



## Gender differences in written mathematical communication skills of junior high school students

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### Abstract

Some research about identifying the differences between male and female students' written communication skills has been done before. However, the previous research only focused on qualitative studies; therefore, there is still a lack of empirical proof of the result. This study aims to test whether a significant difference exists between male and female students' written mathematical communication skills and identify their performance difficulties. The subjects were 14 male and 14 female students at the junior high school. The instrument was a test of mathematical communication skills on quadrilateral topics. The research method used was a mixed method with a sequential explanatory design. The data were analyzed using Mann-Whitney U to measure the difference between male and female students' written mathematical communication skills, and document analysis was conducted to analyze their difficulties in performing written mathematical communication. The results showed that even though there is no significant difference between written mathematical communication skills between male and female students, there is a significant difference when viewed from each indicator. In addition, the difficulties experienced by male and female students are difficulties expressing mathematical ideas using mathematical symbols, using facts and concepts to solve problems, and operating algebraic forms.

**Keywords:** 21-st century skills; gender; mathematical communication; mathematical process; mathematics education; quadrilateral; written communication

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## Introduction

Communication skills are one of the essential skills in this globalization era. Therefore, students must master it to face various challenges and changes in the 21st century (Chiruguru, 2020). Given the importance of communication skills in the 21st century for students, the skill must be integrated with the teaching and learning process, including mathematics. Since students are challenged to think and reason mathematically in math class, communication skills can be an essential element that can help them to express their mathematical thinking orally or in writing (NCTM, 2000). In this research, the communication skills in mathematics learning are called mathematical communication skills.

Mathematical communication skills are understanding, interpreting, expressing, responding to, and using mathematical facts, such as terms and symbols to present mathematical ideas orally and in writing (Disasmitowati & Utami, 2017; Rohid et al., 2019). In addition, mathematical communication skills are the transmission of meaning via spoken, written, and visual means, such as providing oral or written reasoning or justification of results, expressing mathematical thoughts in writing, using symbols, using visual representation, and using concrete objects (Kusumah et al., 2020). Furthermore, mathematical communication skills can improve students' communication skills and play a vital role in improving their mathematical abilities. Mathematical communication skills can assist students in developing their understanding and provide opportunities for them to express their mathematical ideas (Hirschfeld-Cotton, 2008). Furthermore, mathematical communication skills are vital in mathematics because they allow students to express, explain, describe, and listen to their understanding of mathematics (Paridjo & Waluya, 2017).

When viewed from the perspective of gender differences, research states that there is no significant difference between the mathematical abilities of males and females (Hyde & Mertz, 2009). However, the PISA results (OECD, 2011) show a difference between boys and girls students; boys' mathematical abilities are better than girls. As for communication skills, females are superior to males (Adani & Capanec, 2019). Other studies have also shown that females have better skills in using productive vocabulary and constructing words than males (Eriksson et al., 2012). These studies certainly support the research findings, which state that female students' mathematical communication skills are more prominent than male students (Aliyah et al., 2020; Amni, 2021; Hayati et al., 2020). However, previous research on mathematical communication skills was carried out qualitatively, so the results cannot be generalized. There may be a difference, but not significantly. Based on that information, it is still necessary to confirm the differences between male and female students in terms of mathematical communication skills; the two are significantly different or not.

Generally, testing of students' mathematical skills is usually carried out in writing form. Therefore, students must have excellent mathematical communication skills for expressing their ideas, primarily through writing. However, previous studies showed that students' mathematical communication skills in writing are low and need to be improved (Chasanah et al., 2020). Other research showed that students' mathematical communication skills in writing are lower than orally (Maulyda et al., 2020). Considering that students' written mathematical

communication skills are still low, it is necessary to carry out further analysis to identify the mathematical communication skills indicators in which students still experience difficulties and the forms of these difficulties. So, this research will only focus on written mathematical communication skills.

This study aims to determine whether there is a significant difference between male and female students' written mathematical communication skills and to identify the difficulties experienced by them in communicating their mathematical ideas in writing. The findings can help teachers determine strategies for facilitating students' mathematical communication skills. So that teachers can realize differentiated mathematics learning for all students. Then, it will support the principle of mathematical equity in mathematics at school by providing appropriate learning situations to promote access and achievement for all students and eliminate disparate and socially inequitable outcomes in mathematics education (Gutstein et al., 2005; NCTM, 2000).

## **Methods**

This research was mixed-method research with a sequential explanatory research design. First, quantitative data will be collected and analyzed, followed by qualitative data analysis to help explain and elaborate on the quantitative results obtained in the first stage (Ivankova et al., 2006). Quantitative methods are used to determine whether there are significant differences between students' mathematical communication skills when viewed from gender. The qualitative method was used to carry out a descriptive analysis of the answers of students to determine their difficulties in written mathematical communication.

The subjects in this study were 28 junior high school students in eight-grade, Bandung City, Indonesia. The subjects consisted of 28 students, with 14 male and 14 female students. Subjects were taken through a random sampling technique.

The data was obtained through students' written mathematical skills tests. The research instrument used was three mathematics questions on a quadrilateral topic to measure students' written mathematical communication skills. Before the instrument is used, two experts carry out a theoretical justification. The instrument was developed based on the mathematical communication skills indicator (NCTM, 2000). Table 1 shows the indicators of mathematical communication skills for school mathematics that were adapted from the NCTM (2000) and scoring guidelines. The guideline for scoring students' mathematical communication skills was adapted from the QUASAR General Rubric, Communication subsection (Lane, 1993) and the Maryland Math Communication Rubric (Maryland State Department of Education, 1991). Each indicator will classify each student into five levels of mathematical communication skills. Since this research emphasizes written communication, the only data source is the students' responses on their answer sheets. Therefore, an interview process was not conducted.

**Table 1.** Scoring guidelines and indicators of written mathematical communication

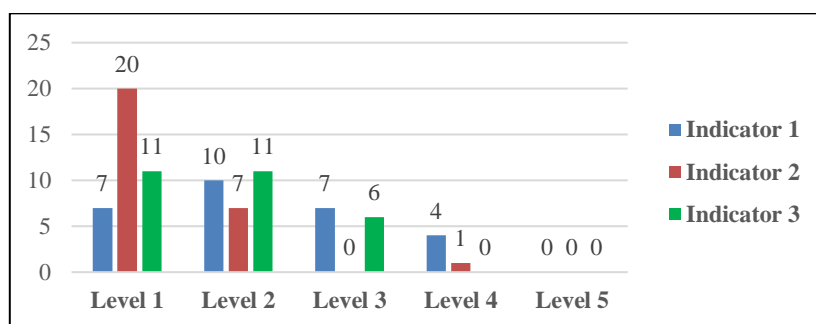
Indicator Number	Indicator	Scoring Guidelines	Category
1	Organize and consolidate mathematical thinking and communicate it to peers, teachers, and others.	QUASAR General Rubric – Communications	Level 1 = Very Low Level 2 = Low Level 3 = Moderate Level 4 = High Level 5 = Very High
2	Analyze and evaluate the mathematical thinking and strategies of others.		
3	Using mathematical language to express mathematical ideas precisely	Maryland Math Communication Rubric	

A statistical test was carried out using the Mann-Whitney U test to determine the difference between the written mathematical communication skills of male and female students, in general, and for each indicator. The significance level used in this study is 5%. The students’ responses to the questions given were analyzed descriptively to depict the differences in the answers of male and female students and the difficulty they faced.

## Results

### Profile of students’ mathematical communication skills

Figure 1 shows that most students’ mathematical communication skills are still at Levels 1 and 2. In addition, no students can reach Level 5 for each indicator. Indicator 2 is an indicator with the lowest achievement among students. As seen from Figure 1, almost all students are at Level 1, which is very low. Apart from Indicator 2, one other indicator of sufficient concern is Indicator 3. Level 3, which is still in the medium category, is the highest-level students can achieve on this Indicator. As for indicator 1, the skill level of students on this indicator is more varied than the other two indicators.



**Figure 1.** Written Mathematical Communication Skills Level of Students

### Comparison of students’ written mathematical communication level

Table 2 compares the number of male and female students who can reach a certain level for each indicator. In indicator 1, more male students tend to be in level 2, while female students are at level 3. In indicator 2, all female students are at level 1, while more male students are at

level 2, and even one male student can reach level 4. In indicator 3, more male students are at level 1, while female students are at level 2. Furthermore, based on Table 2, there may be differences in students' mathematical communication skills in general and for each indicator. So, it is necessary to carry out statistical tests to determine whether these differences are significant. Because the data is ordinal, the Mann-Whitney U test was applied to compare male and female students' written mathematical communication skills, in general, and for each indicator. The analysis results are obtained in Tables 3, 4, and 5.

**Table 2.** Comparison of students' written mathematical communication skill levels based on gender

	<b>Students' Mathematical Communication Skills Level</b>									
	<b>Level 1 (%)</b>		<b>Level 2 (%)</b>		<b>Level 3 (%)</b>		<b>Level 4 (%)</b>		<b>Level 5 (%)</b>	
	<b>M*</b>	<b>F*</b>	<b>M</b>	<b>F</b>	<b>M</b>	<b>F</b>	<b>M</b>	<b>F</b>	<b>M</b>	<b>F</b>
Indicator 1	21.43	28.57	71.43	0	7.14	42.86	0	28.57	0	0
Indicator 2	42.86	100	50.00	0	0	0	7.14	0	0	0
Indicator 3	78.57	0	14.29	64.29	7.14	35.71	0	0	0	0

\*Description: M = Male students

F = Female students

**Table 3.** Differences in written mathematical communication skills based on gender

	<b>Mean Ranking</b>		<b>Significance Value Mann-Whitney U Test (2-tailed)</b>	<b>Decision</b>
	<b>Male</b>	<b>Female</b>		
Written Mathematical Communication	38.46	46.54	0.103	H0 Accepted

Table 3 shows the differences in students' scores in the written mathematical communication test statistically. The Mean Rank column provides information about male and female students' average scores on the test. It shows that female students' average score is better than that of male students. However, a Mann-Whitney U test was conducted to ensure whether their scores were significantly different. This study's null hypothesis (H0) is that no significant difference exists between male and female students' written communication skills. The Significance Value column shows that using the Mann-Whitney U test, it was obtained that the significance value is 0.103. It means that the null hypothesis is accepted. Therefore, no significant difference was detected between male and female students' written mathematical communication skills.

Even though, in general, students' written mathematical communication skills are not significantly different, Table 4 shows a significant difference for each indicator. The Mean Ranking column provides information on each indicator's average male and female students' scores. It shows that the average score of female students is higher than that of male students in indicators 1 and 3. However, the male students can surpass the female students' score in indicator 2. A Mann-Whitney U test was conducted to prove the differences between male and female students for each indicator. The significance value column shows that the significance value for each indicator is under 5%. Using null hypotheses (H0), there is no significant difference between male and female students' written communication skills in indicators 1, 2,

and 3; the significance value for each indicator indicates that the null hypotheses must be rejected. Thus, this study shows that there is a significant difference between male and female students' written mathematical communication skills in each indicator.

Table 5 provides an interpretation of the one-tailed Mann-Whitney U test to ensure that in indicators 1 and 3, female students' written mathematical communication skills are significantly higher than male students. In indicator 2, male students' written mathematical communication skills are significantly higher than females. Using the null hypothesis, the male students' written mathematical communication skills are higher than the female students'; Table 5 shows that for indicators 1 and 3, the significance value is less than 5%. It means the null hypotheses are rejected for those indicators. Meanwhile, for indicator 2, the null hypothesis is accepted since the significance value of the indicator is more than 5%. Therefore, female students' written mathematical communication skills are significantly higher than male students in indicators 1 and 3, while male students' written communication skills are significantly higher than female students in indicator 2.

**Table 4.** Differences in written mathematical communication skills of each indicator (two-tailed test)

Indicator	Mean Ranking		Significance Value Mann-Whitney U Test (2-tailed)	Conclusion
	Male	Female		
1	11.29	17.71	0.039*	H0 is rejected
2	20.00	9.00	0.000*	H0 is rejected
3	8.96	20.04	0.000*	H0 is rejected

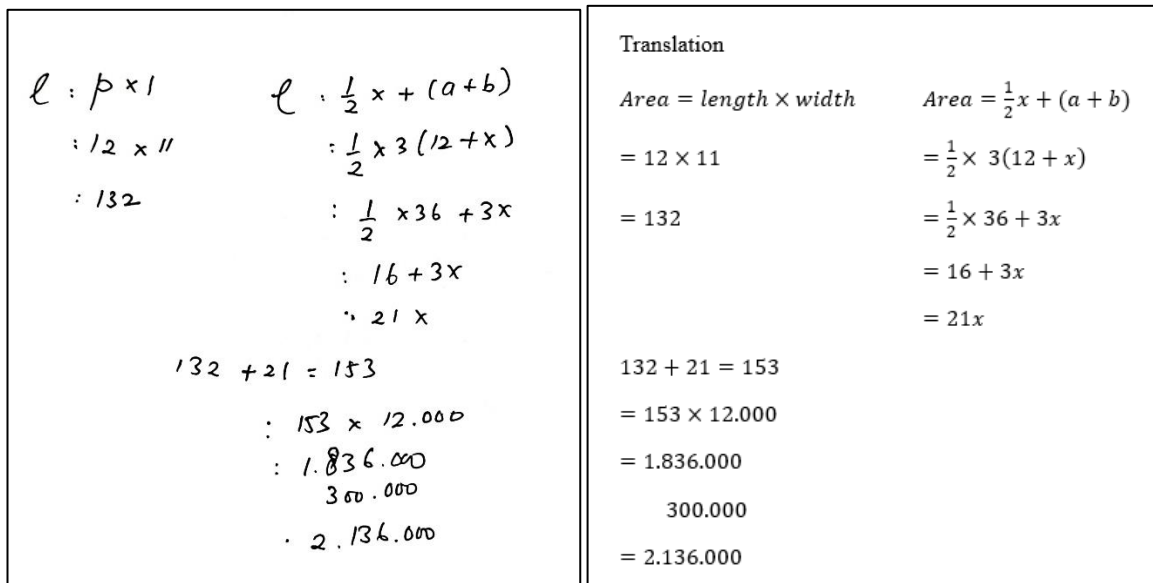
\*Significance  $p < 0.05$

**Table 5.** Differences in written mathematical communication skills of each indicator (one-tailed test)

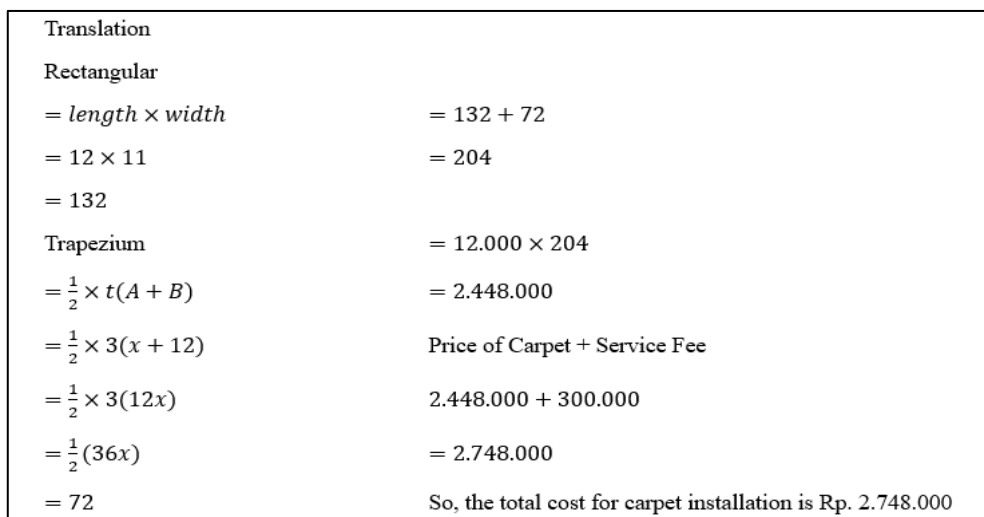
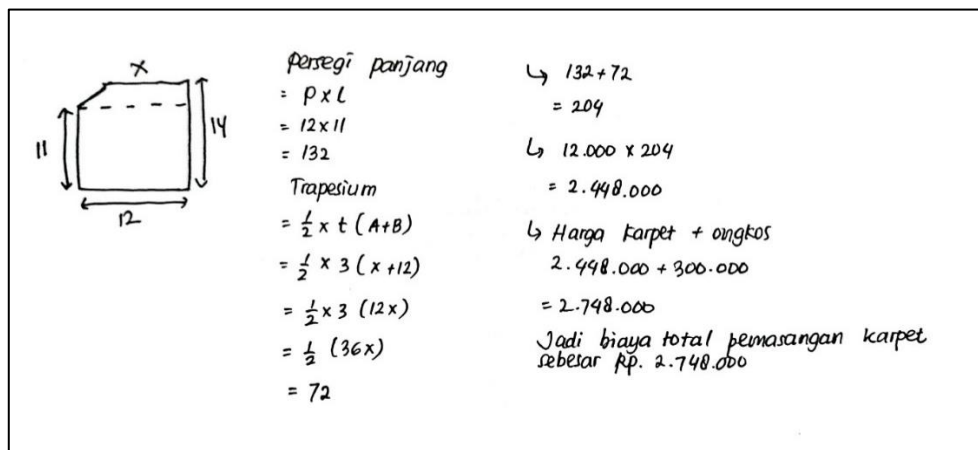
Indicator	Mean Ranking		Significance Value Mann-Whitney U Test (1-tailed)	Conclusion
	Male	Female		
1	11.29	17.71	0.015*	H0 Rejected
2	20.00	9.00	1.000	H0 Accepted
3	8.96	20.04	0.000*	H0 Rejected

\*Significance  $p < 0.05$

**Students' difficulties in organizing and consolidating mathematical thinking and communicating it coherently and clearly to peers, teachers, and other people in writing (Indicator 1)**



**Figure 2.** Example of a male student's answer Indicator 1



**Figure 3.** Example of a female student's answer Indicator 1

In Indicator 1, students are asked to determine the total cost needed to install carpet on a floor formed from a combination of two quadrilateral. Figure 2 and Figure 3 show the solving strategies of male and female students, respectively. Figure 2 shows that the answers of male students tend to be more abstract than female students. In the male student's answer, there needed to be an explanation regarding the purpose of carrying out that mathematical operation. Besides that, the step-by-step process of solving the problem was complicated for the reader to understand and interpret. From Figure 3, female students can write detailed information clearly so readers can quickly follow the flow of students' thinking. Students also accompanied pictures to help readers understand the initial idea to solve the problem. The descriptions for each step of the solution are also clearly written so that the strategy and flow of solving the problem become easier to understand. However, male and female students must improve their understanding of algebraic operations. Since they often made mistakes while calculating algebraic form. For example, students wrote  $18 + 3x = 21x$  and  $12 + x = 12x$ . Apart from errors in operating algebra, students made other mistakes using facts and concepts of quadrilateral.

**Students' difficulties in analyzing and evaluating other people's mathematical thinking and strategies in writing (indicator 2)**

Jawaban anak ke-1

$\circledast$  Luas :  $AC \times BD = 15 \times 8 = 60 \text{ cm}$      $\times \rightarrow 15 \times 8 = 120 \text{ cm} //$      $\frac{4}{15} \times \frac{8}{120}$   
 $\circledast$  keliling :  $AB + CD = 5 + 12,6 = 17,6$  ✓

Jawaban anak ke-2

$\circledast$  Luas :  $AB \times CD = 5 \times 12,6 = 63 \text{ cm}^2$  ✓  
 $\circledast$  keliling :  $2(AB) + 2(CD) = 2(5) + 2(12,6) = 35,2 \text{ cm}$

$\Rightarrow$  Jawaban yg benar yaitu jawaban dari anak ke-2 .  
 Karena jawaban dari anak ke-1 salah saat menghitung luas dari bangun ruang tersebut ( $15 \times 8 = 60 \text{ cm}$ ) seharusnya hasil dari  $15 \times 8$  yaitu  $120 \text{ cm}$ .

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Translation

The answer of The First Child

$Area = AC \times BD = 15 \times 8 = 60 \text{ cm} \rightarrow 15 \times 8 = 120 \text{ cm}$   
 $Perimeter = AB + CD = 5 + 12.6 = 17.6$

The answer of The Second Child

$Area = AB \times CD = 5 \times 12.6 = 63 \text{ cm}^2$   
 $Perimeter = 2(AB) + 2(CD) = 2(5) + 2(12.6) = 35.2 \text{ cm}$

The right answer is the second child, because the answer of the first child was wrong when calculating the area of the kite ( $15 \times 8 = 60 \text{ cm}$ ), it must be  $15 \times 8 = 120 \text{ cm}$

**Figure 4.** Example of a female student's answer Indicator 2



Jawaban anak ke-1: Salah, karena rumus luas dan keliling layang  $\cong$  nya tidak sesuai

\* Rumus luas:  $\frac{1}{2} \times \text{diagonal 1} \times \text{diagonal 2}$

Rumus keliling: semua sisi di tambahkan

Jawaban anak ke-2: Benar, karena sesuai dengan rumus layang  $\cong$

Translation

The answer of the first child was wrong since the formula of area and perimeter of kite is not appropriate.

Area Formula =  $\frac{1}{2} \times \text{diagonal 1} \times \text{diagonal 2}$

Perimeter Formula = all of side are added

The answer of the second child was right because it used the appropriate kite formula.

**Figure 5.** Example of a male student's answer Indicator 2

In Indicator 2, students are given problem-solving strategies from two children, Child A and Child B, related to the area and circumference of a kite. Students are asked to analyze and evaluate the correctness of the problem-solving strategies of the two children. In this indicator, all female students are at Level 1 because the reasons given do not reflect the solution to the problem. Based on Figure 4, female students only justify the results of number operations without paying attention to the correctness of the area and perimeter concepts of the kites used by the two children. As for the male students, most of them were at Level 2. Their answers indicated that they used the concepts of the area and circumference of kites to evaluate problem-solving strategies (Figure 5). However, some male students made the mistake of justifying the solving strategy from Child B. Even though Child B used the wrong concept in determining the area of the kite, they tend to consider it as the correct answer. So, there is a possibility that male students have not mastered the facts and concepts of kites.

### **Students' difficulties in using mathematical language to express mathematical ideas appropriately in writing (Indicator 3)**

In indicator 3, students were given two horse stables designs, Designs A and B. They were asked to determine which design a horse breeder could make if the materials they had were limited. This question will examine students' skills in expressing their mathematical ideas using mathematical language. Most male students on this indicator are at Level 1 because they only state which design can be made by a horse breeder without giving reasons for choosing it (Figure 6). At the same time, the majority of female students are at Level 2. Female students have tried to explain why they chose a particular design using mathematical language (Figure 7). However, the mathematical language used is still limited to number symbols. In addition,

there were still errors in using metrics in the female student, and She wrote that super script that  $15^2 = 15 + 15$  and  $5^2 = 5 + 5$ .

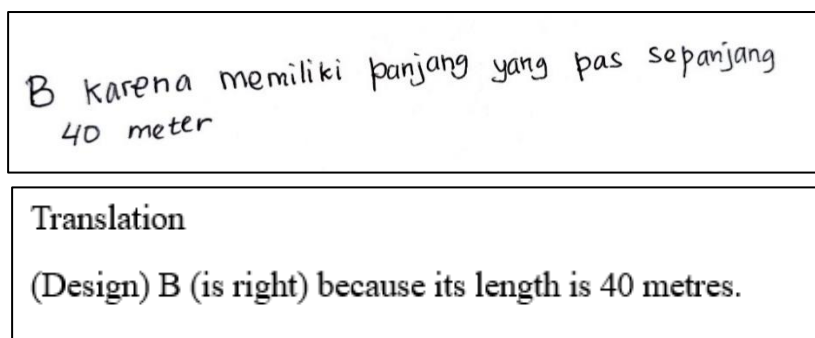


Figure 6. Example of a male student's answer Indicator 3

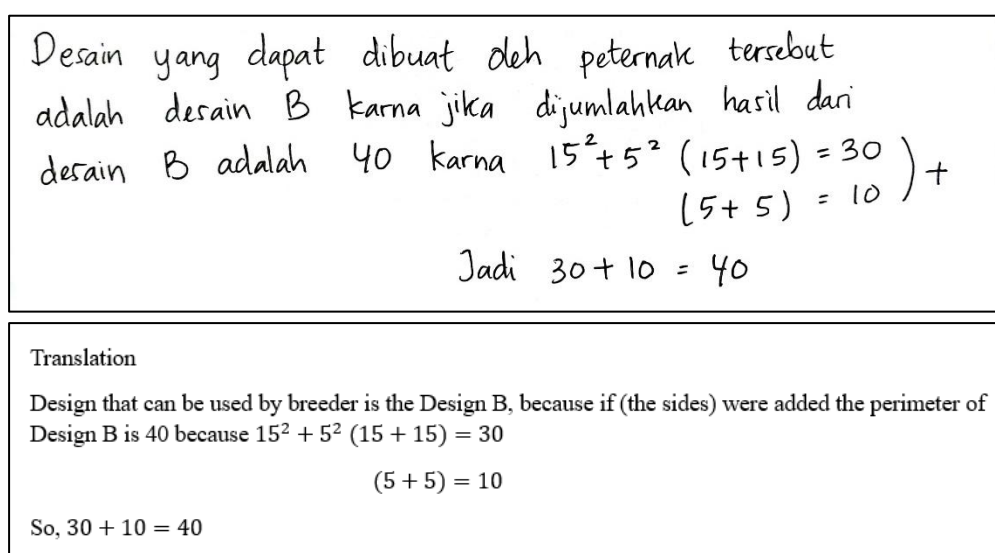


Figure 7. Example of a female student's answer Indicator 3

## Discussion

This study aims to identify differences in students' written mathematical communication skills based on gender (male and female). There are three indicators that were used in the study, namely organizing and consolidating mathematical thinking and communicating it coherently and clearly to others; analyzing and evaluating the mathematical thinking and strategies of others; and expressing mathematical ideas precisely using mathematics language. In addition, this study also aims to show the difficulties experienced by students in conveying their mathematical ideas in writing. This research only focuses on written mathematical communication skills so that the analysis results are only based on what is written on the student's answer sheet.

Based on the analysis results, it was found that most of the students' mathematical communication skills in writing were in the deficient category. This result is in line with previous research that students' mathematical communication is still low (Sari et al., 2017)

because they still have difficulty expressing their mathematical ideas in writing (Ningtias et al., 2020; Zulkarnain et al., 2021). The student's lack of writing skills can occur because, in written communication, the writer cannot correct or explain the purpose of the information conveyed directly, so written communication requires more effort to be understood by others (Wallace & Roberson, 2008). So, this needs to be a concern for teachers to focus on increasing students' understanding and their skills in expressing their mathematical ideas, especially in writing. Even though students' mathematical skills are good, that does not align with their mathematical communication skills (Firdiani et al., 2020; Samawati, 2021). Therefore, even though students understand the strategy for solving a problem but lack the ability to express it, it can be a loss for students. In addition, this can cause the results of the learning evaluation to be different from the actual situation.

Several studies have shown that male students surpass female students in mathematical ability (Gabay-Egozi et al., 2022; Keller et al., 2022), while females are superior to males in terms of communication and language skills (Adani & Cepanec, 2019; Al-Saadi, 2020; Denton & West, 2002). Then what about mathematical communication skills? This study shows that, in general, male students are not significantly different from those of female students, viewed from written mathematical communication skills. The result aligns with previous research by Kamid et al. (2020). Likewise, Previous research found no difference in verbal (Hyde & Linn, 1988) and mathematics performance (Hyde & Mertz, 2009) between males and females. As a result, it is unsurprising that male and female results in this study do not differ significantly. Conversely, PISA also assesses mathematical communication (OECD, 2003) and shows different results for gender differences in mathematics. According to PISA results (OECD, 2020), there are countries where boys outperform girls in mathematics and countries where the opposite is true. Therefore, there are currently conflicting findings in this issue regarding whether or not gender influences students' written mathematical communication skills. It suggests that additional factors may influence students' written mathematical communication skills. Family, peers, school, training, and experience are sociocultural factors (Halpern et al., 2007).

Furthermore, when viewed from each indicator, there are indicators where males are superior to females and vice versa. Again, it is hard to explain "why?" since research and facts show inconsistent results on the difference between males and females in mathematics (e.g., Gabay-Egozi et al., 2022; Hyde & Mertz, 2009). Previous study has also found that gender disparities in mathematics are complex, but it is important to note that there are other elements that contribute to gender differences in mathematics (Halpern et al., 2007). For example, when gender and cognitive styles were included, there were significant differences in students' mathematical communication skills, but not when only gender was considered (Kamid et al., 2020). It confirms that gender differences in students' mathematical communication skills are not caused solely by gender, but that another factor appears to contribute to the skills.

Statistically, female students are more superior than male students on the first indicator of written mathematical communication skills. It shows that female students can express and communicate mathematical ideas to others in writing. Analysis of students' answers showed that all male and female students tend to experience difficulties performing algebraic

multiplication and addition operations. It may happen because students have an incomplete understanding of the topic, resulting in errors in solving the problem (Tambychik & Meerah, 2010). Several male and female students also experienced difficulties using the facts and concepts to solve problems in indicator 1. Even so, female students could present mathematical ideas in a structured manner, accompanied by clear information regarding the steps taken to solve them.

Meanwhile, male students still need help presenting mathematical ideas in a structured manner and tend to be challenging to understand because the flow of the completion steps is hard to follow. At the same time, mathematical communication skills do not only focus on problem-solving skills but also how to show the idea of solving the problem to others. The finding is consistent with the previous study's results, which showed that female students could explain strategies and steps for solving problems clearly and structured, while male students tended to be less structured (Kamid et al., 2020).

In indicator 2, male students are superior to female students. It shows that males' skills in analyzing and evaluating are better than females. However, even though males' skills are higher on this indicator, their skill level is still low, while females are deficient. This indicator has the lowest achievement compared to other indicators because almost all students are at levels 1 and 2. Remembering that analyzing and evaluating skills is one of the higher-order thinking skills (Anderson et al., 2001), this can indicate that students' higher-order thinking skills are still low. It can be used as an evaluation for teachers so that they do not only focus on giving questions or assignments that only focus on memorization and application but also provide assignments or questions that can stimulate students' higher-order thinking skills.

Based on the results of the analysis of student answers, on indicator two, female students tend to have difficulty understanding and interpreting the information presented in the questions, so they all only focus on the final answer without checking the truth of the facts and concepts presented in the questions. On the question of Indicator 2, the researcher wrote that the formula for the area of a kite is the multiplication of the two sides of the kite. However, none of the females focused on these mistakes. So, this can be an indication that female students do not understand the facts and concepts of kites. On this indicator, male students still experience difficulties using kite facts and concepts in solving problems. It can be seen from their inconsistency in justifying the two strategies presented in the questions. For example, they can justify that Child A's strategy is wrong because Child A uses the wrong concept in determining the area of a kite. Meanwhile, they justify Child B's strategy as correct in determining the area of the kite, even though Child B also made the same mistake as Child A. Even so, male students have demonstrated the use of critical information to solve the problem. However, that information is still lacking to be able to solve all problems precisely. From the cases above, besides their lack of mastery of mathematical facts and concepts, students may face difficulty in information skills; therefore, they cannot analyze the important data or information properly, which leads them to the wrong answer (Tambychik & Meerah, 2010).

Indicator 3 also shows that female students' written mathematical communication skills are better than male students. It shows that female students are more proficient in using mathematical language to convey their problem-solving strategies. This finding is in line with

previous research that shows female students can use mathematical language better than male students (Alfarisyi & Sutiarmo, 2020). However, the highest level that students can achieve on this indicator is only at level 3; they can use mathematical languages, such as symbols or terms, but their use is still less accurate and less effective. Teachers should always pay attention to the skills and accuracy of students in using symbols or mathematical terms, remembering that each symbol and term has its meaning. From the analysis of student answers, on Indicator 3, male students tend not to give reasons for their answer.

In comparison, female students have shown an effort to explain their reasons. However, the use of mathematical language still needs to be improved, and there are still errors in using some symbols. The ineffectiveness of students' use of mathematical language in expressing their ideas can also be seen in their answers to Indicators 1 and 2. Students tend to write certain mathematical symbols without writing down the meaning of the use of those symbols, even though this is very important so that other people can understand their ideas in solving problems (Maryland State Department of Education, 1991).

Therefore, in general, male and female students tend to have difficulties applying facts and concepts in solving problems, using mathematical language, and performing algebraic operations. The previous research also revealed that most students needed to improve while doing algebraic form calculations, interpreting the sentence about the presented questions, and understanding the concept that should be used to solve the problem (Nurjanah et al., 2019). Another research also showed that students still have difficulty expressing their mathematical ideas through symbols or mathematical notation (Azizah et al., 2020; Islami & Priatna, 2021). It also becomes an evaluation for teachers to improve student understanding of facts and concepts on a particular mathematical topic. In addition, the teacher needs to review algebraic operations topics since that is fundamental in solving mathematical problems.

## **Conclusion**

Male and female students' written mathematical communication skills are not significantly different. It is in contrast when viewed from each indicator, the difference is significant between the two. In Indicators 1 and 3, female students can perform better than males, but in Indicators 2, males are more superior than females. The challenge for female students in Indicator 1 needs help applying quadrilateral facts and concepts to solve problems and difficulties in operating algebraic forms. The difficulties experienced by male students in indicator 1 are the same as those of female students, but they also experience difficulties in expressing mathematical ideas in a structured manner. In indicator 2, the difficulties experienced by male students are difficulties using facts and concepts related to the quadrilateral. In contrast, female students have difficulty understanding and interpreting information and using facts and concepts in solving problems. In indicator 3, male and female students struggle to use mathematical symbols to express ideas. Thus, male and female students struggle to apply facts and concepts to solve problems, use mathematical language, and perform algebraic operations.

This study reveals differences in male and female students' written mathematics communication skills and the obstacles they experience. As a result, it can assist teachers in

determining the best teaching strategies to help their students' overcome challenges and enhance their written mathematical communication skills. However, this study only compares students' written communication skills based on gender; future research may conduct this study with other variables such as motivation or prior knowledge. Further research is needed to investigate the factors that influence students' mathematical communication skills, while gender appears to have little effect.

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### **Conflicts of Interest**

The authors declare no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and falsification, double publication and/or submission, and redundancies, have been completed by the authors.

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### **Author Contributions**

**Muhamad Syahidul Qirom:** Conceptualization, writing - original draft, editing, and visualization; **Jarnawi Afgani Dahlan:** Writing – review and methodology; **Turmudi:** Validation and supervision.

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