Figure 1.

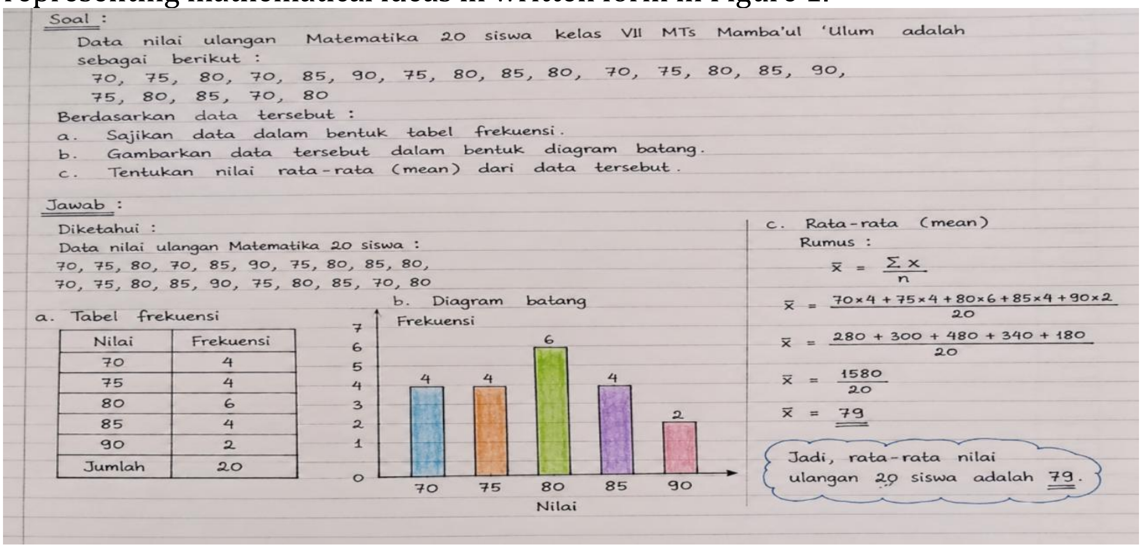

Figure 1. High-Ability Student's Answer to Question Number 1

As shown in Figure 1, the student in the high-ability category successfully identified both the given and required information comprehensively and represented it appropriately. This finding demonstrates that the student not only understood the problem accurately but was also capable of communicating mathematical reasoning systematically through written explanations and mathematical symbols. Furthermore, the student's response reflects the ability to organize information logically, construct meaningful representations, and explain

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the problem-solving process coherently, which are essential characteristics of strong mathematical communication skills.

In the drawing indicator, the student was able to represent data accurately and completely in the form of tables and diagrams. The interview results showed that the student understood the process of data presentation and was able to explain the representations created, reflecting strong abilities in communicating mathematical information through visual representations.

In the mathematical expression indicator, the student was able to construct mathematical models, use appropriate symbols and formulas, and obtain correct solutions. The interview results indicated that the student understood the problem-solving procedures applied. These findings suggest that the student possessed strong abilities in communicating mathematical ideas through mathematical expressions.

b. Results of Students' Mathematical Communication Skills in the Moderate Ability Category

Students with moderate mathematical communication skills were able to express mathematical ideas relevant to the given problems. However, the explanations provided were not entirely complete and still contained several inaccuracies. The interview results showed that the students understood the information presented in the problems and the procedures used to solve them, but they were not yet able to communicate all of their ideas in a detailed and systematic manner. These findings indicate that the students' mathematical communication skills in the writing indicator were fairly good, although the completeness and accuracy of information delivery still need improvement in Figure 2.

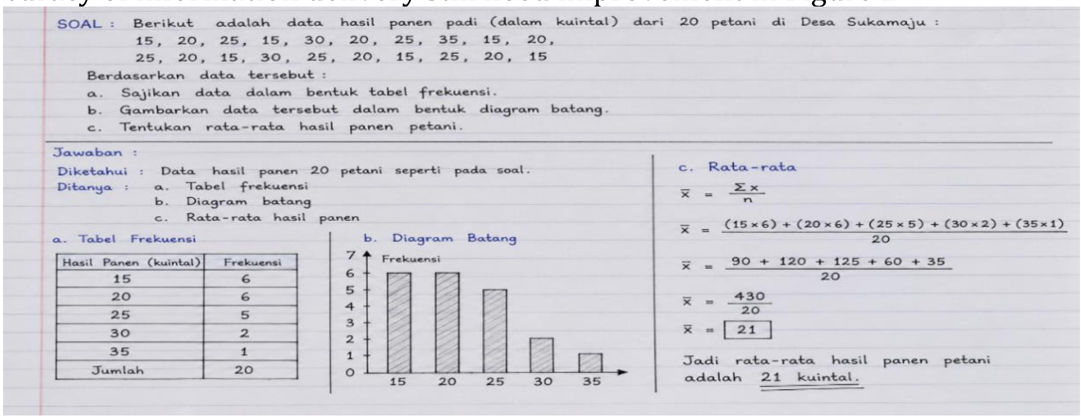

Figure 2. Moderate Ability Student's Answer to Question Number 2

In the drawing indicator, students with moderate mathematical communication skills were able to present data in the form of tables or diagrams; however, there were still shortcomings in terms of completeness and accuracy of presentation. The interview results indicated that the students understood the purpose of data presentation, but they were not yet able to represent it accurately.

In the mathematical expression indicator, the students were able to construct mathematical models and apply appropriate solution procedures, although they still made calculation errors. The interview results revealed that these errors were caused by a lack of accuracy rather than difficulties in understanding the concepts.

c. Results of Students' Mathematical Communication Skills in the Low Ability Category

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In the writing indicator, students with low mathematical communication skills were only able to present a small portion of information relevant to the problem. The interview results showed that the students experienced difficulties in expressing mathematical ideas and explaining the problem-solving procedures systematically in Figure 3

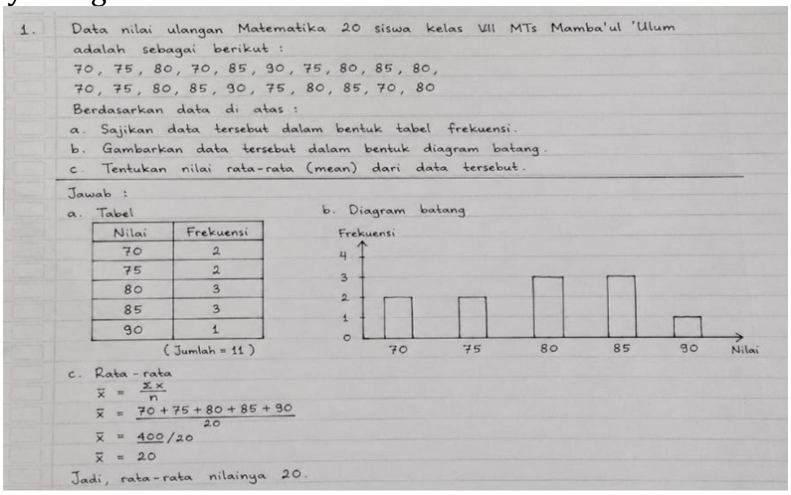

Figure 3. Low Ability Student's Answer to Question Number 1

In the drawing indicator, students with low mathematical communication skills were only able to produce a small portion of correct visual representations. The interview results indicated that the students still experienced difficulties in presenting information accurately in the form of tables or diagrams. Meanwhile, in the mathematical expression indicator, the students were only able to construct a small portion of appropriate mathematical models. The interview results revealed that the students encountered difficulties in determining mathematical models, using mathematical symbols, and applying appropriate solution procedures. These findings indicate that the students' mathematical communication skills in visual and symbolic representation aspects were still low.

The differences among the three categories indicate that students' mathematical communication skills developed at different levels. Students with high ability tended to be more capable of organizing mathematical information and presenting solution procedures coherently. Students with moderate ability were generally able to understand the problems, but their written explanations and representations were not yet fully complete. Meanwhile, students with low ability showed difficulties in identifying relevant information, constructing appropriate representations, and using mathematical models. This finding is in line with Rohid et al. (2019), who stated that students with good mathematical communication skills are able to express mathematical ideas clearly, use representations appropriately, and explain problem-solving procedures systematically.

Written Text Indicator

The written text indicator was used to analyze students' ability to write known and asked information, explain solution procedures, and present mathematical reasoning in written form. In this indicator, students in the high ability category showed strong performance. They were able to write mathematical information accurately, distinguish between known and asked information, and explain the steps of problem solving in a logical and systematic manner. Their written answers showed a clear relationship between the information in the problem, the strategy used, and the final conclusion. The interview results also indicated that students in this category understood the problems well and were able to re-explain their solution process consistently.

Students in the moderate ability category were able to write some relevant information and explain part of the solution procedure. However, their written explanations were not entirely complete. Some students wrote the final answer without providing sufficient reasoning, while others identified the data correctly but did not clearly explain how the data were processed to obtain the answer. This condition shows that students in the moderate category had begun to communicate mathematical ideas in written form, but still needed guidance to improve the completeness, clarity, and coherence of their explanations.

Students in the low ability category experienced more serious difficulties in the written text indicator. They tended to write incomplete information, did not clearly distinguish between known and asked information, and had difficulty explaining the solution procedure. Some answers only contained numbers without adequate written explanation, making it difficult to identify the students' reasoning process. The interview results also showed that students in this category had difficulty expressing mathematical ideas both orally and in writing. This indicates that students with low mathematical communication skills had not yet developed the ability to organize and communicate mathematical reasoning clearly.

The findings on the written text indicator are consistent with the concept of mathematical communication proposed by Aini and Setianingsih (2022), who stated that mathematical communication involves students' ability to express mathematical ideas orally and in writing. Written explanation is important because it reflects students' understanding of the problem and their ability to organize mathematical reasoning. The results of this study also support the findings of Ikhsan and Afriansyah (2023), who found that students often experience difficulties in presenting complete and systematic mathematical explanations. Therefore, the weakness in the written text indicator shows that students need more learning activities that encourage them to write mathematical reasoning, not merely produce final answers.

Drawing Indicator

The drawing indicator was used to analyze students' ability to represent data in tables, diagrams, or other visual forms. In data presentation material, this indicator is very important because students are required to organize data and present it visually so that the information becomes easier to read and interpret. The results showed that students in the high ability category were able to construct visual representations accurately and completely. They could present data in the form of tables or diagrams, arrange the data systematically, and ensure that the representation corresponded to the information given in the problem. The interview results also showed that students in this category understood the process of data presentation and could explain the representations they created.

Students in the moderate ability category were able to construct visual representations, but several inaccuracies were still found. Some students could create tables, but the tables did not include all required components, such as complete data labels, frequency values, or conclusions based on the table. Other students were able to construct diagrams, but the representation was not fully accurate because there were errors in organizing the data or determining the frequency. This shows that students in the moderate category understood the purpose of data representation, but their accuracy and completeness still needed improvement.

Students in the low ability category showed considerable difficulty in the drawing indicator. Some students were unable to transform the given data into tables or diagrams correctly. Others produced visual representations that were incomplete or did not match the information in the problem. The interview results indicated that students in this category still had difficulty understanding how data should be organized and presented visually. These difficulties show that students had not yet mastered the relationship between data, representation, and interpretation.

These findings strengthen the view of Hendriana et al. (2017), who stated that drawing is one of the indicators of mathematical communication skills because students need to represent mathematical ideas through diagrams, tables, graphs, or illustrations. In data presentation material, visual representation is not merely an additional component, but an essential part of mathematical communication. The results of this study are also in line with Sulisti et al. (2022), who found that students' mathematical communication skills varied across indicators, especially in constructing representations. Thus, difficulties in the drawing indicator indicate that students need learning experiences that train them to organize data and transform it into accurate visual forms.

The analysis of the drawing indicator also shows that students' ability to construct representations is closely related to their understanding of the problem. Students who understood the information in the problem tended to be able to create more accurate tables or diagrams. Conversely, students who did not fully understand the problem produced incomplete or incorrect representations. This finding supports the idea that mathematical communication and problem solving are interconnected. Visual representation helps students organize information, while problem understanding helps students determine the appropriate form of representation.

Mathematical Expression Indicator

The mathematical expression indicator was used to analyze students' ability to construct mathematical models, use symbols, perform calculations, and draw conclusions. The results showed that students in the high ability category were able to use mathematical expressions appropriately. They could determine the frequency of data, use mathematical symbols correctly, perform calculations accurately, and write conclusions based on the obtained results. This indicates that students in the high category were able to connect the problem context with the required mathematical procedures.

Students in the moderate ability category were generally able to construct mathematical expressions and apply appropriate solution procedures. However, several calculation errors were still found. These errors were not always caused by conceptual misunderstanding, but were often related to a lack of accuracy in processing data or performing calculations. For example, some students were able to determine the correct procedure, but made mistakes in counting frequency or writing the final result. This shows that students in the moderate category had partial mastery of mathematical expression, but their precision and consistency still needed improvement.

Students in the low ability category had difficulty constructing mathematical expressions. Some students did not know how to translate the problem into mathematical form, while others used inappropriate symbols or procedures. In several answers, students only copied numbers from the problem without organizing them into meaningful mathematical expressions. The interview results revealed that students in this category encountered difficulties in determining mathematical models, using mathematical symbols, and applying appropriate solution procedures. This condition indicates that students in the low category still had difficulty connecting verbal information, visual representations, and mathematical symbols.

The findings on the mathematical expression indicator are in line with Ikhsan and Afriansyah (2023), who stated that mathematical communication includes the ability to translate real-life situations into mathematical forms and explain relationships among concepts logically. The results also support Sibarani et al. (2022), who reported that students often experience difficulties in using mathematical symbols, constructing models, and explaining problem-solving procedures. Therefore, weaknesses in mathematical expression indicate that students need more practice in transforming contextual problems into mathematical models and using mathematical notation appropriately.

The comparison among ability categories shows that students' mathematical expression skills were strongly influenced by their ability to understand and represent the problem. Students with high ability could move coherently from written information to visual representation and then to mathematical expression. Students with moderate ability could follow part of this process, but still made errors in calculation or conclusion. Students with low ability often failed to connect the three stages. This finding indicates that mathematical communication skills are integrated abilities, in which written text, drawing, and mathematical expression support one another.

Comparison of Students' Mathematical Communication Skills Across Indicators

The comparison of students' mathematical communication skills across the three indicators shows that each ability category had different characteristics. Students in the high category demonstrated relatively balanced performance in written text, drawing, and mathematical expression. They were able to write mathematical information clearly, present data accurately, use mathematical models appropriately, and explain conclusions coherently. Students in the moderate category showed adequate performance, but still had weaknesses in completeness and accuracy. Meanwhile, students in the low category experienced difficulties in almost all indicators, especially in constructing visual representations and mathematical expressions. The detailed description of students' performance in written text, drawing, and mathematical expression for each category is presented in Table 3

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Table 3. Characteristics of Students' Mathematical Communication Skills Across Indicators

Ability Category	Written Text	Drawing	Mathematical Expression
High	Able to write known and asked information clearly, explain solution procedures systematically, and present reasoning coherently	Able to present data accurately and completely in tables or diagrams	Able to construct mathematical models, use symbols correctly, perform calculations accurately, and draw conclusions
Moderate	Able to write relevant information, but explanations are not fully complete or systematic	Able to construct visual representation s, but some components are incomplete or inaccurate	Able to use mathematical procedures, but still makes errors in calculation or final results
Low	Has difficulty writing complete information and explaining solution procedures	Has difficulty presenting data accurately in tables or diagrams	Has difficulty constructing mathematical models, using symbols, and determining appropriate procedures

Table 3 shows that students' mathematical communication skills varied across ability categories and indicators. The most visible differences were found in the completeness of explanations, accuracy of representations, and appropriateness of mathematical expressions. Students in the high category could integrate the three indicators in solving problems, while students in the moderate and low categories still showed gaps between understanding the problem and communicating the solution. This means that students' mathematical communication skills cannot be assessed only from the final answer, but must also be seen from how students write, represent, and express mathematical ideas during the problem-solving process.

The findings of this study are consistent with Kamid et al. (2021), who found that students with strong mathematical communication skills are more capable of expressing ideas clearly and using mathematical models appropriately. They are also in line with Samawati and Ekawati (2021), who reported that students' mathematical communication skills influence their ability to solve story problems. In addition, the results support Nguyen et al. (2025), who emphasized that mathematical communication helps students understand concepts, connect ideas with symbols, and solve problems effectively. These similarities indicate that mathematical communication plays an important role in supporting students' problem-solving performance.

However, the findings of this study also provide a more specific contribution by showing how mathematical communication skills appear in data presentation

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problems. Data presentation requires students to read, organize, represent, and interpret information. Therefore, students' difficulties in this material are not only related to calculation, but also to the ability to communicate data through written explanations, tables, diagrams, and mathematical expressions. This finding enriches previous studies by providing a qualitative description of students' communication patterns across high, moderate, and low ability categories.

The findings of the present study are in line with previous studies which state that students with better mathematical abilities tend to communicate mathematical ideas more systematically. Students in the high ability category were able to write known and asked information, construct visual representations, and use mathematical expressions accurately. This is consistent with Siregar et al. (2022), who showed that flexibility in mathematical thinking helps students solve problems more effectively. In contrast, students in the moderate and low categories still experienced difficulties in completing representations and explaining solution procedures coherently.

The results also support the view that representation is an important part of mathematical communication. Students who were able to construct tables or diagrams accurately tended to explain the data more clearly. This finding is consistent with Siregar et al. (2025), who emphasized that representation ability can support students in communicating mathematical ideas. In the present study, difficulties in the drawing indicator showed that some students had not yet been able to transform information into appropriate visual forms, indicating the need for learning activities that strengthen students' representation skills.

Furthermore, the errors found in the mathematical expression indicator indicate that students' difficulties were not only related to calculation, but also to the process of translating information into mathematical models. This finding is relevant to Erliananda et al. (2025) and Sakdiah and Siregar (2025), who reported that students often experience difficulties in understanding problems, applying procedures, and avoiding errors in mathematical problem solving. Therefore, teachers need to guide students to connect written information, visual representations, and mathematical expressions in an integrated manner.

Overall, the results of this study strengthen the argument that mathematical communication skills are closely related to problem-solving ability. Students who are able to explain information, construct representations, and use mathematical expressions appropriately tend to show better performance in solving data presentation problems. This finding is in line with Siregar et al. (2024) and Firmansyah et al. (2025), who emphasized the importance of learning activities that support students in understanding, representing, and solving mathematical problems.

Theoretical and Practical Implications

Theoretically, the findings of this study strengthen the concept that mathematical communication is an essential component of problem solving. Students who are able to communicate mathematical ideas well tend to show better problem-solving performance because they can identify information, represent data, construct mathematical expressions, and explain conclusions. The results also confirm that written text, drawing, and mathematical expression are interrelated indicators. Weakness in one indicator may affect students' performance in other indicators. For example, students who cannot organize information in written form may also experience difficulty constructing visual representations or mathematical expressions.

Practically, the findings imply that mathematics learning should provide more opportunities for students to communicate mathematical ideas in various forms. Teachers should not only ask students to find final answers, but also train them to write known and asked information, explain solution steps, construct tables or diagrams, and justify their conclusions. In data presentation material, teachers can use contextual problems that require students to collect, organize, present, and interpret data. Such activities can help students develop mathematical communication skills more naturally and meaningfully.

The results also suggest that students with different ability levels need different forms of support. Students in the high category need enrichment tasks that challenge them to explain and justify their reasoning more deeply. Students in the moderate category need guidance to improve the completeness and accuracy of their representations and calculations. Students in the low category need more structured assistance, such as examples of how to identify information, construct tables, use symbols, and write conclusions. Therefore, differentiated learning can be used as an alternative strategy to strengthen students' mathematical communication skills.

The findings of this study indicate that students at different levels of mathematical communication ability require different forms of instructional support. This difference is not merely reflected in the quality of students' answers but also in the way they process, organize, and communicate mathematical information. Students in the high-ability category demonstrated a strong capacity to identify relevant information, construct appropriate representations, and express mathematical reasoning systematically. This suggests that these students have developed a deeper conceptual understanding that enables them to integrate mathematical ideas into coherent explanations. Consequently, they require enrichment activities that challenge them to justify their reasoning, evaluate alternative solution strategies, and communicate mathematical arguments at a higher level of complexity.

In contrast, students in the moderate-ability category were generally able to understand problems and communicate mathematical ideas; however, their responses often lacked completeness and accuracy. This condition may be attributed to partial conceptual understanding, where students are able to recognize relevant information but encounter difficulties in connecting representations with mathematical procedures. As a result, errors frequently occurred in the construction of diagrams, the use of mathematical expressions, and computational processes. Therefore, learning activities for these students should focus on strengthening the relationships among concepts, representations, and procedures so that mathematical communication can be expressed more accurately and consistently.

Meanwhile, students in the low-ability category experienced difficulties across almost all indicators of mathematical communication. Their inability to identify essential information, construct visual representations, and formulate mathematical expressions suggests that they have not yet developed a sufficient understanding of how mathematical ideas can be translated into communicative

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forms. This finding indicates that weak mathematical communication is closely related to limited conceptual understanding and inadequate experience in expressing mathematical reasoning. Consequently, these students require structured scaffolding, including guided examples, explicit modeling of problem-solving procedures, and continuous opportunities to communicate mathematical ideas in written and visual forms.

Taken together, these findings reveal that differences in mathematical communication skills are not solely the result of students' ability levels but also reflect differences in how students interpret information, construct meaning, and represent mathematical ideas during problem solving. Students with higher communication skills tend to engage in more organized and reflective thinking processes, enabling them to explain their reasoning systematically. Conversely, students with lower communication skills often focus on obtaining answers without adequately representing or justifying their thinking. This pattern suggests that mathematical communication functions not only as a means of expressing solutions but also as a cognitive tool that supports mathematical reasoning and problem-solving processes.

Therefore, the development of mathematical communication skills should become an integral part of mathematics instruction. Learning activities should provide students with opportunities to explain their reasoning, construct multiple representations, develop mathematical models, and reflect on their solution strategies. Through such experiences, students can gradually strengthen their ability to communicate mathematical ideas effectively, which in turn contributes to deeper conceptual understanding and improved mathematical problem-solving performance.

Overall, the results of this study indicate that students' mathematical communication skills in solving data presentation problems differ across ability categories. Students in the high category were able to communicate mathematical ideas systematically through written text, drawing, and mathematical expression. Students in the moderate category were able to communicate ideas but still made errors in completeness, representation, and calculation. Students in the low category experienced difficulties in almost all indicators. These findings show that mathematical communication skills need to be developed continuously through learning activities that emphasize explanation, representation, modeling, and reflection in problem solving.

Conclusion and Suggestion

This study aimed to analyze students' mathematical communication skills in solving data presentation problems based on the indicators of written text, drawing, and mathematical expression. The findings indicate that students' mathematical communication skills varied across ability categories. Students in the high category demonstrated strong performance in communicating mathematical ideas through written explanations, visual representations, and mathematical expressions. Students in the moderate category were able to communicate mathematical ideas adequately but still showed limitations in the completeness and accuracy of their representations and calculations. Meanwhile, students in the low category

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experienced difficulties across most communication indicators, particularly in constructing representations and mathematical expressions.

The study also revealed that mathematical communication skills are reflected not only in students' ability to obtain correct answers but also in their ability to organize information, represent data, and explain mathematical reasoning systematically. Among the indicators examined, students showed relatively stronger performance in written communication than in visual representation and mathematical expression. These findings confirm that mathematical communication skills play an important role in supporting students' understanding and problem-solving processes in data presentation tasks.

Based on the findings of this study, mathematics teachers are encouraged to design learning activities that provide students with greater opportunities to communicate mathematical ideas through written explanations, visual representations, and mathematical expressions. Learning tasks should emphasize not only the correctness of answers but also the process of explaining, representing, and justifying mathematical reasoning.

Future studies may expand this research by involving larger numbers of participants from different educational settings to obtain broader insights into students' mathematical communication skills. Further research may also investigate the relationship between mathematical communication skills and other variables, such as mathematical reasoning, problem-solving ability, self-efficacy, or learning models. In addition, studies employing intervention-based approaches are recommended to examine the effectiveness of specific instructional strategies in improving students' mathematical communication skills across different mathematical topics.

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