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Research Article

MATHEMATICAL COMMUNICATION OF STUDENTS WITH LOW PERFORMANCE IN MATHEMATICS: GENDER PERSPECTIVE

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Abstract
This study aims to describe mathematical communication between male and female students with low mathematical performance and to identify ways to support their mathematical communication skills. Students with mathematical abilities often struggle to express mathematical ideas clearly, making it important to explore their communication patterns and develop effective teaching strategies. A male and a female student from the twelfth grade of high school, were chosen as participants due to their low performance in mathematics. The selection of these subjects was based on the method of pairing data created by Milles. Data collection involved administering tests and using a semi-structured interview approach, which were then analyzed qualitatively. The results of this research indicated that there are differences in mathematical communication exhibited by male and female students. Both participants expressed mathematical concepts by identifying key points obtained from the test. They correctly used mathematical notation and adequately represented their ideas through graphical means. The male student showed a stronger grasp by connecting various concepts. However, there were instances when they struggled to articulate their thoughts accurately in writing. The results of this study provide insights for teachers in designing teaching strategies that improve low-achieving students' mathematical communication skills, both oral and written communication. This is expected to support students in expressing mathematical ideas effectively.

Keywords: Gender, Limit, Mathematical Communication, Mathematics Ability.

INTRODUCTION

Mathematics is deeply intertwined with human life, as most human activities inherently involve mathematical thinking (Wijaya et al., 2014). Therefore, a strong understanding of fundamental mathematical concepts is essential, especially at the elementary education level (Bakar et al., 2021). Due to its universal importance, mathematics is studied across the world and is characterized by its diverse

patterns of reasoning (Muslimin et al., 2020). To support this, students need to build mathematical communication skills through the use of appropriate mathematical symbols (Qohar et al., 2013). As such, communication is a vital component of learning mathematics (Lanya et al., 2020).

Effective communication plays a vital role in both mathematics and mathematics education (Morgan et al., 2014), and mathematical communication plays a pivotal role in the learning process (Rusyda et al., 2020; Sumaji et al., 2020). Communication enables students to collaborate effectively, construct concepts, organize and reflect on ideas, and clarify mathematical processes. It also enables them to develop and refine mathematical thinking that can contribute to their future careers (Darawsheh, 2022; Vale & Barbosa, 2017). Learners can express their ideas in multiple ways—verbally, in writing, or visually (Lanya et al., 2020).

Students' abilities in mathematical communication can vary widely, influenced by several factors, including gender. Gender differences are known to affect how students acquire mathematical knowledge and skills (Wang et al., 2017), a phenomenon commonly linked to biological distinctions between male and female brain structures. (Ramírez-Uclés et al., 2020). Research has shown that male students tend to show more interest in mathematics compared to females (Halpern et al., 2007; Triana, 2019). This aligns with findings by (Anggraini et al., 2018), who reported statistically significant differences in students' interest in mathematics, with males scoring higher. On the other hand, some studies have found that female students often outperform males in problem-solving tasks (Sabat et al., 2021).

According to the 2018 OECD report, Indonesian students ranked 72nd out of 78 countries in terms of mathematical literacy and related soft skills (OECD, 2019). This low performance reflects the relatively weak mathematical communication abilities of Indonesian students, as evident from the difficulties they face in completing assignments and understanding the material (Umbara et al., 2021). Thus, there is a pressing need to improve students' mathematical communication skills so they can compete internationally (Marwanda et al., 2021). One of the important yet challenging concepts in mathematics is the concept of limits (Mendezabal et al., 2018), which many students struggle to grasp (Boniecki Carneiro et al., 2024). In light of this, the present study aims to explore the mathematical communication skills of low-performing students through the lens of the limit concept.

Mathematical communication refers to the process of expressing mathematical ideas clearly and accurately (Ontario. Ministry of Education., 2005; Yusra et al., 2016; Rohid et al., 2019). It typically involves both written and oral forms. Written mathematical communication conveys ideas and understanding through written language (Ontario Ministry of Education, 2005), while oral mathematical communication involves expressing thoughts verbally and sharing knowledge with others (Pantaleon, et al., 2018). Mathematical communication is essential as it serves as a means for reflection, structuring ideas, reinforcing understanding, and supporting personal growth (Reni et al., 2020). Teachers' instructional approaches significantly influence how well students develop these skills (Chasanah et al., 2020), underscoring the need to prioritize mathematical communication in educational settings (Kamid et al., 2020).

Students are encouraged to express their thoughts both verbally and in written form, which can deepen their conceptual understanding. Mathematical communication enables students to share their thinking and support their ideas (Chung et al., 2016); Kaya et al., 2016). Additionally, it helps in assessing how well students understand mathematical notations and ideas (Ratnasari et al., 2018). Through communication, teachers can better evaluate students' abilities to interpret and represent mathematical knowledge (Ratnasari et al., 2018). Research by (Firdiani et al., 2020) indicates that only a limited number of students are capable of articulating, comprehending, and presenting mathematical ideas effectively. According to (Lanya et al., 2020), female students tend to outperform their male counterparts in written mathematical problem-solving, as observed through an analysis of their mathematical communication. Meanwhile, (Pantaleon, et. al, 2018) highlight that male students demonstrate greater precision in their mathematical communication compared to females. These findings underline the need for further investigation into students' mathematical communication abilities. Understanding how students communicate mathematically can assist teachers in designing instructional strategies that enhance these skills, thereby supporting the achievement of learning objectives (Sfard, 2002)..

Research indicated that middle school students in Vietnam exhibited diminished motivation to participate in mathematics communication and presentation when subjected to an uncomfortable learning environment. The construction and structuring of learning environments is essential for enhancing self-confidence and encouraging student participation in learning activities, as well as promoting flexibility in

applying mathematics to real-life problem-solving through mathematical communication. Early-developed mathematical skills are crucial, providing a foundational basis for the acquisition of more complex concepts (Nanda et al., 2025). The innovative approach to education aligned with the enhancement of students' mathematical competence represents an additional advantage of mathematical communication. In conclusion, renovating education and implementing strategies to enhance students' mathematical communication competence in mathematics instruction is essential for fostering competitiveness and quality (Uyen et al., 2021)..

Research on mathematical communication skills has been widely carried out, including (Rusyda et al., 2020) examining differences in mathematical communication abilities according to cognitive style (FI and FD) and gender in students with varying mathematical performance. The results showed that students with a Field Independent (FI) cognitive style had better mathematical communication skills than students with a Field Dependent (FD) cognitive style. However, this study was more general and covered the entire student population, and did not examine the mathematical communication skills of students with low performance in mathematics. (Qohar et al., 2013) stated that students' mathematical communication abilities influence their overall mathematical performance, where independent learning can be a strategy to improve these abilities. Other studies emphasize the importance of mathematics teaching that focuses on developing students' understanding of mathematical concepts. In addition, mathematical communication skills play a role in clarifying innovative teaching approaches that are in accordance with the development of student competencies, increasing accountability and activeness in learning, building strong conceptual understanding, and connecting mathematics learning with real practice. Efforts to improve mathematical communication skills are needed so that students can achieve better proficiency and quality in mathematics (Uyen et al., 2021). However, these studies have not specifically discussed differences in mathematical communication based on gender, especially in students with low mathematical abilities. Students with mathematical abilities often have difficulty expressing mathematical ideas clearly. Therefore, this study explores the variations in mathematical communication between male and female students with low academic ability, which have not been widely studied in previous studies.

RESEARCH METHOD

This study uses a qualitative descriptive approach. The aim is to obtain an in-depth description and understanding of the situation under study through observation of ideal conditions. The main focus of this study is students' mathematical communication skills on limit material, especially for students with low mathematical abilities. The subjects in this study were grade XII students at a high school in Palu City, Indonesia. The selection of subjects was carried out purposively, taking into account the low level of mathematical ability, as well as social aspects such as gender and student behavior in the school environment. The assessment of mathematical ability was carried out through a mathematics ability test comprising 20 items, adapted from past National Examination questions. The classification of mathematical ability is based on the criteria of (Prabawanto et al., 2019), namely: High: score > 80 to ≤ 100; Medium: score ≥ 60 to ≤ 80; Low: score < 60.

The instruments in this study consist of the main instrument and supporting instruments. In qualitative research, the researcher himself acts as the main instrument responsible for the process of collecting, processing, analyzing, and reporting data. Meanwhile, supporting instruments include interview guidelines and limited problem-solving tasks. This task aims to investigate written and verbal mathematical communication of the research subjects. The material in this task pertains to an intuitive grasp of the concept of limits. Prior to implementation, the task was discussed with the supervising lecturer and verified by a mathematics teacher from a high school in Palu City. The validation results showed that the instrument was suitable for use.

Data were collected by giving limit material tasks to research subjects. To get a comprehensive picture of students' mathematical communication, in-depth interviews were also conducted. This interview uses a previously prepared question guideline, but is flexible and can develop according to the dynamics during the interview (Kallio et al., 2016). The indicators of mathematical communication aspects used in this study are detailed in Table 1, and these indicators are arranged based on the results of previous studies as a reference in analyzing data.

Table 1. Aspects of Mathematical Communication

Aspect of Communication	Description
Expressing mathematical ideas	Conveying ideas orally, in writing, using mathematical terms and notations, and visual representations
Understanding the ideas conveyed	Comprehending ideas through writing, conveying their meaning verbally, and describing the connections between concepts
Explaining or presenting mathematical ideas	Explaining orally with mathematical terms/notations, and connecting various mathematical concepts

The data analysis in this study refers to the model from (Milles, et al, 2014), which includes data condensation/reduction, data presentation, and drawing conclusions/verification (see Figure 1). Data reduction involves selecting, emphasizing, simplifying, and summarizing information gathered from observations, field notes, video recordings, and interviews. Data presentation is done in the form of information that has been systematically arranged to facilitate drawing conclusions and taking action. The last stage is drawing conclusions and verification, which is carried out continuously throughout the analysis process.

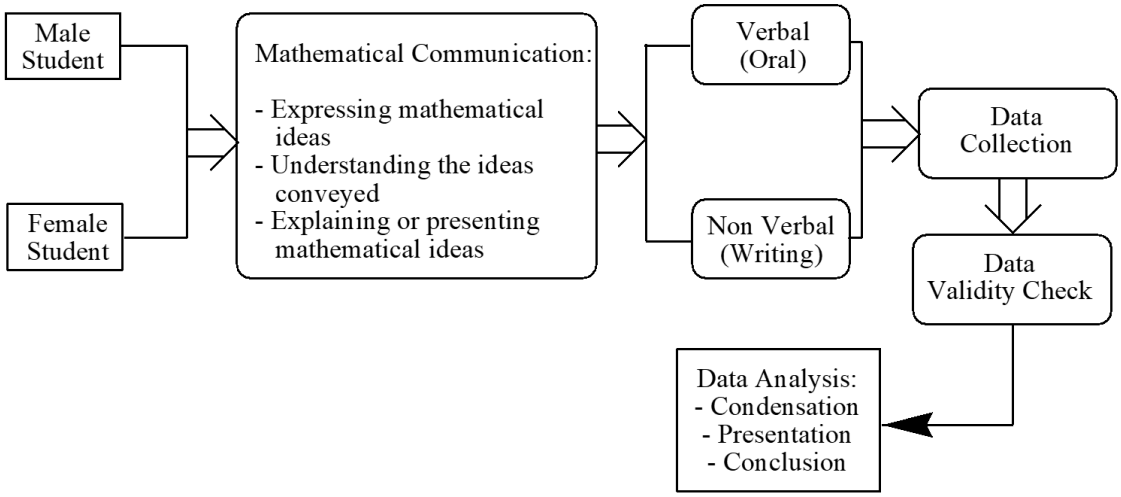

Figure 1. Data Processing Design

RESULTS AND DISCUSSION

Male Students Matematical Communication on Limit Material

Figure 2 shows the results of the test and interview with a male student with low mathematical ability in describing mathematical ideas. The data in Figure 2 shows the analysis of the interview conducted with the student when conveying mathematical concepts verbally. He was able to convey his ideas clearly using clear and concise language. The student explained the concept of limit as an approach, wrote the limit notation correctly, and pronounced it correctly. Furthermore, he put forward several different approaches, He described the left and right limits based on his understanding to demonstrate their relationship. Additionally, he could visually represent ideas using graphs and explain them verbally.

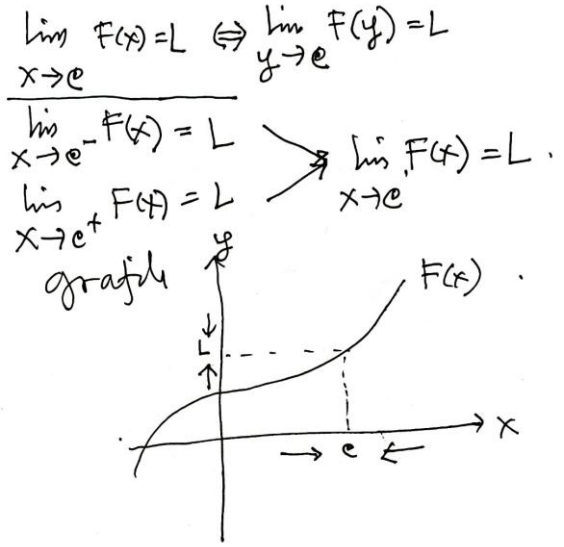

Figure 2. Male students with low mathematics ability's doodles while describing the answer, along with interview excerpts

P-019	Why is that $y \rightarrow c$?
M-020	Because if $f(x)$ we use the x approach and if $f(y)$ we use the y approach
P-025	How does that mean?
M-026	The left limit is the real number from the left and if it is a limit right is the real number to the right of c.
P-039	Try explaining?
M-040	This means all the numbers in x that are close to the number c (while pointing $\rightarrow c \leftarrow$), and if this is the result L of $f(x)$ which has been replaced with the numbers c (while pointing to $\rightarrow L \leftarrow$).

The test results of male students with low mathematical ability in describing mathematical ideas in writing are shown in Figure 3. The figure shows that students are able to express concepts by presenting important points from the limit material. They can also convey their ideas concisely using their own language and supported by appropriate mathematical notation. However, there are difficulties in expressing ideas in writing, which can be seen from the presentation of ideas that are not clear when explaining the characteristics of limits.

Explanation of Mathematical Concepts

Using words to explain mathematical concepts: Figure 2 shows that a male student with limited mathematical competence could accurately and concisely explain the notion of limit orally. He defines the limit as an approximation and correctly uses the notation $\lim_{x \rightarrow c} f(x) = L$. He goes on to explain that limits exist when the two sides' limits are equal and provides examples of limit approximations like $x \rightarrow c$ $x \rightarrow 1$ and $y \rightarrow c$. In this example, the student is describing the real values to the left and right of point c, respectively, as the left and right limits. Extensive observation revealed that the student had no trouble verbalizing his mathematical concepts and could express himself clearly and confidently. The student's ability to convey the concept of limits orally shows that despite his limitations in mathematics, he can communicate his understanding well using verbal language and appropriate mathematical notation. This is in line with the research results of (Rahmawati et al., 2023) which shows that oral communication can be an important tool for students with low mathematical skills to express their understanding, although they may face challenges in written communication.

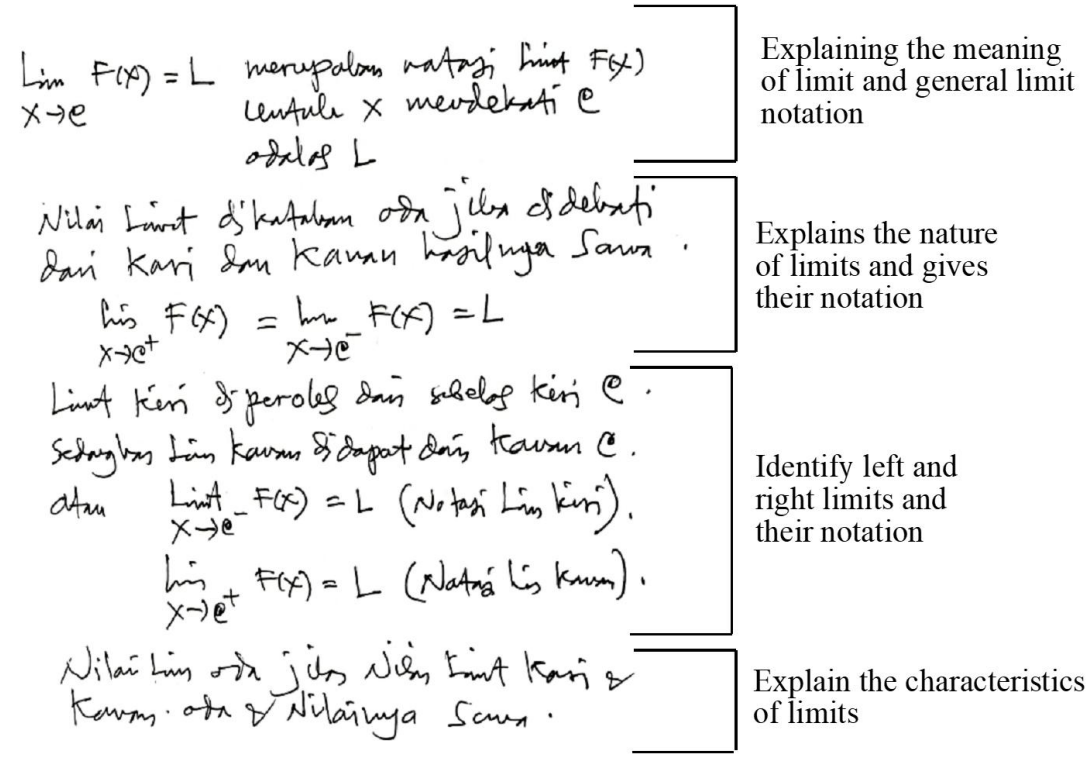

Figure 3. Output of Male students with low mathematics ability's limit material test

Describing mathematical ideas in writing requires the ability to organize information systematically, use clear language, and include appropriate mathematical notation. This can be seen in Figure 3, where students with low mathematical skills describe concepts by presenting important points from the limit material and using their own language briefly. He can also write mathematical notation correctly, such as:

$$\lim_{x \to c^-} f.(x) = L = \lim_{x \to c^+} f.(x).$$

and write the left and right limit notation correctly, namely:

$$\lim_{x \to c^-} f(x) = L \text{ and } \lim_{x \to c^+} f(x) = L$$

However, students have difficulty in describing ideas in writing, which can be seen from the unclear sentence structure and the ambiguous presentation of ideas in describing the characteristics of limits (Figure 3). This shows that although students understand the concept of limits mathematically, they face challenges in expressing their understanding in writing, which is in line with the findings of (Sari et al., 2018). The study stated that students' low ability to change and describe their understanding in writing has an impact on low mathematical communication in written form.

Using mathematical terms also notation and Express mathematical ideas visually in different types. The use of mathematical terms and notation, as well as expressing mathematical ideas visually in different types, is an important aspect of mathematical communication. The results of the study showed that male students with low mathematical abilities had a good understanding of writing limit notation correctly and understood that a limit only exists if the limit values from the left and right are the same. His ability to use mathematical notation correctly is supported by the results of research by Click or tap here to enter text.(Aini et al, 2020), which stated that male students' mathematical communication can use mathematical notation well. In addition, the results of the study also showed that the student was also able to write the concept of limit in the form of a graph, by visually depicting the approach of the value of x to c (Figure 2). His success in compiling the graph shows that he can communicate his mathematical ideas in the form of visual representations, in line with the findings of Paroqi et al. (2020), which stated that male students can state problems in the form of graphs. In addition, this finding is also supported by (Lanya et al., 2020), which emphasizes that graphs are an important communication tool in mathematics. Based on these results, it can be concluded that low-ability male students are able to communicate their mathematical ideas orally well, using clear terms and providing appropriate examples. However, he has difficulty in expressing mathematical ideas in writing, which can be seen from unclear

sentences and corrections in his answers. However, he has a good understanding of the use of mathematical notation and is able to represent concepts in graphical form.

Understanding the ideas presented

Understanding ideas presented in written form. After reviewing the data resulting from the disclosure of limit material and interviews, in understanding the ideas presented, the male student expressed his approach to limits and stated the imit notation correctly, as in the interview:

M-048	Limit is an approximation and is notated like this (pointing $lim_{x \to c}\ f(x) = L$).
P-049	What approach?
M-050	The limit $f(x)$ is where x approaches the variable c is equal to the variable L, and the approach is this one (pointing $x \to c$).
P-051	You said earlier that x approaches the variable c and is equal to the variable L. What are variable c and variable value L dik?
M-052	The variable c is the real value variable on the left and next to it right.
P-053	What about variable L?
M-054	The result of the limit of the function $f(x)$.

The male student understands that $x \to c$ is an approximation with c as the approach point. The male student states that c and L are variables and reveals that the variables are any real numbers (M-052, M-054). This shows that male students cannot use mathematical terms correctly. Thus, it can be concluded that male students are able to convey the meaning of the limit material clearly and confidently. This was confirmed by Kamid et al (2020) that male students' oral communication is not long-winded, has lots of explanations, answers firmly and confidently. Through the process of mathematical communication, researchers learned that male students had misconceptions about the concepts of left limit and right limit and were unable to use the terms variable and substitution correctly. Lee, (2015) and (Ona Sabat et al., 2021) revealed that communication can help develop students' conceptual understanding, problem solving and can help discover and correct misconceptions about mathematical concepts.

Expressing the meaning of ideas presented orally. Male students were able to convey the nature of a limit, namely "*a limit is said to exist if it has the same approximate real function value on the left and right*" as well as the process for finding the approximate value. Next, the male students conveyed their understanding regarding the concepts of left limit and right limit. As in the following interview excerpt:

P-065	OK, what does this mean?
S1-066	A limit is said to exist if it has the same real function value approach from the left and right and is notated like this (pointing $limx \to c^{-}\ f(x) = L = limx \to c^{+}\ f(x)$).
P-067	How does it approach the same value of a real function?
S1-068	Approximate real function values from the left and right sides are the same. Like this, sis, the values of the left limit and right limit, if you have included them in the problem, the results will both be close to the value of L. So, the limit of the function exists if the results L are the same.

Through extended observations it was discovered that the subject had a misconception, the subject stated that the left limit and right limit were only limited to the numbers around point c. Until finally the male student emphasized that the left and right limits have different meanings from approaching real function values from the left and right. Despite having misconceptions, male students were able to show the approach to the left limit and right limit correctly, namely $x \to c^{-}$ and $x \to c^{+}$. The male student was able to convey the characteristics of the limit, namely the value of $f(x)$ approaches L when x approaches c which is defined on the interval containing c except perhaps at c itself. The subject revealed that there is a possibility that the limit value $f(x)$ is not defined at the point c itself and gave an example.

Thus, it can be concluded that male students are able to convey the meaning of the limit material clearly and confidently. This was confirmed by Kamid et al (2020) that male students' oral communication is not long-winded, has lots of explanations, answers firmly and confidently. Through the process of mathematical communication, researchers learned that male students had misconceptions about the concepts of left limit and right limit and were unable to use the terms variable and substitution correctly. Lee, (2015) and (Ona Sabat et al., 2021) revealed that communication can help develop students' conceptual understanding, problem solving and can help discover and correct misconceptions about mathematical concepts.

Describe/display mathematical concepts

Verbalizing mathematical concepts. The mathematical concepts are articulated by the male pupil in a composed manner, utilizing his own language. The male student elucidates the approach to limits and correctly states the limit notation. The male student then elucidated the concept of limits, stating that "a limit is said to exist if it has the same left limit and right limit." He then proceeded to clarify the left limit and right limit one by one. The sentence "the left limit and the right limit are the same" expressed by the male student is understood to refer to the approximate value that is obtained when the numbers around c are substituted for $f(x)$. The substituted real numbers are referred to as the left limit and the right limit. This information is derived from extensive observations. Ultimately, the male student clarified the characteristics of limits, specifically that the limit value of a function may not be defined at the point c alone.

Explaining ideas accompanied by the use of terms and mathematical notation and Explaining ideas by connecting various concepts. During the presentation, male students were unable to use the terms variable and substitution. Male students always start their explanations by writing the concept and limit notations on the blackboard. (Pantaleon et al., 2018 c) found that starting an oral explanation by writing back ideas on the whiteboard is a good thing in communication. Thus it can be concluded that male students are able to explain mathematical ideas verbally quite well, are able to use mathematical notation but are unable to use mathematical terms correctly.

Mathematical Communication of Female Students Regarding Limit Material

Figure 4 displays the outcomes of material assessments and interviews with female students exhibiting inadequate mathematical proficiency in articulating mathematical concepts. Figure 4 indicates that she talks about a topic in a long-winded way and can only use a few symbols, yet she is wrong when she says it out loud. Girls who aren't very good at arithmetic can also use graphs to show their thoughts and explain them, but they aren't as sure of themselves when it comes to explaining what they understand, which has led to a lot of blunders when using math symbols.

Figure 5 shows the outcomes of the female students with low math skills' limited content test when they had to write about math topics. Figure 5 indicates that she can summarize the important parts of the restricted content and use brief words with the right math notation. According to female students who aren't very good at math, the left limit and the appropriate limit are two ways to calculate a function's limit value. This unclear way of saying things reveals that she has trouble putting her thoughts into writing.

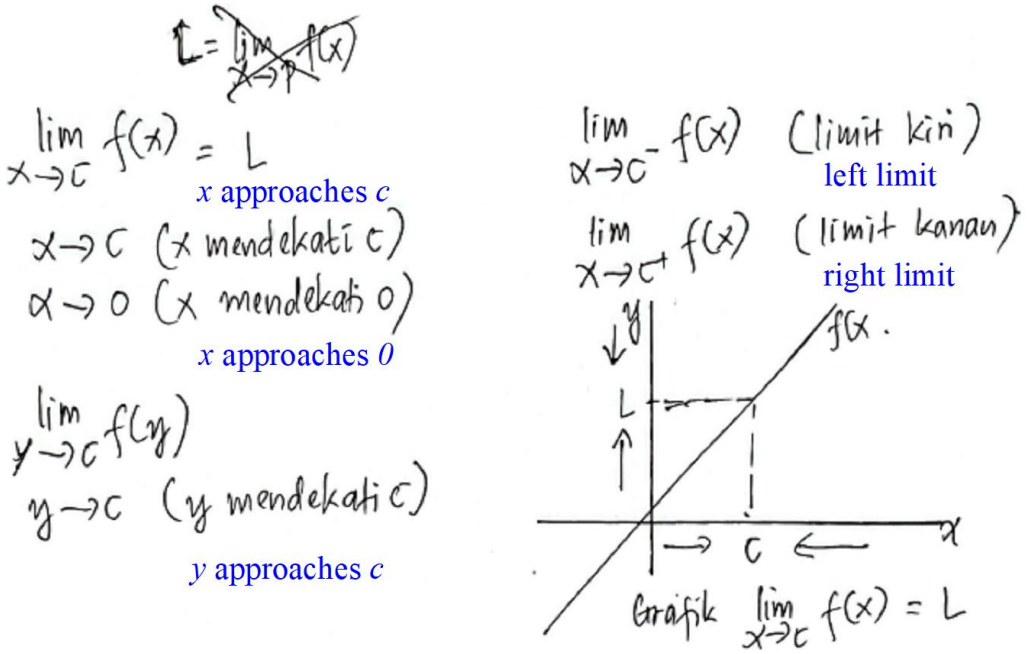

Figure 4. Female students with low mathematics ability's doodles when describing

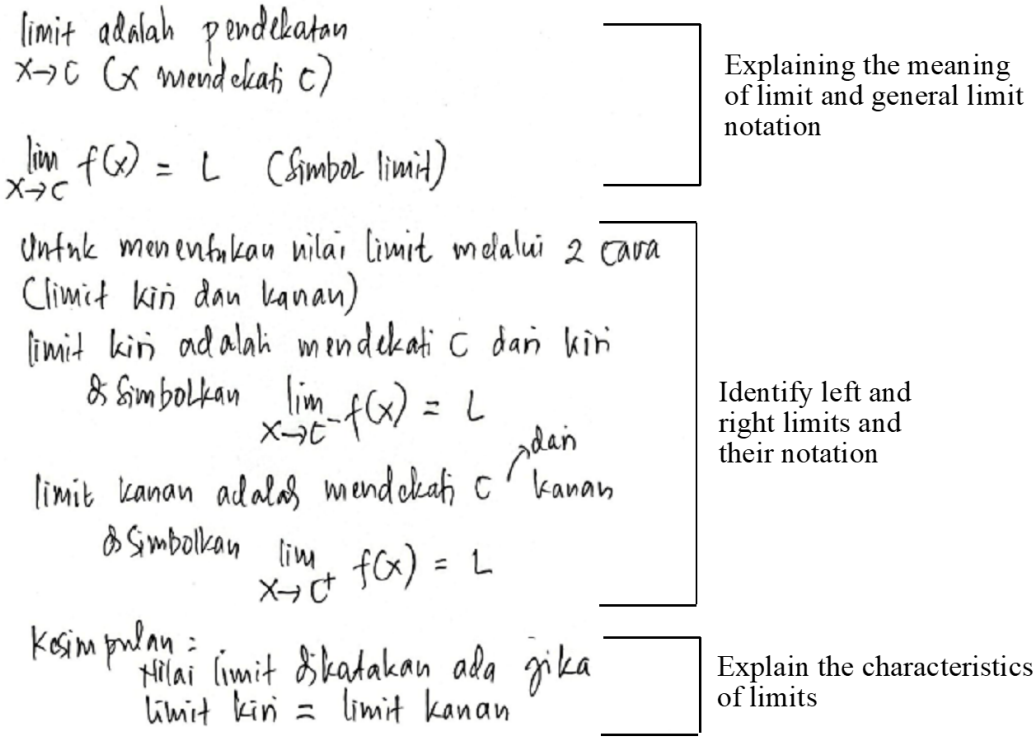

Figure 5. Output of Female students with low mathematics ability's limit material test

Describing Mathematical Ideas

Describing mathematics ideas by speech. The results of the study in Figure 4 show that female students with low mathematical ability express the concept of limit as an approximation at length. She was able to state that $x \to c$ is an approximation to the limit and gave several examples of approximations, such as $x \to 0$ and $y \to 0$. However, in describing the process of finding the left and right limit values orally, she had difficulty expressing her understanding clearly in the interview, as in the following interview excerpt:

P-033 How do you do it?

F-034 To get the value of L, right c to find the value of L of x, x approach c to find L then x approaches the point c and enter it into the function and get L.

Finally, She connects the left and proper limits, namely, "*the limit is said to exist if the left and right limits are the same*." This finding is in line with (Kamid et al., 2020 a), which states that barriers in verbal communication can affect the clarity and accuracy of female students' mathematical ideas. **Describing Mathematical Ideas in Writing.** The results of the study showed that in written communication, the student was able to write limit notation correctly (Figure 5), including $\lim_{x\to c} f(x) = L$, $\lim_{x\to c^-} f(x)$ and $\lim_{x\to c^+} f(x)$. She also presented important points regarding the concept of limits. However, in describing the characteristics of limits in writing, she had difficulty in constructing clear and structured sentences, so that some of the ideas conveyed became ambiguous. This error indicates that although she understood the concept of limits mathematically, she faced challenges in expressing it in written form. This is in accordance with the findings of Pathuddin et al., (2019) and Sari et al., (2018), which stated that students' low ability to change and describe their understanding can have an impact on less effective mathematical communication in writing.

Employing mathematical terminology and symbols. The female student demonstrated a solid understanding of mathematical terms and notations by accurately writing the limit notation. She recognized that a limit is defined by the equality of the limit values approached from both the left and the right. Furthermore, she illustrates $\lim_{x\to c} f(x) = L$ graphically (Figure 4). Mathematics employs graphs, diagrams, symbols, and equations as means of communication (Aini, et al, 2020). Following the extension of the observation, she experienced challenges in articulating her mathematical concepts verbally. The subject exhibited a sense of urgency and lacked confidence, resulting in errors in the application of variables to represent the function $f(y)$. Additionally, the subject incorrectly positioned the x and y axes on the graph $\lim_{x\to c} f(x) = L$ (Figure 4). The student also made an error in pronouncing the notation verbally, which indicates a gap between the symbolic understanding of the concept and the ability to express it in words. However, the subject immediately identified and corrected errors when the researcher asked. This finding is in line with research conducted by (Aini, et al, 2020), stating that male students tend to be more skilled in using mathematical notation verbally than female students. And also the results of research (Kamid et al., 2020 a) which states that the problem of verbal and mathematical communication of female students is less confident. Students who have low self-confidence have difficulty communicating, have difficulty understanding, and solving mathematical problems (Handayani et al., 2025).

Expressing Mathematical Ideas Visually in Various Types. The student was also able to represent the concept of limits in the form of graphs by visually depicting the approach of the $x \to c$ values. However, she made mistakes in determining the positions of the *x* and *y* axes, and in placing the function *f(y)* on the graph $\lim_{x\to c} f(x) = L$. This error shows that although she understands the concept of limits symbolically, she still has difficulty in representing it visually. However, after being asked questions by the researcher, she was able to identify and correct the error. This is in accordance with the research of (Lanya et al., 2020), which emphasizes that graphs are an important communication tool in mathematics, but their use still requires a good understanding of the relationships between variables. In line with these findings, (Fry, 2025) stated that graphs also function as a tool for exploring various data.

In summary, she experiences challenges in articulating mathematical concepts both verbally and in written form. The individual employs ambiguous sentences and demonstrates a lack of confidence in articulating their comprehension. She is capable of employing mathematical notation to graphically represent $\lim_{x\to c} f(x) = L$.

Understanding the Ideas presented

Understanding ideas presented in written form. Female students are not able to convey the limits material which is presented clearly, the subject expresses his understanding in a convoluted way so that it is difficult to understand. The female student first defined the limit as an approximation to the value of c. female students express c as a real number approximated by x and L as the limit value $f(x)$. Female students were unable to convey their understanding regarding the process for finding the limit value $f(x)$, this was shown through the subject's statement during the interview, namely "*I know but I don't know how to say it*".

Expressing the meaning of ideas presented orally and Reveal the relationship of various concepts. Female students try to reveal the nature of limits, namely that a limit is said to exist if it has the same left limit and right limit, so it is necessary to know the value of both first. However, female students

are not able to express their understanding well, this is shown by conveying ideas in a convoluted way, namely "if the left limit and the right limit exist. Eh, the limit is said to exist if the right limit and the left limit are the same. It's like they are close to the same. To know whether they are the same or not, you have to look for both." Through extended observations, it is known that female students are able to understand the concept of limits and the relationship between the left limit and the right limit, female students are able to show the approach to the left limit and right limit, namely $x \to c-$ and $x \to c+$, apart from that, female students are also able to understand that "-" and +" are symbols that indicate the direction of numbers that approach the point c.

Thus, it can be concluded that female students are able to understand the limit material presented in the course but are unable to convey their understanding clearly, the subject expresses his understanding in a convoluted manner and lacks confidence. This is in line with the findings of Kamid et al (2020) that female students' oral mathematical communication tends to be long-winded, answers softly and lacks confidence. In line with that, (Gosselin, 2024) stated that women more often face obstacles in verbal communication, including in expressing ideas clearly and assessing the accuracy of their delivery and analysis, which tend to be inaccurate.

Explain/Present Mathematical Ideas

Explaining mathematical ideas verbally, Explaining ideas accompanied by the use of terms and mathematical notation, and Explaining ideas by connecting various concepts. Female students explain the meaning of function limits by writing on paper as in Figure 6.

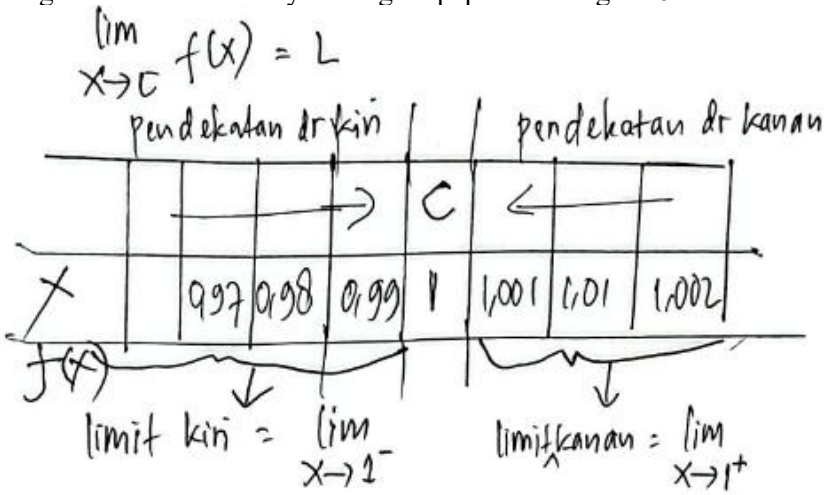

Figure 6 Female students scribble when explaining the limits of the material

The female student first explained the meaning of limit but made a mistake in stating the notation $\lim x \to c\ f(x) = L$. Then the female students explained the concept of left limit and right limit and the process for finding the value of both, until finally explaining the nature of limits. However, the female students were not able to explain this understanding well, the subject expressed his understanding in a complicated and difficult to understand manner. Apart from that, the subject also asked the researcher several times to pause the recording process. Despite these challenges, the female student consistently initiated her explanation by writing limit notations on the blackboard, including the general limit notation ($\lim x \to c\ f(x) = L$), the left limit notation ($\lim x \to c-\ f(x) = L$), and the right limit notation ($\lim x \to c+\ f(x) = L$). in line with the findings of Panteleon et al. (2018) that starting an oral explanation by writing back ideas on the whiteboard is a good thing in communication. In addition, Kersna (2025) emphasized that data can be more easily analyzed and explored with written guidance.

Based on the results and discussion, it can be understood that male and female students with low mathematical abilities can still express their mathematical ideas, but there are differences in characteristics between the two. Male students tend to excel in oral communication and the use of mathematical notation in detail and with confidence. This is in their ability to describe the definition of limits, use notation and determine the left and right limits of a function in detail and compose graphs correctly. Meanwhile, female students show difficulty in conveying ideas in detail and in a structured manner, both verbally, in writing, and in visual representation. This is more due to low self-confidence and difficulty using mathematical language verbally, not because of a lack of understanding of the

material. The results of this study are in accordance with and support the findings of (Rahmawati et al., 2023), (Aini et al., 2020), and (Kamid et al., 2020) which state that male students excel in aspects of mathematical communication, use of notation, and graphic representation. In addition, (Handayani et al., 2025) emphasized that female students with low mathematical abilities tend to be less confident, experience obstacles in verbal communication, and have difficulty understanding and conveying mathematical ideas completely and accurately. Thus, it can be generalized that students with low mathematical abilities still have the potential to understand and convey their mathematical ideas, but different approaches are needed based on their respective characteristics.

These findings provide important implications for teachers and education practitioners, namely the need for more interactive and in-depth learning strategies, as well as paying special attention to female students in conveying ideas verbally, writing mathematical notation, and describing concepts visually. The novelty of this study lies in the detailed and qualitative description of the differences in the mathematical communication process of male and female students on the limit material, especially those with low mathematical abilities, which have not been widely revealed in previous studies. This study also highlights that communication barriers do not only come from cognitive aspects, but also from self-confidence and mastery of mathematical language as a means of expressing ideas. This study has several limitations, including only focusing on one mathematical topic, namely limits, and using interview instruments and written tests that depend on students' ability to express ideas. Recommendations for further research are to conduct a more in-depth study of mathematical communication from other perspectives and high school teachers are expected to design learning by implementing the appropriate approach that fosters students' mathematical communication skills, particularly in oral expression.

CONCLUSION

Students with low mathematics abilities demonstrate distinct patterns of mathematical communication based on gender. This distinction is not evident in written mathematical discourse but holds importance in oral mathematical discourse. Male students can articulate their understanding in verbal and mathematical contexts succinctly and with confidence. Female students demonstrate a complex understanding, exhibit low confidence, and employ sentences that are challenging to comprehend. In written communication, one must present mathematical ideas by intuitively articulating essential points related to the concept of limits, employing correct mathematical notation, and effectively representing ideas visually through graphs. However, neither student was able to present ideas effectively in mathematics. The written presentation of ideas is marked by unclear sentences and sketchy drawings in the results of the material test.

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CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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