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Mathematical Communication Skills of Female Students in Solving Derivative Problems

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Abstract

This study aimed to examine the mathematical communication skills of female students in solving derivative problems in the eleventh grade at SMA Negeri 1 Sigi. The research followed a qualitative approach with a descriptive design. The study sample consisted of three female students selected based on a questionnaire focusing on feminine gender traits. Data were collected through written tests, interviews, and direct observation of the subjects. The dependability and credibility techniques were used to ensure the quality of the research findings. Data analysis involved three stages: data condensation, data presentation, and drawing conclusions. This study contributes to the existing literature by addressing the gap in understanding the mathematical communication skills of students with feminine gender traits, specifically in the context of solving derivative problems. The uniqueness of this study lies in the use of a feminine questionnaire for subject selection and the integration of mathematical language with everyday language and physical gestures in the evaluation of mathematical ideas. The findings revealed that female students with feminine gender traits demonstrated proficiency in all indicators of mathematical communication skills, including: (1) the ability to communicate their mathematical thoughts coherently and clearly to their peers and teachers; (2) effective use of mathematical language, such as numbers, letters, symbols, charts, graphs, and logical connections, in conjunction with everyday language and physical gestures when presenting, solving, and evaluating mathematical ideas during interactions with others; and (3) the capacity to explain mathematical ideas, situations, or relationships in written form. These results suggest that approaches combining mathematical language with physical interaction and everyday language can enhance the effectiveness of mathematical communication. The findings of this research can be utilized as a foundation for developing more inclusive and adaptive teaching strategies that consider gender differences in mathematics education.

Keywords: Mathematical Communication Skills; Derivation; Feminine Gender

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INTRODUCTION

Mathematics is a significant discipline that is taught at all levels of education, ranging from elementary school to college. The study of mathematics not only entails comprehending concepts and theories, but also entails the development of analytical and problem-solving skills. Undoubtedly, mathematics holds immense importance in everyday life, as well as in the realms of academia and the professional world. By engaging in mathematics learning, students are expected to cultivate critical thinking abilities, logical reasoning skills, and systematic approaches, all of which prove invaluable in addressing global challenges across various domains. Consequently, mathematics serves not only as a compulsory subject within the

national education curriculum, but also as a crucial foundation for advancements in science and technology.

As per Baird and Turnbull (1980), communication is a process that involves the transmission and reception of thoughts through symbols to others. Abdulhak and Darmawan (2013) define communication as the act of relaying messages from senders to recipients through specific mediums and with particular intentions. In addition, Triana and Zubainur (2019), along with Xu et al. (2021), state that communication encompasses the exchange of information using language, symbols, diagrams, and artistic forms, requiring proficiency in listening, speaking, reading, and writing as primary means of communication. Based on the viewpoints mentioned above, communication comprises the messageitself, the sender/recipient of the message, and the medium through which the message is conveyed. Through the process of learning mathematics, students are expected to develop coherent and effective mathematical communication skills, both in oral and written forms, which prove invaluable in addressing global challenges across various domains.

Rahmawati (2013) asserts that communication serves as a medium through which teachers and students share the process of learning, comprehending, and engaging in mathematics. The National Council of Teachers of Mathematics emphasizes that, in classrooms where students are encouraged to think critically and logically about mathematics, effective communication becomes an essential aspect, as students express the results of their thoughts through oral and written means. Accordingly, communication poses a challenge for students in the classroom, as they strive to think critically and logically about mathematics, necessitating effective means of expressing their thought processes through oral and written forms (Putri, 2011).According to the National Council of Teachers of Mathematics (2010), one of the objectives of learning mathematics is to develop mathematical communication skills. Communication plays a vital role in the learning process as it enables students to express their ideas effectively, both in written and verbal forms. Pertiwi and Siswono (2021) define mathematical communication ability as the capacity to systematically articulate thoughts using mathematical language, whether through oral or written means. Furthermore, Baroody, as cited in Agus (2018), emphasizes two key reasons for the acquisition of mathematical communication skills. Firstly, mathematics serves as a language in itself, not just as a tool for problem-solving or reasoning, but as a means to convey ideas with clarity, precision, and thoroughness. Secondly, mathematics learning is a social activity, facilitating interaction among students and serving as a communication tool between teachers and students (Umar, 2012).

It is important to note that there are gender differences in mathematical communication. Keitel (1998) states that gender, social, and cultural dimensions significantly influence the conceptualization of mathematics education, implying that these factors shape interactions within the field. Gender, in particular, profoundly impacts students' communication skills, including their ability to think creatively and express ideas. As noted by Nugraha and Pujiastuti (2019), communication styles differ between men and women, leading to variations in problem-solving approaches and understanding.Based on observations conducted at SMA Negeri 1 Sigi and interviews with mathematics teachers, it was found that there are differences in the mathematical communication of male and female students. These differences primarily manifest in listening, reading, and writing. However, the specific nature of these differences has not been thoroughly examined, and the prevailing tendencies remain uncertain. Moreover, it is evident that students' mathematical communication skills are not yet optimal, largely due to their lack of curiosity towards new ideas. Many students passively engage in learning, simply sitting, remaining quiet, and taking notes, with only a few actively participating. Teachers report that most students are hesitant and passive in expressing their mathematical ideas. Gender differences may play a role in students' thinking processes, including their communication skills during learning (Sadikin & Andi, 2019). Consequently, it is possible that there are differences in mathematical communication skills within each gender group. This

research paper focuses specifically on the mathematical communication of the feminine gender group.

The purpose of this study is to examine the profile of female students' mathematical communication skills in derivative problem-solving. The research aims to understand the extent to which female students with feminine characteristics can effectively convey their understanding of derivative concepts through mathematical communication. Furthermore, the study aims to analyze the factors that either facilitate or hinder their mathematical communication abilities, and to identify effective learning strategies that can enhance these abilities. The findings of this study are anticipated to contribute to the development of more inclusive and effective teaching methods in mathematics education, particularly in the teaching of derivative concepts.

In summary, this research focuses on exploring and understanding the mathematical communication skills of female students, with the overall goal of improving mathematics education by fostering inclusive and effective teaching practices.Mathematical communication encompasses the expression and interpretation of mathematical concepts through various mediums such as oral and written language, visual aids like pictures, diagrams, tables, formulas, and demonstrations (Prayitno et al., 2013). According to Ahmad (2019: 19), mathematical communication refers to students' proficiency in conveying their mathematical ideas using oral, written, and visual methods, including drawings, diagrams, real-life objects, algebraic expressions, and mathematical symbols.

Teachers typically categorize mathematical communication into four domains: verbal communication, which includes speaking and listening; listening, which involves comprehending mathematical ideas through reading; and written communication, which encompasses writing assignments (Utari et al., 2020; Tong et al., 2021).

Kennedy and Tipps (1994) state that mathematical communication skills entail three key elements: (1) the use of appropriate mathematical language in oral, written, or visual forms; (2) the utilization of mathematical representations in written or visual formats; and (3) the ability to present ideas clearly, including interpreting mathematical concepts, expressing them using precise mathematical terms and notations, and describing mathematical relationships or problem-solving approaches. The study employs specific mathematical communication indicators, which are outlined in Table 1.

Table 1. Indicators of mathematical communication ability

No	Indicator of mathematical communication		Code
1	Communicates his/her mathematical thinking coherently and clearly to his/her peers and teacher.	Students can mention the question information with their own language	D1S1
		Other students can repeat their friend's explanation	D1S2
		Students can mention or write the reason for each step of solving the problem	D1S3
2	Use mathematical language effectively in combination with common language or physical gestures when presenting, solving, and evaluating mathematical ideas in interactions with others.	The subject can read the symbols in the problem correctly.	D2S1
		The subject can write limit notation	D2S2
		The subject can explain the meaning of the graph in the picture.	D2S3
		Other subjects can re-explain	D2S4
		The subject can provide ideas to solve the problem	D2S5
		Using mathematical language	D2S6

No	Indicator of mathematical communication		Code
3	Ability to explain mathematical ideas, situations or relationships in writing.	The subject listened when his friend explained.	D3S1
		The subject can make a conclusion from solving the problem.	D3S2

Gender

According to Caplin (1987), gender is a behavioral difference between men and women that goes beyond biological structure and is mostly shaped by social and cultural processes. In the field of social science, gender is defined as the pattern of relations between men and women based on their social characteristics. It encompasses the characteristics that differentiate masculinity and femininity in an individual, including their sex (male, female), social structures influenced by sex (such as gender roles), and gender identity. Psychological differences in student learning can arise from differences in gender. Therefore, male and female students are likely to exhibit distinct variations in learning mathematics (Nugraha & Pujiastuti, 2019). As stated by Fitriani & Nurfauziah (2019), women and men display diversity in problem-solving, including mathematical abstraction.

According to Baron (2000; 188), gender is a component of self-concept that involves an individual's identification as a man or a woman. Furthermore, Santrock (2003: 365) suggests that the terms gender and sex differ in their dimensions. Sex (gender) refers to the biological dimension of being male or female, whereas gender refers to the social-cultural dimension of being a man or a woman. Additionally, gender encompasses the social characteristics and traits associated with men and women. These attributes and traits are not solely based on biological differences but also on social and cultural interpretations of masculinity and femininity.

Sandra Bem (1974) identifies various gender identities, including masculine, feminine, and androgynous. Gender identity comprises aspects of personal appearance and behavior that are culturally influenced and not strictly masculine or feminine. Gender can be categorized into four types: masculine, feminine, androgynous, and undifferentiated (Miler et al., 2009). Individuals with a masculine gender identity possess traits commonly associated with men, such as strength, independence, competitiveness, and emotional reserve. On the other hand, individuals with a feminine gender identity exhibit characteristics typically associated with women, such as nurturing behavior, emotional expressiveness, politeness, and helpfulness (Helgeson, 2012). The androgynous gender identity represents an integration of both masculine and feminine qualities. Androgyny is considered to be associated with high levels of psychological functioning as it allows for adaptability in various social situations. In contrast, those referred to as undifferentiated have a self-concept that does not conform to or acknowledge cultural definitions of appropriate gender behavior (Miler et al., 2009).

According to Gallagher & Kaufman (2004), the relationship between gender and math performance has been extensively studied in psychology and education. The term gender originates from the Latin word "genus," which means type or kind. It encompasses the traits and behaviors associated with men and women that are shaped by social and cultural influences. As gender is influenced by local social culture, its manifestations are not fixed and may vary depending on the prevailing trends and societal norms.

METHOD

This research utilizes qualitative research methods with a descriptive approach. The participants in this study consisted of three individuals. The selection of participants was determined using a gender questionnaire, which was measured using a tool called the BSRI (Bem Sex Role Inventory). The primary instrument used in this study was the researcher themselves (human instrument), who acted as an observer, interviewer, and data collector. Supporting instruments included interview guidelines and written task sheets that were prepared based on the mathematical communication indicators utilized in this study. To

enhance data credibility, time triangulation was employed, combining two methods: focus group discussions (FGD) and presenting two limit function problems to deepen the findings. Moreover, data credibility was ensured by applying the converging data criteria to establish consistent meaning. The data analysis technique employed in this research followed the model by Miles et al. (2014). The data analysis activities encompassed data condensation, data display, and conclusion drawing/verification.

The data analysis process in qualitative research involves three primary stages: data condensation, data presentation, and conclusion drawing and verification. Data condensation entails selecting, simplifying, and transforming information from field notes, interview transcripts, and other relevant documents in order to ensure the relevance and accessibility of the collected data. Data presentation serves to organize and structure the data into patterns that facilitate analysis and conclusion making, typically in the form of narrative text. Finally, once the data has been condensed and presented, conclusion drawing and verification take place. During this stage, the researcher analyzes the data to draw conclusions, which are subsequently verified to ensure the accuracy and relevance of the research findings. Additionally, the Feminine gender group was assigned a derivative task, as depicted in Figure 1.

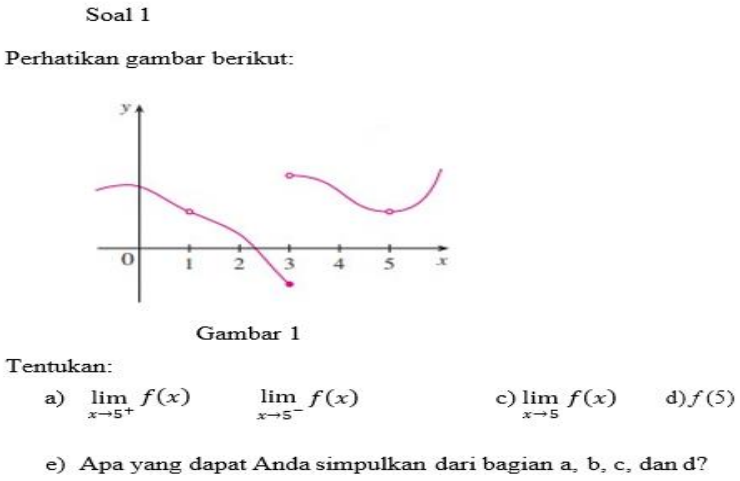


Figure 1. Derivative Task

The derivative problem illustrated above was designed to assess students' mathematical communication skills by evaluating their problem-solving approach through communication.

RESULTS AND DISCUSSION

The subjects in this study were three students of class XI MIPA 3, SMA Negeri 1 Sigi. The selection of these subjects was based on the results of the gender questionnaire analysis. Based on the questionnaire results, three subjects with feminine gender were selected. The data of students who were used as subjects in this study can be seen in Table 2.

Table 2 Research Subject

No	Subject Code	Category
1	UK	*Feminine*
2	FHR	*Feminine*
3	N	*Feminine*

Mathematical Communication Profile of Students based on Feminine Gender Group in solving Derivative Problems.

Her Mathematical Thinking Coherently and Clearly to Her Friends and Teacher

Based on the results of the discussion of the feminine gender group subject, it can be seen that the subject explains the information contained in the problem. Furthermore, other subjects

can also explain the information contained in the problem. the following discussion transcript in Table 3. convey the steps of the derivative problem clearly and structurally, and provide a clear and structured explanation.

Table 3. Transcript of discussion of Feminine gender group students on indicator 1

RDO	:	Can you please explain the problem? And why is the result 1	
UK	:	in part a, lim x approaches 5 positive f(x) equals 1, because the limit approach from the right is positive, then he is at 1.	D1S1
RDO	:	the a part is why the result is 1	
FHR	:	Because the approach is from the right and on the graph is at 1	D1S2
RDO	:	How to solve the problem?	
UK	:	in part a, lim x approaches 5 positive f(x) equals 1, because the limit approach from the right is positive, then he is at 1. If part b is the opposite, so why did he get 1 also because the approach from the left is negative and is also at 1. From the graph, why is the result the same as 1 because on the graph of the limit of x to 5 from the right and left both results are 1. So, f(5) is undefined because on the graph the roundabout is not full and open so f(5) is undefined.	D1S3

From the results of the discussion, the subject of the Feminine gender group explained all the information contained in the picture, determining the limit value, determining the value of the function. Furthermore, they said, to determine the limit, you can pay attention to the roundabout and the graph. Feminine gender group subjects can mention problem information in their own language, other students can repeat their friends' explanations and can mention or write the reasons for each step of solving the problem This is in line with Ansari's opinion (2012) which states the indicators of mathematical communication skills, namely: 1) drawing/drawing, namely reflecting real objects, images and diagrams into mathematical ideas and vice versa, namely from mathematical ideas into the form of images or diagrams, 2) mathematical expression/mathematical expression, namely expressing mathematical concepts by stating everyday events in mathematical language or symbols. and 3) writing/written text, and 3) writing/written text, namely expressing answers in their own language, modeling situations or problems using oral, written, graphic, and algebraic language, explaining, and making questions about mathematics that have been learned, listening, then discussing, and writing about mathematics, then making conjectures, composing arguments, and generalizations. In this case the subject has communicated his mathematical thinking coherently and clearly to his friends and the teacher.

Use mathematical language effectively in combination with common language or physical gestures when presenting, solving, and evaluating mathematical ideas in interactions with others.

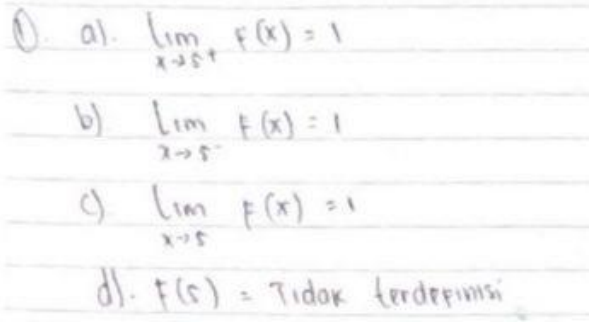
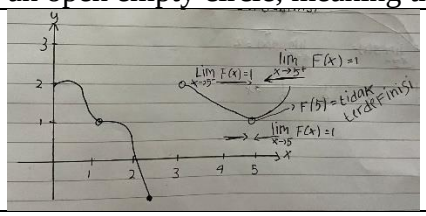
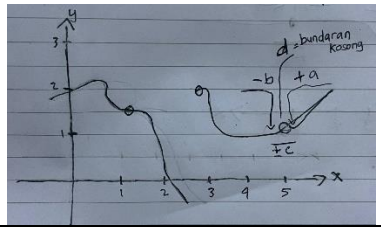
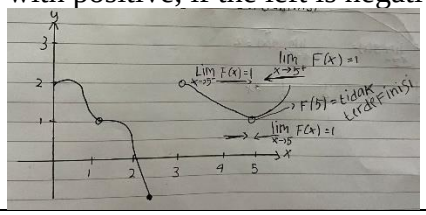


Figure 2. Written Test Results of Feminine Gender Group Students

Based on Figure 2 of the written test answers of Feminine gender group students, it can be seen that Feminine gender group students can write limit notation, by writing down from each part of the problem.

Table 4. Transcript of student discussion Using mathematical language (numbers, letters, symbols, charts, graphs, logical connections)

RDO	:	Can you please explain the symbols?	
UK	:	The first is a symbol in the form of zero or the letter o, which is an open empty circle, meaning that the value is undefined.	D2S1
N	:		D2S2
RDO	:	Please explain what you understand about the graph in the problem?	
FHR	:	right, if you look at the problem and the picture a,b,c, the value of a is the approach from the right marked with positive, while the approach from the left is marked with negative and the result is one. 	D2S3
RDO	:	Did N understand, please explain again!	
N	:	So the empty symbol is an empty or open roundabout so the value is undefined and if the approach from the right is marked with positive, if the left is negative 	D2S4
RDO	:	How about part C?	
UK	:	From the graph, why is the result the same as 1 because on the limit graph x goes to 5 from the right and left both results are 1.	D2S5
UK	:	So, f(5) is undefined because the roundabout graph is not full and open so f(5) is undefined.	D2S6

Based on the results of the discussion in Table 3. it can be seen that the subject uses mathematical language in solving problems They also use effective mathematical language is very important. It can be seen that this subject uses various mathematical elements such as numbers, letters, symbols, diagrams, and graphs to present mathematical ideas but in explaining and writing the meaning of graphic images. In line with the opinion according to Xu, et al (2021) communication is the process of receiving and conveying through language, symbols, diagrams, and artistic forms, which requires hearing, speaking, reading, and writing as the main means. Based on some of the above opinions, communication is the message, the carrier / recipient of the message, and the media to convey the message. And according to Ramdani, (2012) mathematical communication includes the ability of students: (1) connect real

objects, images, and diagrams into mathematical ideas, (2) Explain mathematical ideas, situations, and relationships orally or in writing with real objects, images, graphs and algebra, (3) State daily events in mathematical language or symbols, Listen, discuss, and write about mathematics, (4) Read with understanding or written mathematical presentations. (5) Making conjectures, constructing arguments, formulating definitions and generalizations, and (6) Explaining and making questions about mathematics that have been learned. In this case the subject is able to use mathematical language effectively combined with common language or physical movements when presenting, solving, and evaluating mathematical ideas in interactions with others.

Explaining Mathematical Ideas, Situations or Relationships in Writing

Based on the results of the discussion, the subject wrote as in Figure 3.

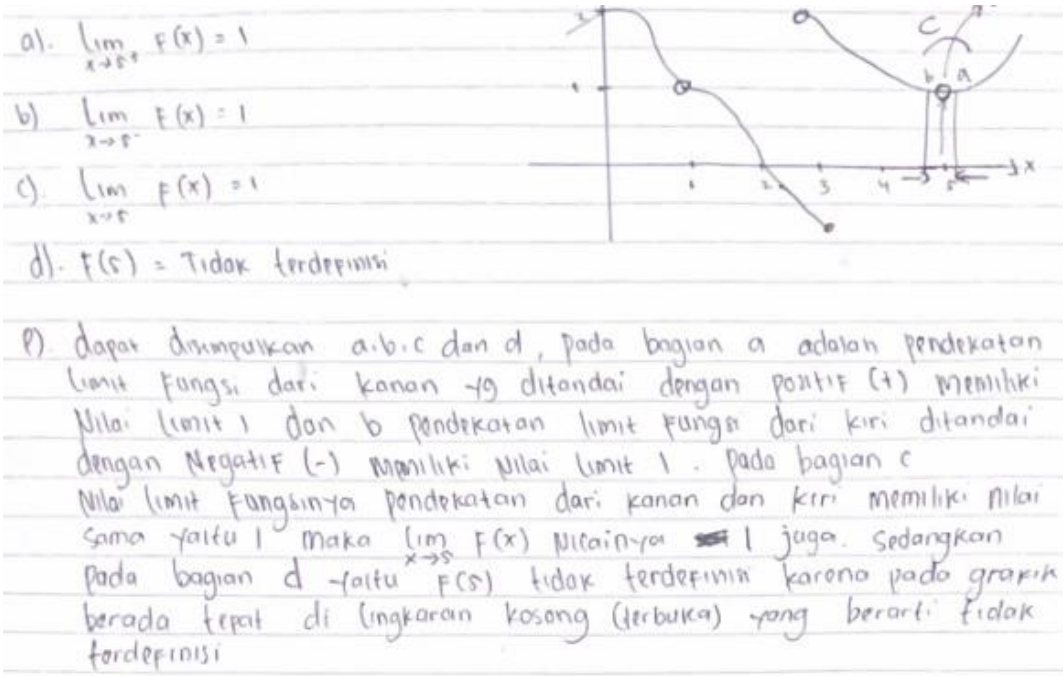


Figure 3. Discussion Results Feminine gender students in explaining mathematical ideas, situations or relationships

Based on Figure 3 written test answers, it can be seen that feminine gender students can explain mathematical ideas, situations, or relationships in writing, feminine gender students use the limit function approach from the right which is marked with positive (+) for a limit value of 1, and from the left with negative (-) for a limit value of 1. If the limit value of the function approach from the right and left is the same (1), then the value of f(x) when x approaches 5 is also 1. However, if f(5) is undefined, it means that on the graph f(x) is right in the empty (open) circle, indicating that the value has no definition.

Researchers conducted discussions with feminine gender students to obtain further information. The following are transcripts of researchers' discussions with feminine gender students in explaining mathematical ideas, situations or relationships in writing.

Table 5. Transcript of Subject Discussion Explaining Mathematical Ideas, Situations or Relationships in a Mathematical Way

Initials	Questions and Answers	Code
UK	In part a, lim x approaches 5 positive f(x) equals 1, because the limit approach from the right is positive, then he is at 1.	D3S2
RDO	So the result is 1 right, what about part B?	
UK	If part b is the opposite, so why did he get 1 also because the approach from the left is negative and is at number 1 as well	

Initials	Questions and Answers	Code
RDO	Then the C part?	
UK	From the graph, why is the result the same as 1 because on the limit graph x goes to 5 from the right and left both results are 1.	
RDO	So F(5)?	
UK	So, f(5) is undefined because the roundabout graph is not full and open so f(5) is undefined.	

Based on the results of the discussion, it can be seen that the subject can clearly describe the mathematical concepts that are the focus, including the steps for solving them. The subject uses appropriate and consistent mathematical notation, such as symbols, formulas, and diagrams, to present mathematical ideas well. Thus, the subject's ability to explain mathematical ideas, situations, or relationships in writing.

Based on the results of the written test and the results of the discussion in table 4, it can be seen that the subject listens when his friend explains and the subject can make conclusions from solving the problem. This is in line with Ahmad's opinion (2019) that defines mathematical communication as the ability of students to convey their mathematical ideas either orally, in writing, drawings, diagrams, using real objects, presenting in algebraic form or using mathematical symbols. In this case the subject has been able to explain mathematical ideas, situations or relationships in writing.

Students with feminine gender can meet all indicators of mathematical communication with good abilities in constructing clear arguments, using symbols appropriately, and integrating feedback from teachers to improve their understanding and explanations in the context of mathematics. This is in line with research conducted by Nugraha & Pujiastuti (2019) which states that female students with feminine gender can meet all indicators that are the reference for the study. This shows that the students' mathematical communication skills are very good.

Good mathematical communication skills in students with feminine gender can be caused by several factors. First, many feminine students tend to have better verbal skills compared to masculine students. These verbal skills allow them to formulate and convey mathematical ideas more effectively. Secondly, feminine students are often more meticulous and detailed in their work, which helps them to construct more comprehensive and logical mathematical arguments and solutions.

In addition, the social environment also plays an important role in developing feminine students' mathematical communication skills. Support from teachers, family and peers can increase their confidence in communicating. Feminine students who are encouraged to speak and discuss actively in their educational environment tend to develop better communication skills. With a supportive environment and opportunities to participate in math discussions, feminine students can continue to hone their skills and achieve higher levels of achievement.

The collaborative learning culture that is often implemented in education also provides great benefits for feminine students. They tend to be more comfortable working in groups and sharing their thoughts with others. In this collaborative setting, they learn to articulate their ideas, listen to others' perspectives, and construct strong arguments. All these factors contribute to the development of superior mathematical communication skills in feminine gender students.

CONCLUSION

Based on the results of the study, it can be concluded that students with feminine gender can fulfill all the indicators used in this study. Therefore, it can be concluded that students with feminine gender have good mathematical communication skills indicated by all subjects with feminine gender who are able to fulfill all indicators of this study. This is because there are many factors that influence the mathematical communication skills of students with feminine

gender such as verbal ability, social environment, and a good learning culture. Recommendations for further research include exploring the factors that influence students' mathematical communication skills.

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