Students’ mathematical communication skills of the straight line equation based on gender in junior high school

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Abstract. Communication is a way for someone to convey an idea or support for a particular purpose; this is very important in the field of education. Mathematical communication is one of the abilities recommended by the National Council of Teachers Mathematics (NCTM). Besides, gender also plays a role in a person's mathematical communication skills. This research type was descriptive qualitative. Data were obtained from 26 students at MTs Al-Qomar Kepung with different student abilities. Data were taken using the test and interview methods. The results of mathematical communication skills showed that females to draw straight-line competency graphs at 64.58%, while the male has lower abilities at 47.32%. Symbols of the ability of students in math problems by 63.54%, while the ability of male students is 66.96%. The ability to make guesses in challenges to female students was 71.88%, while the ability of male students was lower at 66.07%. Female students improve mathematical communication skills higher than male in the straight line of equation material, to improve students’ communication skills, male students need help and often do math problem exercises.

1. Introduction
Humans are social creatures who cannot live individually, and this is needed for humans to communicate with each other [1]. Communication occurs in every activity, both within the school environment and outside the school environment. Whereas in the school environment communication is widely used in the learning process. Besides, communication is one of the learning objectives formulated by the 2006 Minister of National Education Regulation in five primary standards, including problem-solving, reasoning, communication, connection, and representation [2, 10]. Mathematics is one of the abilities recommended by the National Council of Teachers of Mathematics (NCTM). Through mathematical communication, students can learn mathematical patterns and mathematical ideas [2]. Communication is often referred to as 21st Century skills [17]. Communication is the process of transmitting information, ideas, emotions, abilities through symbols, words, images, numbers, and others [18].

Mathematical communication is the main capital of students in formulating mathematical concepts and strategies [5]. Besides, mathematical communication is a prerequisite for solving problems [6]. Mathematical communication skills can be in the form of oral and written. Mathematical communication in oral form, for example, can be seen when students express ideas or thoughts about mathematics to friends or teachers in class. Meanwhile, mathematical communication in the form of writing can be seen when students can make tables, pictures, diagrams, or mathematical symbols, which he stated in writing about mathematical problems [19]. Mathematics becomes an important skill
and must be mastered well by students [7]. Need indicators are needed to measure mathematical communication skills [3].

However, in reality, students’ mathematical communication skills are still not as expected. The lack of students’ mathematical communication skills becomes a significant problem that requires attention and a solution. Several studies show that students’ mathematical communication skills in Indonesia are still poor [7]. Some studies have found that students are not able to answer the questions asked. Besides, students still have weaknesses in using mathematical symbols/notations appropriately and have not been able to provide visual representations that contain known images or graphics [14, 19, 20].

Mathematics learning in class VIII includes algebraic groups, namely factoring, relations and functions, and straight-line equations. Algebra is the gateway to Mathematics [15]. Algebra is a language that allows classification and symbols that can improve a child’s ability to communicate about challenges and mathematics itself [16]. Therefore mathematics communication becomes an ability that needs to be developed by junior high school students to achieve maximum learning outcomes through knowledge resources.

The knowledge aspect is one of the innate aspects of males and females, which can be changed according to time travel [9]. Some researchers believe the facts about gender differences (male and female differences) in mathematics due to biological differences in the brains of males and females are understood through observation. In general, females are superior in languages and writing, while males are superior in mathematics because of their better abilities [8, 11]. On the other hand, some claim that there are no male or female gender roles that outperform each other in mathematics, but it turns out that females can be superior in mathematics [9]. Gender in education is rarely discussed. Knowledge about gender can help the division of roles by reality in society [12]. Previous research has shown that males are more successful in learning mathematics than females [21]. But according to Lubieneksi, girls are believed to have the ability to learn mathematics better than boys [22].

Although there are gender differences in science, technology, and mathematics education (STME) in general, discussions that bridge the gender grouping are one way to improve human development. Therefore male and female students need the same assistance and policies [13].

This study aims to analyze how the mathematical communication skills of junior high school students based on gender in the material of straight-line equations.

### 2. Method

This research is a qualitative study using qualitative descriptive methods. The research subjects in this study were four ninth-grade students, selected using purposive sampling taken from 26 students and based on gender, male and female. This study describes the results of the survey descriptively based on the results of the written test essay which was modified from multiple-choice questions on the material of straight line of equations, in this case, students have studied the material of straight line of equations in eighth grade. The researcher also conducted interviews with students to reinforce the results of the analysis. To verify the data using the method triangulation method. As for the scoring guidelines for mathematical communication skills, researchers modified the mathematical communication ability indicators that were taken from Tiffany [2] and Rahmy [4], which are presented in Table 1.

| Mathematics Communication Skill Indicator | Aspect of Communication | Score |
|------------------------------------------|-------------------------|-------|
| Draw or explain mathematical ideas in writing | Do not answer            | 0     |
|                                           | Can paint pictures, diagrams, graphs, and tables but incomplete and incorrect | 1     |
|                                           | Can paint pictures, diagrams, graphs, and tables to complete but not good | 2     |
|                                           | Can paint pictures, diagrams, graphs, and tables with | 3     |
3. Results and Discussion

3.1 Results
The modified mathematical communication ability indicator [2, 4] has three indicators: Draw or explain mathematical ideas in writing, mathematical expressions or express the situation into the language of mathematical symbols and arrange the conjecture, argument, or formulating generalization definition. Based on mathematical communication skills in research subjects using written tests, the results can be seen in Figure 1.

![Figure 1](image_url)

Figure 1. Percentage mathematical communications skills based on gender
Figure 1 shows the acquisition of mathematical communication ability scores by gender. In Figure 1 it can be seen that the indicators draw or explain mathematical ideas in writing, male students get lower scores than female students with a difference of 23.51%. This means that the ability of male students to draw graphs or explain mathematical ideas in written form is still low. On indicators of mathematical expressions or express the situation into the language or mathematical symbols, male students get lower scores than female students with a difference of 5.76%. This means that the ability of male students to use appropriate mathematical language or symbols is still low. While the indicators make conjecture or formulating generalization definition, male students also get lower scores than female students with a difference of 17.42%. This means that the ability of male students to make conjecture to solve a problem is still low.

3.1.1 Mathematical communication skills analysis of the subject's male 1 (M1)

M1 gets the highest score from the other male subjects. Figure 2 shows that male students are unable to draw graphs because no graphs are found on the results of students' answers; students are only able to make tables. Male students can write mathematical symbols but are incomplete and incorrect. Male students can make guesses correctly but are incomplete.

Based on interviews with male students, it was concluded that male students were not able to draw graphs because the subject did not understand the purpose of the graph; therefore the subject found it difficult to draw graphs, subjects were only able to make tables. Male students can write mathematical symbols but are incomplete and incorrect. The subject does not provide examples of $x$ and $y$. Male students can make allegations to solve the problem, but the allegations that are written are incomplete and incorrect; this is proven in the formula used is appropriate, but at the completion stage, there is an error in the process.

3.1.2 Mathematical communication skills analysis of the subject's male 2 (M2)

M1 gets the highest score from the other male subjects. Figure 2 shows that male students are unable to draw graphs because no graphs are found on the results of students' answers; students are only able to make tables. Male students can write mathematical symbols but are incomplete and incorrect. Male students can make guesses correctly but are incomplete.

Based on interviews with male students, it was concluded that male students were not able to draw graphs because the subject did not understand the purpose of the graph; therefore the subject found it difficult to draw graphs, subjects were only able to make tables. Male students can write mathematical symbols but are incomplete and incorrect. The subject does not provide examples of $x$ and $y$. Male students can make allegations to solve the problem, but the allegations that are written are incomplete and incorrect; this is proven in the formula used is appropriate, but at the completion stage, there is an error in the process.
M2 gets the lowest score of the other male subjects. Figure 3 shows that male students were unable to draw graphs because no graphs were found in the results of students' answers. Male students can write mathematical symbols, but they are incomplete and incorrect. Male students can make guesses, but the allegations made are incomplete and incorrect. Based on interviews with male students, it was concluded that male students were unable to draw graphs because the subject did not understand the purpose of the graph, so the subject found it difficult to draw graphs. Male students can write mathematical symbols but are incomplete and incorrect, such as the use of the symbols $\bar{V}$ and do not explain the purpose of the symbols. Male students can make allegations to solve the problem, but the allegations that are written are incomplete and incorrect. It is proved that the formula used is not suitable for solving problems.

3.1.3 Mathematical communication skills analysis of the subject's female 1 (F1)

F1 gets the highest score from another female subject. Figure 4 shows that female students are able to draw graphs of the problems that occur. Female students are able to write symbols entirely and correctly. Female students are able to provide guesses and formulate definitions to solve problems completely and correctly. Based on interviews with female students, it was concluded that female students understood about graphs. As seen in the graphs that were described, there was information for each axis. Female students are able to write mathematical symbols completely and correctly. These students write their symbols systematically. Female students are able to make guesses in solving problems completely and correctly; this is seen in the formulas used to the completion and conclusion stages.

\[
\begin{align*}
 & x_1 \cdot x_1 \cdot x_2 \cdot x_2 \\
 & (1,10) (5,50) \\
 & y - 10 = x - 1 \\
 & \frac{50 - 10}{y - 10} = \frac{5}{x - 1} \\
 & 4(y - 10) = 40(x - 1) \\
 & 4y - 40 = 40x - 40 \\
 & 4y = 40x - 40 + 40 \\
 & 4y = 40x + 4 \\
 & y = 10x \\
 & y = 10(1.1) \\
 & y = 110
\end{align*}
\]

So, the long distance traveled by the car is 110 hour.

**Figure 4.** The answer to subject F1
3.1.4 Mathematical communication skills analysis of the subject’s female 2 (F2)

\[
\begin{align*}
\frac{y - y_1}{y_2 - y_1} &= \frac{x - x_1}{x_2 - x_1} = (1,10)(5,50) \\
\frac{y - 10}{y - 10} &= \frac{x - 1}{x - 1} \\
\frac{50 - 10}{5 - 1} &= \frac{40}{4} \\
\frac{4(y - 10)}{4y - 40} &= 40(x - 1) \\
4y - 40 &= 40x - 40 \\
4y &= 40x \\
\frac{4y}{4} &= 10x \\
\frac{110}{4} &= y \\
\frac{y}{4} &= 10x \\
\frac{110}{4} &= y \\
\end{align*}
\]

So, the long distance traveled by the car is 110,000 km/ hour.

**Figure 5.** The answer to subject F2

F2 obtained the lowest score of the other female subjects. Figure 5 shows that female students are unable to draw graphs of the problems that occur. Female students are able to write symbols correctly but are not very good. Female students are able to provide guesses and formulate definitions to solve problems correctly but are incomplete.

Based on interviews with female students, it was concluded that female students did not understand graphs so students could not draw graphs on the results of their completion. Female students are able to write mathematical symbols correctly, but some do not match the symbols used as there are two equal signs “=” in each line, in addition to the \(x\) variable that remains when there is a variable value. Female students are able to make guesses in solving problems completely but not well because when drawing conclusions, the students change the answers that have been done, so the results obtained are wrong.

3.2 Discussion

Based on the descriptions that have been obtained from the highest and lowest scores in each gender, female students have higher mathematical communication skills than male students. In indicator, the draw or explain mathematical ideas in writing, the subjects M2 and F2 are not able to draw graphs. For the subject, M1 is also not able to draw graphs but he makes tables because they don’t understand about making graphs. While the subject of F1 can draw graphics well because she already understands how to make graphics.

In indicator mathematical expressions or express the situation into the language of mathematical symbols, subjects M1 and M2 make the same type of error. They do not provide examples of the variables used because they are not able to understand the problem well. For the subject, F2 can express ideas using mathematical symbols, but there are two equal signs "=" written on each line, this is because students are accustomed to writing signs equal to "=" at the beginning of a mathematical sentence. In addition, subject F2 does not eliminate variable \(x\) when it has to multiply by the value requested in the question, whereas F1 subjects can express mathematical ideas completely and correctly and also systematically.

In indicators that make conjecture or formulating generalization definition, subjects M1 and M2 make the same type of error. They cannot make arguments that fit the problem because they are confused about what is known in the material. For the subject, F2 is able to make arguments correctly, but when writing conclusions, the subject writes answers that are different from the results of the solution. This is because students are not careful in writing the results at the conclusion. Whereas subjects F1 are able to make arguments well in solving the problems presented.

Based on the results of the analysis above, on the draw or explain mathematical ideas in writing
indicators female students scored higher than male students. This means that female students are better able to draw or explain a problem using graphics than male students. In the indicators of mathematical expressions or expresses the situation into the language of mathematical symbols, female students get higher scores than male students, but the difference is only slight. This means that the ability of female students and male students is almost the same in expressing mathematical situations into mathematical symbols/languages. While in the indicator make conjecture or formulating generalization definition, female students get higher grades than male students, meaning that the ability of female students to make arguments to solve problems is better than the ability of male students.

Overall mathematical communication skills of female students are higher than male students. This is in line with research which states that women are believed to have the ability to study mathematics better than men [22]. Besides, the results of other studies also stated that female students scored significantly higher than male students in science process skills [23]. Based on the percentage of mathematical communication skills scores, it can be seen that the mathematical communication skills of male students are lower than female students. This is due to the lack of experience of male students in doing practice questions, so they do not have good mathematical communication skills.

4. Conclusion
Based on the results of the study, it can be concluded that female students have better mathematical communication skills than male students, especially regarding the material of straight-line equations. This is because male students cannot imagine graphs that match the information in the problem. Besides, male students cannot understand information, so their ability to predict problems is still low. Therefore, it is necessary to improve mathematical communication skills of male students by developing teacher competencies, selection of strategies, approaches, or learning models that are appropriate to be applied in the classroom, so that male students can have better mathematical communication skills.

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