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Analyzing the Gender Strategy in Math: Good, Routine, or Naive Problem Solver?

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Abstract: *Each student's problem solving has different characteristics and can be seen in terms of gender differences. Both female and male students have different levels of achievement in problem-solving, where male students are seen as superior to female students. Gender in mathematics achievement is still a hot topic to be researched. Therefore, this study aims to analyze the problem-solving strategies of primary school students in terms of gender using the Polya model in Geometry. This study uses a qualitative approach design. The subjects in this study were 25 primary school students who were then grouped according to high and moderate achievement based on midterm grades. Researchers collected data by giving problem-solving tests then selected 4 students consists of male and female students with the highest scores representing each achievement group to be interviewed as part of the triangulation process. Data analysis was performed using reduction, data presentation, and conclusion drawing. Based on the study results, we found that: (1) there are differences in problem-solving strategies carried out by male and female students. (2) The male subject at high achievement shows confidence, able to find other ways when encounters obstacles and is a good problem solver. The female subject at high achievement was repeatedly inaccurate in using the solution plan, also appears to be manipulating only the numbers that appear in the problem and she is a naive problem solver. (3) Male subjects at moderate achievement, only manipulate the numbers on the problem into some calculation operations and he is a naive problem solver. Female subjects at moderate achievement, do not do the looking back process, so there are mistakes at some of the problem-solving stages and she is a routine problem solver. We suggest to conduct a study with a more sample measure for primary school students and focus on their characteristics when solving the problems.*

Keywords*: Mathematics; Problem-Solving; Geometry; Gender; Primary School.*

Introduction

In mathematics education, problem-solving plays a significant role. Therefore, problem-solving is an integral part of the mathematics competencies that students must have. One of the goals of problem-solving teaching is to encourage students to refine and create their processes over time. Their experience allows them to discard specific ideas and make them aware of other possibilities (Fennema et al., 1989). Learning by using problem-solving in class has positive benefits for students 'mathematical thinking skills and has the potential to significantly provide an intellectual context for students' mathematical development (Ersoy & Güner, 2015; Noor & Ekawati, 2017).

The student's ability to solve problems is represented through the selection of appropriate problem-solving strategies (Chapman, 2005). Rusminati (2018) states that problem-solving is an attempt to solve the problems he is facing. Besides, through problem-solving activities, students' self-confidence and persistence can be formed to lead them to success in life both at school and outside of school. Solving problems will involve a cognitive behavioral process where it takes logical steps to find a successful solution (Demirel et al., 2015). Because solving problems is very important both now and in the future, we need an appropriate strategy in solving problems.

Many steps can be found in a math problem-solving strategy. Polya (1957) acts to solve mathematical problems, namely understanding the problems, to devise a plan, to do a plan, and to look back. Also, Carlson and Bloom (2005) suggest the stages of problem-solving with orientation, planning, executing, and checking. Yimer and Ellerton (2010) revealed other stages are engagement, transformation-formulation, implementation, evaluation, and internalization. Furthermore, students' problem solving abilities can be classified based on the characteristics that appear when they solve problems. Muir, Beswick and Williamsom (2008) classify students' skills to solve problems, including good problem solvers, routine problem solvers, and naive problem solvers.

In'am (2014) states that every problem has characteristics and types that are familiar, as an effort to facilitate the design and determination of the right strategies, approaches, and methods to solve them. From an early age, it is expected that students will be accustomed to choosing the right problem-solving strategy when faced with a mathematical problem. Several studies reported that both young and old students showed low achievement, misconceptions, and errors in choosing strategies in solving math problems, especially related to measuring length and area in geometric material due to confusion in distinguishing units and partitions (Jones & Tzekaki, 2016; Özerem, 2012; Ozkan & Bal, 2017; Rusyda et al., 2017). Meanwhile, Ekawati and Wulandari (2011) stated that there was no significant difference in solving math problems in primary school students' Geometry when viewed from gender.

Gender differences have become an issue in several studies related to students' mathematical abilities (Ciascai & Lavinia, 2011; Kane & Mertz, 2012; Leyva, 2017). Furthermore, Asante (2010) reveals that gender differences in math ability remain a hot issue as researchers try to address women's underrepresentation at the highest levels of mathematics, physics, or engineering. Meanwhile, Noor and Ekawati's (2017) study shows that differences in the ability to solve math problems are seen that male students are more likely not to double-check answers and give up easily than female students. This is different from the results of Ajai & Imoko's (2015) study, which states that male and female students' mathematics achievement and retention are not significantly different. Both male and female students can compete and cooperate in mathematics.

Based on the theoretical study that has forward, this study adapts Polya's problem-solving strategy. We use Polya's approach selected because the Polya method has extensively used to solve mathematical problems at primary, secondary, and tertiary levels (In'am, 2014). Several studies have reported regarding the types of student problem solving both by looking at the gesture and behavior side (Harisman et al., 2017; Harun et al., 2019; Muir et al., 2008), and those who see the strategy from the gender side are still limited. Besides, this is important to do because some students at SDN 001 Tarakan are still used to solving problems if they have been given examples of solutions and not all students have shown mastery of the plane figure material. Therefore, this study aims to analyze the problem-solving strategies of primary school students on Geometry in terms of gender.

Method

The research conducted is qualitative, aiming to describe the skills of problem-solving primary school students on Geometry in terms of gender using Polya's strategy. This research was completed in May 2020 at SDN 001 Tarakan. Subjects in this study were 25 of fifth grade students in SDN 001 Tarakan. Based on the results of the midterm test, all of students were grouped according to their level of achievement. We grouped the achievement into 3 namely high, medium and low. Table 1 shows the grouping of achievement from the results of the midterm exam.

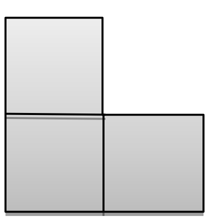
Table 1. Student achievement category from midterm test scores

Score (x)	Category	Gender	
		M	F
$x > 75$	High	2	4
$58 < x \leq 75$	Moderate	10	9
$x \leq 58$	Low	0	0
Total students		25	

After grouping the achievements, we then got two group categories, namely high and medium, because none of the students met the criteria for the low achievement. Furthermore, the researcher gave a problem-solving test on the Geometry material. The sampling technique used in this study was purposive sampling with consideration of the research objectives and student answer sheets (Bachriani et al., 2021). We chose one male and one female student with the highest score based on the high achievement and one male and one female student with moderate achievement from the results of analysis the answer sheet in the Geometry problem-solving test. The four research subjects were then followed up through an in-depth interview process. Male high-achievement refer to S1, female high-achievement refer to S2, male moderate-achievement refer to S3, and female moderate-achievement refer to S4.

The research data was collected using problem-solving test instruments and in-depth interviews. The data collection process was carried out in 4 stages. In the first stage, we provide a test of solving mathematical problems on the topic of Geometry. In preparing the problem-solving test, we carried out the instrument validation process through expert validation. The instrument was validated by 2 experts, namely one lecturer with a SINTA ID 6071062, and one grade V teacher at SDN 001 Tarakan. The problems given are as follows:

1. Look at the figure A figure below!



Shape A made by 3 squares. The circumference of shape A is 32 cm.
a. What is the length of the side of the square in shape A?
b. What is the area of one square?
c. What is the area of the whole shape A?

2. Father will lay tiles on his house, which is 6 m x 6 m. The tiles to be installed are 30 cm x 30 cm in size. One tile box consists of 10 tiles for IDR 50,000 / box. If Father has IDR 2,100,000, is it enough to buy all the tiles that will be used?

The second stage that we did was conducting in-depth interviews with S1, S2, S3, and S4 subjects by paying attention to Polya's problem-solving stages, namely understanding the problems, devising a plan, doing a plan, and looking back. We used interviews to conducted a triangulation process, and each interview was recorded using video.The third stage is to classify the subjects' problem-solving abilities based on worksheets and interviews. The classification of problem-solving categories refers to Muir, Beswick, and Williamsom (2008), including good problem solver, routine problem solver, and naive problem-solver, which can be seen in Table 2.

Table 2. Characteristics of student problem-solving categories

Good Problem Solver	**Routine Problem Solver**	**Naive Problem Solver**
Using one's strategy	Implement problem-solving steps systematically.	Copying previous problem-solving strategies.
Combine strategies and develop problem-solving alternatives	Do not change the strategy if it does not work, so focus on one way.	Problem-solving strategies are the same for all problems.
A high score in problem solving	Did not evaluate the strategy used, so there were errors in some of the problem-solving steps	There were errors in all of the problem-solving steps
Adequate written and verbal communication.	Written and verbal communication is quite clear.	Written communication is not optimal

(Muir, Beswick, & Williamsom, 2008)

The data that has been collected is then analyzed using data reduction, data presentation, and concluding. We analyzed problem solving and ability based on problem solvers' categorical characteristics that emerged concerning gender differences in high student achievement and moderate student achievement, drawing conclusions based on the research results and discussion findings. Figure 1 shows the stages that were passed in this research.

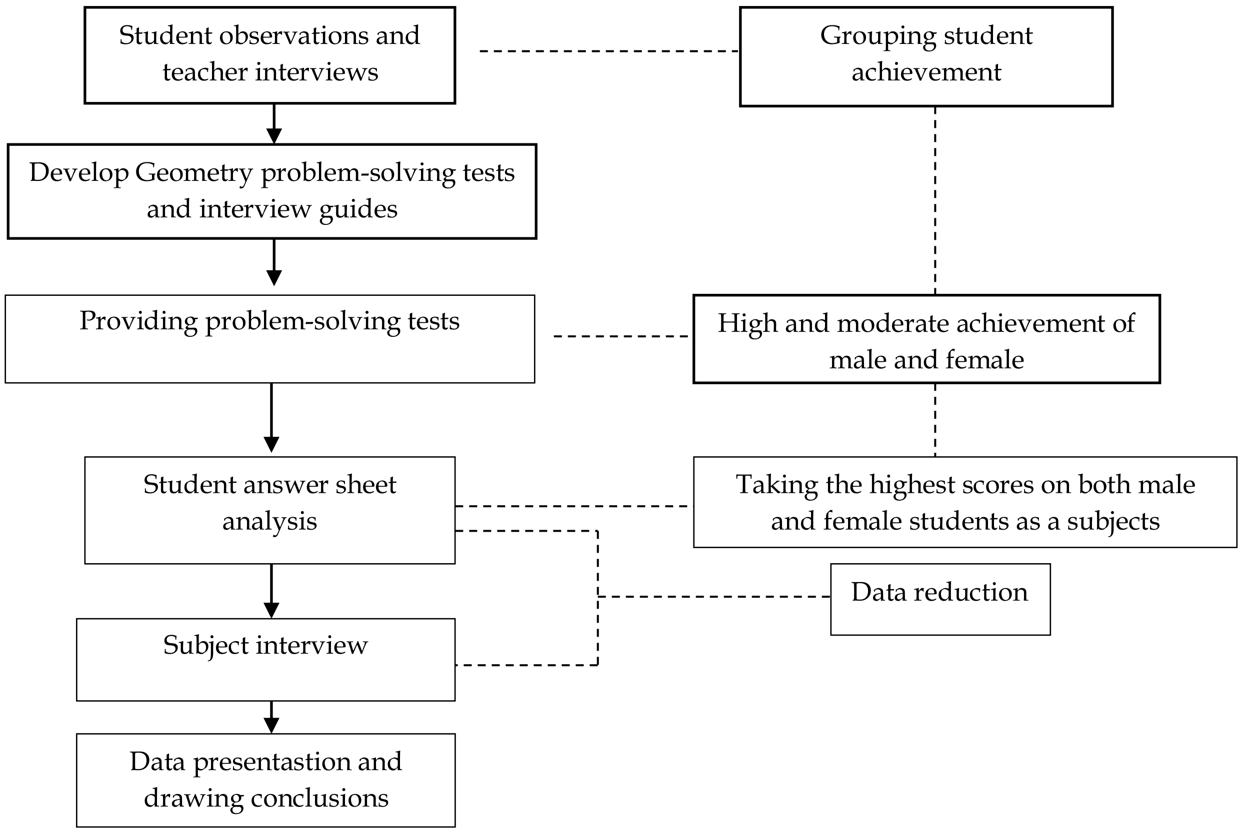


Figure 1. Stage in Research

Results and Discussion

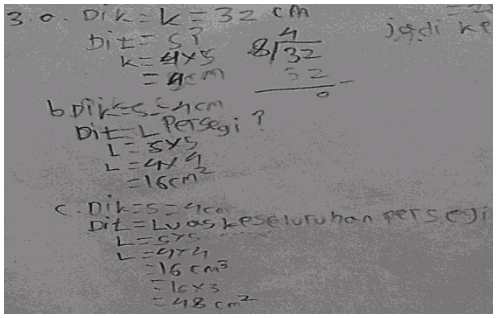
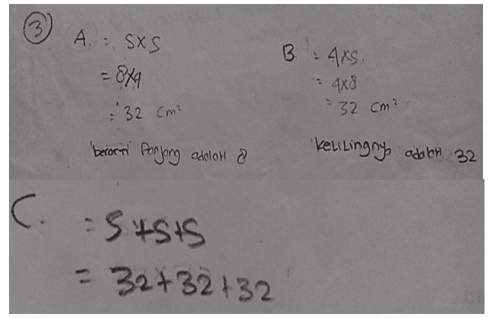
This section presents research findings and discussions about solving math problems in terms of gender differences given to subjects S1, S2, S3, S4.

Problem Solving by Subjects High-Achievement

Analysis of the results worksheet and in depth interviews from first problem by S1 and S2 subjects are presented in Table 3.

Tabel 3. Subjects Response Related to Polya's Problem-Solving Strategy

First Problem

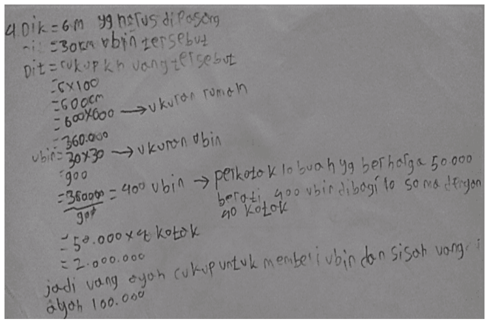
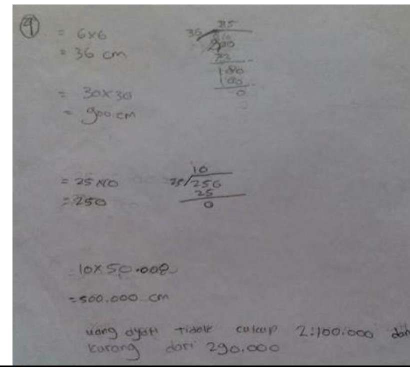
Stages	**Example Response S1-Male**	**Example Response S2-Female**
Written response		
Understanding the problem	I read a problem more than once before I fully understood what had to solve it.	I can solve a problem (a) and (b), but for question (c) I doubt it.
Devising a plan	For points (b) and (c), I used the formula for the area of a 4 x s square. For point (a), I wrote the formula wrong.	Problem (a) uses the formula for the area of a square, s x s. For (b), the perimeter of the square is 4 x s. Which (c), I'm confused.
Do a plan	First, I mistakenly used the formula to find the length of the side, after rereading, I finally saw that the side of the shape A has 8. So the length of the side of the shape is 32: 4, which is 4 cm. The area of one square is 16 cm^2, and the area of the whole shape is 16 x 3 (because there are 3 equal squares).	There are 32 cm in the problem, so I multiply 8 x 4. The area of the square = side x sides, if I multiply 8 x 8 the result is not 32. The side length is 8 cm. After doing this, finding the perimeter of the square, which is 4 x s, will give 32.The area of the entire shape is 32 + 32 + 32.
Looking back	I am sure of the answer because I saw it again while working on it at the beginning.	(Researchers ask subjectss to reread the problem)

S1 and S2 show different understanding and strategies in solving the first problem. On the S1 worksheet, there was an error writing the problem-solving plan part a, but when the interview process, S1 confirmed that he tried to reread the question and found that there were 8 sides of the figure. In line with Hershkowitz et al. (2001), which states that the problem-solving process can lead to the behavior of recognizing, assembling, and reconstructing the knowledge or information that students have. Because S1 makes a process of looking back when he experiences an error in the part a problem, so the questions in part (b), and (c) can be solved correctly and decide not to double-check what he has finished.

S2 subject already experienced obstacles when understanding the problem and could not be resolved, resulting in unsuccessful problem-solving. Obstacles in problem-solving could be because students are accustomed to generalizing every problem they find so that they carry out the same or similar strategies repeatedly (Antonijević, 2016; Nanna & Pratiwi, 2020). This can be seen in S2, she using the area square formula without paying attention to the problem again. Inaccuracy and obstacles experienced by S2 result in problem-solving errors. She does not do a looking back process. This study's results contradict the statement of Noor & Ekawati (2017) that female students with high achievement have a regular thinking structure and look back very well.

The worksheet analysis results and the results of the second problem interviews for S1 and S2 subject are presented in Table 4.

Table 4. Subjects Response Related to Polya's Problem-Solving Strategy

	Second Problem	
Stages	**Example Response S2-Male**	**Example Response S2-Female**
Written Response		
Understanding the problem	I understand this, I have to find the area of the house and the tiles area, then divide it to get the number of tiles to use.	It is known that the size of the house is 6 x 6 m, the size of the tile is 30 x 30 cm.
Devising a plan	Use square area and should change the house size to cm for convenience .	I am confused, so write it like that.
Do a plan	At first, I forgot to change the unit. Still, when I tried, 36 when divided by 900 the result is a decimal. I just remembered converting m to cm so I got 400 tiles. I divide 400 tiles by 10 because each box contains 10. There are 40 tile squares that dad will use, so daddy's money should be enough.	The house and the area of the tiles are first found using the formula s x s.
Looking back	I counted it back, and nothing was wrong.	The house area is 36 cm, while the tile area is 900 cm. Next I divide 900 by 36 and find 25 tiles. I also multiplied 10 by Rp.50,000. After that, I was confused.

We found a difference in understanding of first and second problems. Based on the worksheet, it appears that the S1 subject have understood the problem well so that he has an appropriate resolution plan. We confirmed through interviews, S1 revealed that initially in implementing the completion plan, he forgot to change the units, so he could not get the number of tiles. However, S1 managed to find new information, which is his used to continue the problem-solving process. According to Nunokawa (2005), in the problem-solving process, students already have mathematical knowledge, which is used to understand problems and get the information used to reflect on their knowledge in finding solutions or problem-solving ideas.

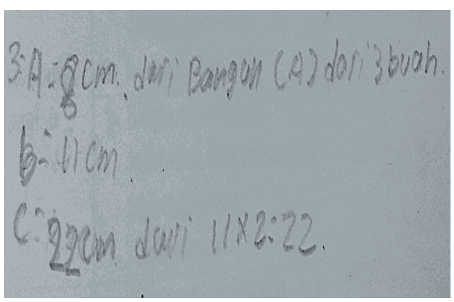
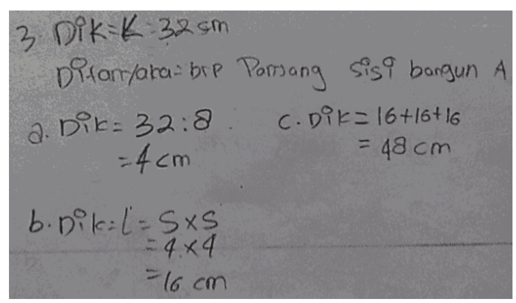
On the other hand, S2 subject were also unable to solve problems correctly. S2 cannot plan a solution even though she knows what is known and information about the questions. Mairing (2018) states that if students cannot take advantage of the information that is known and asked, it can make students unable to write down answers or answer incorrectly.

Based on the problem-solving characteristics carried out by S1, he has been included in the good problem solver category, while S2 is included in the naive problem solver category. S1-men with high achievement are more dominant in understanding problems, making plans, doing and looking back. According to Harisman, et al. (2017), male students with the same math achievement tend to remain calm when facing a shift in cognitive understanding and focus on questions in problems. S1 is more confident with his answer than S2 and can look for other strategies when he believes the strategy used is wrong. Meanwhile, S2 was repeatedly inaccurate in using the solution plan, which resulted in her inability to reach the final problem-solving stages. S2 also appears to be manipulating only the numbers that appear in the problem. This is in line with Muir's, et al. (2008) opinion that naive problem solvers are oriented towards problem-solving behavior, which is only related to the activity of manipulating available numbers.

Problem Solving by Subjects Moderate-Achievement

Analysis of the results worksheet and in depth interviews from first problem by S3 and S4 subjects are presented in Table 5.

Table 5. Subjects Response S3 and S4 to the First Problem

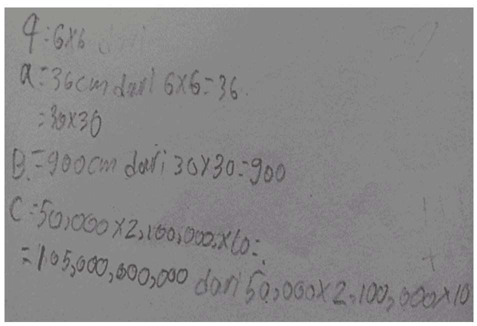
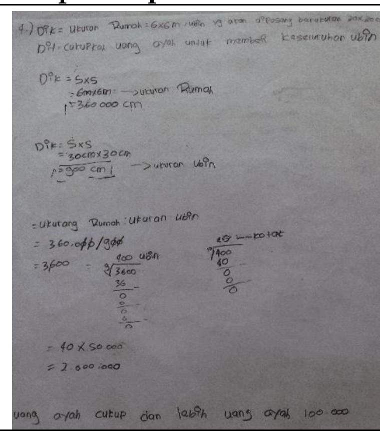
	First Problem	
Stages	**Example Response S3-Male**	**Example Response S4-Female**
Written Response	 3. A: 8cm. dari Bangun (A) dari 3 buah. b: 11cm. C: 22cm dari 11x2:22.	 3 Dik = K = 32 cm Ditanya = bjp Panjang sisi bangun A a. Dik = 32 : 8 = 4 cm c. Dik = 16+16+16 = 48 cm b. Dik: L = S x S = 4 x 4 = 16 cm
Understanding the problem	The perimeter of the shape A is 32 cm, which is the question is the side length and area of the shape A.	You know that, the circumference of the shape is 32 cm, with 8 sides.
Devising a plan	Problem (a) uses the formula for the perimeter of a square, which is 4 x s. For questions (b), and (c) I only guessed.	I use the formula for the area of a rectangle. (Researchers asked again regarding the formula used)
Do a plan	The side length is 8 cm because 32 is divided by 4. This is a square, right?	Stick to the area of the rectangle, which is the side x side, so you'll need to find the side length first. The length of a side is the circumference divided by the number of sides by 4 cm. The area of a 4 x 4 square =

Looking back	(Researchers ask students to pay attention to the picture again).	16 cm, and the area of 3 squares is 48 cm. I think, i do not know about this problem, mam.

Subjects S3 and S4 with moderate achievement also showed differences in the problem-solving process. S3 does not fully understand the meaning of the problem. He only understands that to find the perimeter of a square, he can use 4 x sides. However, when he faced with a problem, S3 cannot apply the knowledge he has to formulate an appropriate idea or method. Meanwhile, S4 solved the second problem correctly even though there was an error in representing the image. Besides, S4 did not write down the unit area entirely on the answer sheet.

The results of the analysis of both the worksheet and the interview results on the second problem for subjects S3 and subjects S4 are presented in Table 6.

Tabel 6. Subjects Response S3 and S4 to the Second Problem

Second Problem		
Stages	**Example Response S2-Male**	**Example Response S2-Female**
Written response		
Understanding the problem	I do not understand, when I meet a problem like this. But I know it uses the area square formula.	It is known that the size of the house is 6 x 6 m, the tile size is 30 x 30 cm. The question is, if daddy had enough money to buy all the tiles.
Devising a plan	I only know the formula for the area of a square, which is to multiply the side by side.	I amm confused, so just write it like that.
Do a plan	I solve this problem with multiplication. The area of the house is 36, the area of tiles is 900. Finally, I multiplied the number of tiles by the price of the tiles.	I must find the area of the house and the area of the tile with the side x side formula. After that, divide the area of the house and the area of the tiles. Then find the number of tile squares needed. House area 360,000 cm, tile area 900 cm. All tiles required are 40. So dad's money is enough because 40 multiply by IDR 50,000 = 2,000,000
Looking back	(Smile) I don't know anymore ma'am. Anyway, I multiplied everything in the problem.	(Researchers asked about the answer and the unit of area) No need ma'am. I am sure my answer is corrett, yes, just cm.

The subjects with moderate achievement were S3 and S4. it seems that S4 female subjects are better. From the two problems given, S3 cannot find a method of solving the problem at all. S3 only manipulates the numbers available in the problem and takes advantage of the multiplication and division operations. From the nature of the problem solver it does, S3 falls into the naive problem solver category. The research results by Harun, et al. (2019), showed that naive problem solvers would tend to behave unwisely and be shown consistently on every question given.

S4 falls into the problem-solver routine category. Although S4 can solve the two problems given, there are some misconceptions about understanding a plane's area. S4's written and verbal communication was insufficient. Even so, he believed that the answer was correct. Subject female S4 skipped the looking back process, paying attention to the unit area he was using. The same condition happens in the female S2 subject. According to Muir, et al. (2008), routine problem solvers do not have the effort to verify solutions to make several mistakes.

That there are differences in problem-solving both students with high achievement and students with moderate achievement. This is in line with Rahimah (2019) research, which states that there are differences in each process of solving problems in flat-shape material between students who have high, medium, or low abilities. Male high achievement students have included in the good problem solver category; high ability students are included in the naive problem solver category. Male high achievement students are also included in the naive category, while female moderate achievement students are routine problem-solving.

Good problem solving will show confidence when solving problems, find other strategies when experiencing obstacles. The problem-solving routine showed no effort to double-check strategy, so the answers were not correct overall, and verbal and written communication was only adequate. Meanwhile, the naive problem-solver could not find a problem-solving strategy and tended to manipulate numbers as the strategy used. The characteristics of problem solving carried out by each subject can be seen in Table 7.

Table 7. Characterictics Problem-Solver Each Subject

Categories Problem-Solver	**H-A**		**M-A**		**Descriptions**
	M	**F**	**M**	**F**	
Good Problem Solver	√				• Reread problem to understanding and manage to find a new information. • Find other strategies when experiencing obstacles. • Confidence when solving problems.
Routine Problem Solver				√	• No effort to double-check strategy. • There are some misconceptions about understanding a plane's area • Verbal and written communication was only adequate.
Naive Problem Solver			√		• Can not find a method of solving the problem at all. • Only manipulates the numbers available in the problem and takes advantage of the calculations operations.
		√			• Do not have the effort to verify solutions and make error in all of stages. • Stop when faced an obstacle.

	• appears to be manipulating only the numbers that appear in the problem.

Another difference can also be seen from the gender perspective. For high achievement, male subject are superior because they can look for other methods when experiencing obstacles. Meanwhile, female subjects tend to stop when they experience obstacles. The results of other studies show that female students tend to show wavering and hesitant gestures (Harisman et al., 2017). Meanwhile, for moderate achievement, female subjectss perform much better to male subjectss. Aunola, et al. (2004) found evidence that boys and girls' math achievement followed different developmental trajectories, with boys' predictions with higher attainment being higher but not right for boys with lower attainments. The results of other studies suggest that men have better mathematical and mechanical abilities than women; this difference is not significant at the primary school level but becomes more pronounced at higher levels (Susilowati, 2016). Mathematical achievement in men and women did not have a significant difference, even though the average score for men was higher (Ajai & Imoko, 2015; Vale, 2008).

Kent & Mertz (2012) revealed that the gender gap in mathematics learning is not only seen from gender, but there are socio-cultural factors, different educational experiences, and class attendance patterns. The same thing was conveyed by Lubienski, et al. (2013) and Leyva (2017) that student success in mathematics is not sufficiently seen from gender. However, there are psychosocial and contextual influences with race or ethnicity, culture, class, and other socially constructed identities. Although in this study has been seen that there are differences between men and women in using their knowledge and skills in solving problems by paying attention to problem-solving characteristics.

Conclusion

Primary school students' strategy to solve mathematics problems in Geometry, seen from gender differences, can be concluded by differences in problem-solving strategies carried out by male and female students. For high achievement, male subjectss perform much better, while for moderate achievement, female subjectss are perform better. Another difference is also seen in the characteristics of the problem solving carried out. A male student with high achievement is a good problem solver. A female student with moderate achievement is routine problem-solvers, and naive problem-solvers are a female student with high achievement and a male student with moderate achievement. Problem solvers are both confident and able to find other ways when they encounter obstacles. Routine problem solvers do not do the looking back process, so they make mistakes at some of the problem-solving stages, and naive problem solvers only manipulate the numbers on the problem into some calculation operations.

This study has limitations in taking the number of subjects, namely only taking subjects that represent their respective achievements. Therefore, it is interesting to conduct a study with a more specific participation measure for primary school students for further research. Researchers suggest paying attention to the level of problem-solving abilities between boys and girls who are more prominent. Teachers need to do this in order to take the right strategy in optimizing their problem skills based on the characteristics of each student.

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