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EXPLORING MATHEMATICAL COMMUNICATION SKILLS OF JUNIOR HIGH SCHOOL STUDENTS ON STATISTICS: A DESCRIPTIVE QUALITATIVE STUDY

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ABSTRACT

The objective of this study was to analyze junior high school students' mathematical communication skills on the topic of statistics. This research employed a descriptive qualitative approach. The subjects consisted of 30 students of class IX.A at SMP Negeri 1 Belitang III who were given a written mathematical communication test. Based on the test results, students' abilities were classified into three levels: high, moderate, and low. Furthermore, three students representing each level were selected as main research subjects for in-depth analysis through interviews. Data were collected using tests, interviews, and documentation, and analyzed through scoring, classification, data reduction, presentation, and verification. The results showed that 20% of students had high mathematical communication skills, 33.3% were in the moderate category, and 46.6% were categorized as low. The main difficulties experienced by students were related to understanding written mathematical representations and restating mathematical ideas in their own words.

ABSTRAK

Penelitian ini bertujuan untuk menganalisis kemampuan komunikasi matematis siswa sekolah menengah pertama pada materi statistika. Penelitian menggunakan metode deskriptif kualitatif. Subjek penelitian terdiri atas 30 siswa kelas IX.A SMP Negeri 1 Belitang III yang diberikan tes kemampuan komunikasi matematis. Berdasarkan hasil tes, kemampuan siswa diklasifikasikan ke dalam tiga kategori, yaitu tinggi, sedang, dan rendah. Selanjutnya, dipilih tiga siswa yang mewakili masing-masing kategori untuk dianalisis secara mendalam melalui wawancara. Teknik pengumpulan data meliputi tes, wawancara, dan dokumentasi. Analisis data dilakukan melalui tahapan penskoran, klasifikasi, reduksi data, penyajian data, dan verifikasi. Hasil penelitian menunjukkan bahwa 20% siswa berada pada kategori tinggi, 33,3% pada kategori sedang, dan 46,6% pada kategori rendah. Kesulitan utama siswa terletak pada kemampuan memahami representasi matematis tertulis serta mengungkapkan kembali ide matematis dengan kata-kata sendiri.

Introduction

According to (Suhenda & Munandar, 2023) and (Lubis et al., 2023), mathematical communication ability is the students' ability to express mathematical ideas or concepts, either orally or in writing. Students' mathematical communication skills can be developed through the learning process at school, one of which is through mathematics learning.

Furthermore, according to (Rapsanjani & Sritresna, 2021), mathematical communication ability is one of the mathematical skills that support students' understanding and mastery of mathematical concepts in general. Mathematical communication ability is a skill that must be possessed by secondary school students (Hanisah & Noordyana, 2022; Rumita et al., 2021). One of the mathematics subjects that must be studied at the secondary school level is statistics.

In addition, mathematical communication skills play a crucial role in enabling students to construct meaning, justify solutions, and share mathematical reasoning with others. Through effective communication, students are able to translate real-world situations into mathematical representations and explain relationships among data in a logical manner. In the context of statistics, these skills are particularly important because statistical concepts such as mean, median, and mode require students to interpret data, recognize patterns, and draw conclusions based on evidence rather than relying solely on procedural calculations.

However, in classroom practice, mathematics learning is often dominated by teacher-centered instruction that emphasizes formula memorization and numerical computation. As a result, students are rarely given opportunities to explain their reasoning, interpret data representations, or communicate their ideas either orally or in written form. This condition contributes to students' weak mathematical communication skills, especially when they are faced with open-ended or contextual statistical problems that require explanation and interpretation.

Furthermore, previous studies have reported that students tend to experience difficulties in expressing mathematical ideas using appropriate symbols, representations, and language (Hanisah & Noordyana, 2022; Lubis et al., 2023). These difficulties indicate that students' mathematical communication skills have not been optimally developed during the learning process. Therefore, an in-depth analysis of students' mathematical communication skills, particularly in statistics learning, is necessary to identify specific indicators that need improvement.

According to (Su'udah & Salama, 2023) statistics is the science that studies data in detail, including data collection, processing/analysis, interpretation, and drawing conclusions from data presented in numerical form. Based on an interview conducted with the eighth-grade mathematics teacher at SMP Negeri 1 Belitang III, the average score of students in the statistics topic is still relatively low. When compared with students' achievement levels in previous years for the same topic, more than 57% of students failed to achieve the minimum competency score.

The students' lack of ability in statistics aligns with findings from research by (Fajriah et al., 2020; Sriwahyuni & Maryati, 2022), which state that students' main difficulties in learning statistics lie in understanding the concepts of mean, median, and mode. Moreover, statistics is often perceived merely as a tool for calculation, without meaningful conceptual understanding. It is viewed as an abstract discipline that cannot be applied to everyday life. The topic of statistics has a strong connection to indicators of mathematical communication ability. This is supported by a study conducted by (Annisa et al., 2025) on the analysis of junior high school students' mathematical communication skills in the statistics topic.

One strategy that can be used to analyze students' mathematical communication ability is Sumarmo's strategy. This aligns with the research conducted by (Saidah & Mardiani, 2021), who concluded that students' mathematical communication difficulties are related to formulating statements from a given case and finding solutions. Similarly, research by (Sukaesih et al., 2020) concluded that students' communication ability remains low, as many students still struggle to understand the direct connection between mathematical concepts and real-world objects. Further research by (Azizah & Abadi, 2022) revealed that students with high and moderate resilience levels are able to complete test questions well, while those with low resilience show weaker performance in mathematical communication.

Although several studies have examined students' mathematical communication skills in statistics (Annisa et al., 2025; Saidah & Mardiani, 2021), most of these studies emphasize quantitative descriptions of students' achievement levels without providing in-depth qualitative analysis of students' difficulties based on specific communication indicators. Moreover, limited research explores students' mathematical communication skills using Sumarmo's indicators in the context of junior high school statistics learning. Therefore, this study focuses on a qualitative analysis of students' mathematical communication skills

based on Sumarmo's indicators, supported by written tests and interviews, to obtain a more comprehensive understanding of students' difficulties.

The indicators of mathematical communication ability according to Sumarmo (Amatul Wahid & Rina Marlina, 2022; Rahmayani & Effendi, 2023) as follows: (1) Expressing a situation, picture, diagram, or real object into mathematical language, symbols, ideas, or models; (2) Explaining mathematical ideas, situations, and relationships orally or in writing; (3) Listening, discussing, and writing about mathematics; (4) Reading and comprehending a written mathematical representation; and (5) Restating a mathematical paragraph or explanation in one's own words.

Method

This study employed a descriptive qualitative research method aimed at analyzing students' mathematical communication skills on the topic of statistics. The research subjects consisted of 30 students of class IX.A at SMP Negeri 1 Belitang III. Data were collected through a written mathematical communication test, interviews, and documentation.

The written test consisted of five essay questions developed based on Sumarmo's mathematical communication indicators. The test instrument was validated through expert judgment to ensure content validity and alignment with the indicators measured. Students' test results were scored and classified into high, moderate, and low ability levels.

Based on the test results, three students representing each level of mathematical communication ability were selected as the main research subjects for in-depth analysis through semi-structured interviews. Data analysis was conducted through scoring, classification, data reduction, data presentation, and conclusion drawing.

Results and Discussion

The results obtained in this study consist of written test outcomes on the topic of statistics, which serve to determine the level of students' mathematical communication ability based on the five indicators employed. The criteria for categorizing students' levels of mathematical communication ability were determined using the classification proposed by (Arikunto, 2021). The classification criteria are presented in Table 1.

Table 1
The Percentage of Students' Mathematical Communication Ability

Persentage (%)	Criteria
$0 \leq p < 40$	Low
$40 \leq p < 70$	Moderate
$70 \leq p < 100$	High

The percentage results of students' mathematical communication ability levels, based on their written test responses on the topic of statistics, are presented in Table 2.

Table 2
Percentage of Students' Mathematical Communication Test Results in the Statistics Topic Based on Their Ability Level

Level of Mathematical Communication Ability	Frequency	Percentage
High	6	20%
Moderate	10	33,3 %
Low	14	46,6%

Based on these percentage results, the researcher selected three students to represent each level of ability. These three subjects were chosen based on the lowest score within each category, to ensure that the analysis results could represent the overall population in each level of students' mathematical communication ability.

The analysis was conducted according to the indicators of each test item, which were developed based on Sumarmo's indicators (Amatul Wahid & Rina Marlina, 2022; Rahmayani & Effendi, 2023) can be seen on Table 3. The analysis results of the written test answers from three subjects representing different levels of mathematical communication skills, as shown in Table 4.

Table 3
Indicators of Mathematical Communication Ability and Corresponding Test Item

Indicators of Mathematical Communication Ability	Test Item Indicator	Code
Expressing a situation, picture, diagram, or real object into mathematical language, symbols, ideas, or models.	Expressing a bar diagram into mathematical symbols and models.	I1
Explaining mathematical ideas, situations, and relationships in written form.	Explaining ideas and situations related to rice production income and the difference in income in written form.	I2
Engaging in listening, discussion, and writing activities related to mathematics	Writing formulas related to statistics.	I3
Reading and understanding written mathematical representations.	Reading and understanding mathematical ideas to find the mode and median in written form.	I4
Restating a mathematical paragraph in one's own words.	Restating a paragraph about the number of book pages in one's own words.	I5

Table 4
Analysis Results of Student Answers Representing Each Communication Skill Level

Communication Skill Level	Problem Indicator				
	I1	I2	I3	I4	I5
High	√	√	√	-	-
Moderate	√	√	-	-	-
Low	-	√	-	-	-

The analysis above indicates that students with a high communication (HC) skill level did not meet indicators 4 and 5. These indicators involve reading with comprehension of mathematical ideas to find mode and median values in writing, as well as paraphrasing a description regarding the number of book pages into their own words. The example of students' solution of this problem can be seen in Figure 1.

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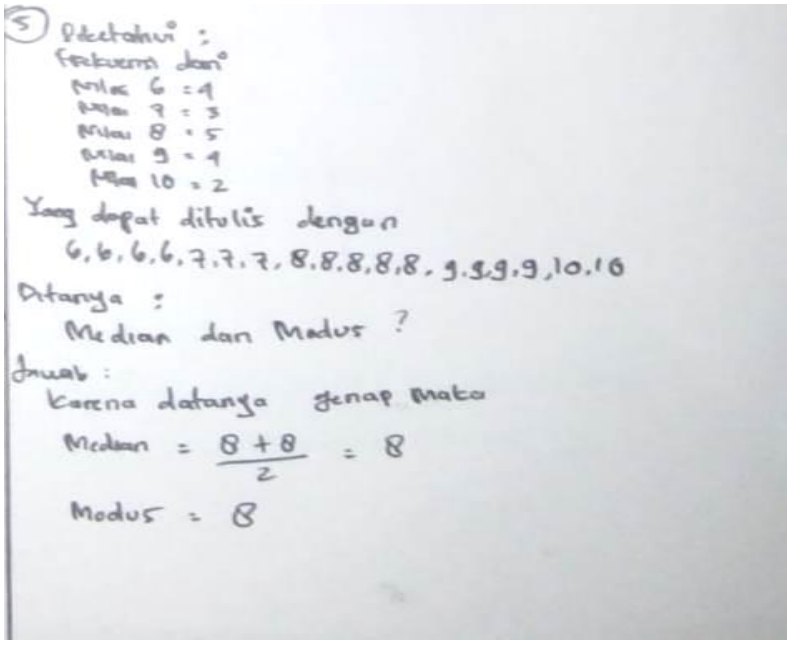

Figure 1. Students' HC solution for I4

Meanwhile, students with a moderate communication skill (MC) level failed to meet indicators 3, 4, and 5. This means they were unable to write statistical formulas, comprehend mathematical ideas for finding mode and median values, or paraphrase the description of book pages. The example of students' solution for this problem can be seen in Figure 2.

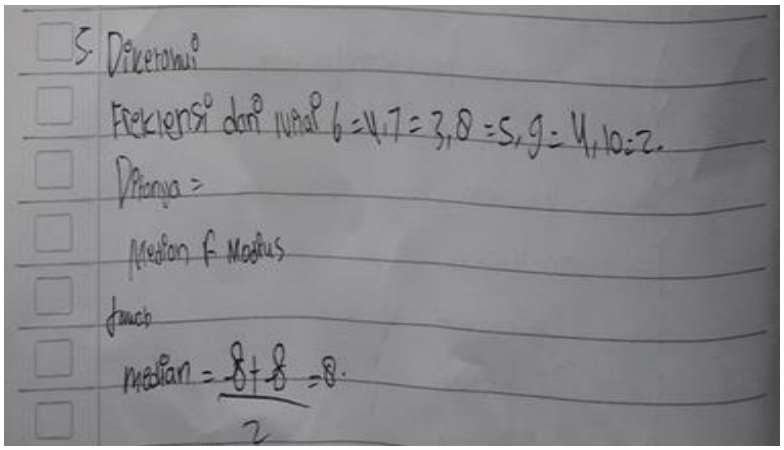

Figure 2. Students' MC solution for I4

Furthermore, students with a low communication (LC) skill level only met indicator 2, which involves explaining ideas or situations regarding rice production income and income difference relations in writing. The example of students' solution for this problem can be seen in Figure 3.

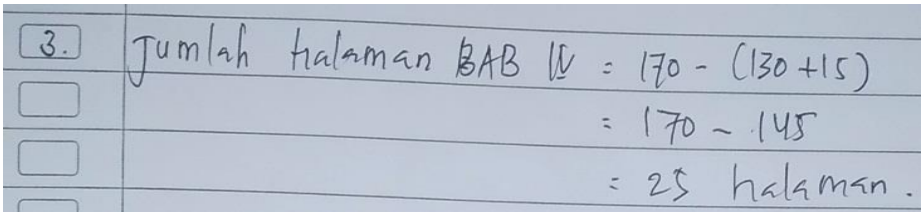

Figure 3. The students' LC solution for I3

The findings indicate that the majority of students (46.6%) were categorized as having low mathematical communication skills. This result is consistent with Sukaesih et al. (2020), who stated that students often experience difficulties in connecting abstract mathematical concepts with real-world contexts. Based on interview results, students with low ability tended to focus on computational procedures without understanding the meaning of statistical concepts such as median and mode.

Furthermore, students also showed difficulties in restating mathematical ideas in their own words. This finding aligns with Saidah and Mardiani (2021), who reported that students frequently struggle to formulate mathematical statements from contextual problems. Interviews revealed that students were not accustomed to explaining mathematical ideas in written form, which affected their communication performance.

In addition, students' difficulties may also be influenced by non-cognitive factors, such as learning resilience. As stated by Azizah and Abadi (2022), students with low resilience tend to give up easily when facing non-routine problems, which contributes to weak mathematical communication skills.

Based on these findings, it can be concluded that students generally struggle to read with comprehension to determine mode and median values and to paraphrase textual descriptions into their own words. This is consistent with research by Asuro dan Fitri (2020), which states that students' performance is categorized as "poor" in the Written Text indicator and "very poor" in the Mathematical Expression indicator.

The findings of this study also indicate that students' mathematical communication skills vary across different indicators. Students generally performed better on indicators related to explaining ideas based on contextual situations, while they showed significant difficulties in indicators that require reading, interpreting, and restating mathematical information. This suggests that students are more accustomed to answering questions that involve direct information from

the problem context rather than tasks that demand deeper comprehension and reinterpretation of mathematical texts.

The difficulty in reading and understanding written mathematical representations can be attributed to students' limited exposure to non-routine problems and interpretative tasks. As stated by Sukaesih et al. (2020), students often fail to connect abstract mathematical concepts with real-world objects because they lack experience in interpreting mathematical representations meaningfully. This condition was also reflected in the interview results, where several students admitted that they were unsure about how to interpret data presented in tables or diagrams when determining measures such as median and mode.

Moreover, students' inability to restate mathematical ideas in their own words indicates a low level of conceptual understanding. According to Saidah and Mardiani (2021), students who do not fully understand mathematical concepts tend to reproduce formulas without being able to explain their meaning. This finding reinforces the importance of integrating learning activities that encourage students to discuss, explain, and write about mathematics as part of daily classroom instruction.

Additionally, non-cognitive factors such as learning resilience may influence students' mathematical communication skills. Students with low resilience often show a tendency to stop working when they encounter difficulties, particularly in problems that require explanation rather than calculation. This is consistent with Azizah and Abadi (2022), who found that students with higher resilience levels demonstrate better performance in mathematical communication tasks. Therefore, strengthening students' resilience alongside communication-oriented learning strategies may help improve their overall mathematical communication ability.

Conclusion

Based on the results of this study, it can be concluded that students' mathematical communication skills on the topic of statistics are categorized into three levels: high (20%), moderate (33.3%), and low (46.6%). The indicators that were relatively well mastered by students were expressing mathematical ideas related to contextual situations in written form. Meanwhile, the weakest indicators were reading and understanding written mathematical representations and restating mathematical explanations in students' own words. These findings indicate that students require more learning opportunities that emphasize understanding, interpretation, and expression of mathematical ideas rather than procedural computation alone.

Declarations

Author contribution. MTA: resources, visualization, writing–original draft, editing; KS: conceptualization, data curation, methodology, validation, writing–review & editing; All authors agreed with the results and conclusions.

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Conflict of interest. The authors declare no conflict of interest.

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