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Gender Differences in Mathematical Proficiency: A Review of Mathematics Performance

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ABSTRACT

Mathematical proficiency is developed in students to be able to solve problems faced in everyday life appropriately and efficiently. This study focuses on one of the things that influence students' abilities, namely gender. This study aims to describe the process of mathematical proficiency in solving problems based on gender. The type of research used is qualitative with a case study design. The instruments of this study were a mathematical proficiency test, a mathematical proficiency test, and an interview guideline. The mathematical proficiency test was distributed to 136 students who were members of the natural sciences interest in one of the high schools in Kendari City. Students who meet the specified criteria, namely having mathematical proficiency equivalent to different genders, will be selected as research subjects. The data analysis techniques used are data reduction, data presentation, and drawing conclusions/verification. In this study, differences were found between male and female in solving problems, namely, male subjects can formulate and represent problems, can understand concepts, and apply procedures well so that they can solve problems, while female subjects can understand concepts, can formulate and represent problems, and do not choose procedures correctly so that they cannot solve problems correctly. In addition, they also have similarities, namely that both subjects represent problems with pictures, can explain the relationship between concepts and problems, and get ideas for solving problems based on everyday experiences. The productive disposition ability of male subjects supports in determining the strategies used in solving problems, while female subjects are less supportive in solving problems.

***Keywords*:** *Gender, mathematical proficiency, mathematical performance*

Perbedaan Gender dalam Kecakapan Matematis: Tinjauan Kinerja Matematika

ABSTRAK

Kemampuan matematika dikembangkan pada diri siswa agar mampu memecahkan masalah yang dihadapi dalam kehidupan sehari-hari secara tepat dan efisien. Penelitian ini difokuskan pada salah satu hal yang mempengaruhi kemampuan siswa yaitu jenis kelamin. Penelitian ini bertujuan untuk mendeskripsikan proses kemampuan matematika dalam memecahkan masalah berdasarkan jenis kelamin. Jenis penelitian yang digunakan adalah kualitatif dengan rancangan studi kasus. Instrumen penelitian ini berupa tes kemampuan matematika, tes kemampuan matematika, dan pedoman wawancara. Tes kemampuan matematika disebarkan kepada 136 siswa yang tergabung dalam peminatan IPA di salah

satu SMA di Kota Kendari. Siswa yang memenuhi kriteria yang ditentukan yaitu memiliki kemampuan matematika yang setara dengan jenis kelamin yang berbeda akan dipilih sebagai subjek penelitian. Teknik analisis data yang digunakan adalah reduksi data, penyajian data, dan penarikan simpulan/verifikasi. Pada penelitian ini ditemukan perbedaan antara laki-laki dan perempuan dalam menyelesaikan masalah yaitu subjek laki-laki dapat merumuskan dan merepresentasikan masalah, dapat memahami konsep, dan menerapkan prosedur dengan baik sehingga dapat menyelesaikan masalah, sedangkan subjek perempuan dapat memahami konsep, dapat merumuskan dan merepresentasikan masalah, serta tidak memilih prosedur dengan tepat sehingga tidak dapat menyelesaikan masalah dengan tepat. Selain itu juga memiliki kesamaan yaitu kedua subjek merepresentasikan masalah dengan gambar, dapat menjelaskan hubungan antara konsep dan masalah, serta mendapatkan ide penyelesaian masalah berdasarkan pengalaman sehari-hari. Kemampuan disposisi produktif subjek laki-laki mendukung dalam menentukan strategi yang digunakan dalam menyelesaikan masalah, sedangkan subjek perempuan kurang mendukung dalam menyelesaikan masalah.

Kata Kunci**:** *Jenis kelamin, kecakapan matematis, kinerja matematika*

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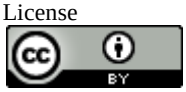 This work is licensed under a Creative Commons Attribution 4.0 International License.

1. Introduction

Education can support the formation of quality human resources by developing the skills possessed by students. Students can learn through the application of proficiency in obtaining, selecting, and processing information to solve problems faced. One form of proficiency that can be developed in the learning process is mathematical proficiency, which can be used as a basis for developing human resources. Mathematical proficiency is a person's ability to understand, apply, and reason mathematically to solve problems in various contexts of everyday life (Khalil & Alnatheer, 2020). Mathematical proficiency is skills that consist of five strands and are interrelated, namely conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (Altarawneh & Marei, 2021). Mathematical proficiency includes skills in logical thinking, analyzing patterns, understanding numerical concepts, and using mathematical tools and methods to make appropriate decisions.

One part of mathematical proficiency is conceptual understanding. Conceptual understanding is an understanding related to understanding a concept in mathematics, operations, and their relationships (Rittle & Siegler, 2021). Conceptual understanding functions to connect concepts that have been understood. Conceptual understanding is the level of learning where a person can explain a concept in their own words so that they can easily solve problems (Cerbito, 2020). The conceptual understanding that a person has can be known through the way they explain a concept used in solving problems. So conceptual understanding is a process of mental activity in understanding and explaining the relationship between concepts and applying them in solving problems. Conceptual understanding allows individuals to comprehend the relationships between concepts and the reasoning behind the procedures associated with them. Procedural fluency, on the other hand, enables accurate and efficient application of procedures. This suggests a reciprocal relationship: a strong conceptual

understanding helps individuals use procedures flexibly in various situations, while procedural fluency reinforces conceptual understanding by revealing patterns and connections between concepts. Therefore, procedural fluency not only facilitates mechanical problem-solving but also deepens one's understanding of the meaning and application of mathematical concepts.

Procedural fluency is knowledge of the rules, time, and how to use procedures properly, and skills in carrying out procedures flexibly, accurately, and efficiently (Schulz, 2023). A person has good procedural fluency when they can choose and apply the appropriate procedure so that they can solve problems (Rahman & Juniati, 2022). Learning procedural knowledge can result in the ability to classify objects and the ability to carry out a series of operational steps on an object. Procedurally fluent students seem to develop the ability to evaluate and simplify expressions, solve simple equations, and represent mathematical relationships graphically (Al-Mutawah et al., 2019). Procedural fluency is the knowledge of the proper use of procedures and the skills to use them flexibly, accurately, and efficiently. Procedural fluency enables the application of steps or algorithms in the problem-solving process. To select accurate and efficient steps, appropriate strategies must be used based on the problem's context. The ability to employ effective strategies is known as strategic competence. If students solve problems without strategic competence, they tend to merely follow procedures without considering alternative options that might be more effective. Therefore, strategic competence is essential for developing problem-solving abilities, enabling students to think more flexibly and efficiently when applying strategies to tackle problems.

Strategic competencies include skills in identifying problem situations, modeling problem situations, and solving problems by applying known mathematical concepts (Khalil & Alnatheer, 2020). Strategic competence is the knowledge that has been possessed regarding problem-solving strategies and using these strategies to analyze and solve problems faced in mathematics learning (Rahman & Juniati, 2022). Strategic competence is an activity carried out by students related to the cognitive abilities they have in helping students obtain strategies for understanding problem situations and using these strategies to solve problems (Schulz, 2023). Strategic competence can be used not only to solve problems in learning mathematics but also to solve problems in everyday life. Problems faced in learning can develop students' abilities in understanding problems, making plans, and implementing plans to solve problems mathematically in everyday life. Strategic competence is related to students' understanding of strategies and how to apply them in solving problems. The focus of strategic competence lies in the ability of students to choose strategies based on their knowledge, adjust to the problem situation, and apply the strategy appropriately. In addition, an important thing to develop in students is the ability to adjust strategies to various unexpected situations called adaptive reasoning. Adaptive reasoning is related to strategic competence, namely strategic competence is used by students to identify various ways to solve problems while adaptive reasoning is used to adjust the right strategy to various situations. Therefore, it is very important to apply adaptive reasoning in solving problems effectively by considering various possibilities and adapting their approach to the given situation.

Adaptive reasoning is the skill of thinking logically, reflecting, explaining, and justifying an idea or decision (Zhang et al., 2024). Adaptive reasoning functions to unite these components. When someone does adaptive reasoning, their cognitive structure will consider facts, procedures, and methods to solve the problems they face. Adaptive reasoning can make students not only answer, solve, and justify questions but also make guesses and generalize. Adaptive reasoning refers to a person's ability to adjust a solution strategy based on the given situation. To develop this ability, a positive attitude toward mathematics is essential. Productive disposition reflects a positive attitude, persistence, and confidence in one's ability to understand and solve problems. Therefore, having a strong disposition is crucial for students—not only to

adjust strategies in various situations but also to maintain the motivation and persistence needed to solve problems effectively.

Disposition is often used without a clear definition but can implicitly mean attitude. This attitude refers to a person's positive or negative assessment. Productive disposition is related to a person's attitude about the influence of positive ideas that are within a person. Productive disposition is the habit of seeing mathematics as something that makes sense, is useful, and is valuable, coupled with a belief in one's perseverance and success (Rahman & Juniati, 2022). A productive disposition reflects positive attitudes toward mathematics, where a person believes that mathematics can be understood, and has benefits. That hard work and perseverance in learning will lead to success. Students' attitudes and perceptions toward mathematics and the way they learn can affect their performance in the subject (Juniati, 2022). This positive attitude can also make students aware of the goals and benefits of learning mathematics.

Problem-solving is important in mathematics learning. Problem-solving can make students more active in using concepts to face new situations and focus on understanding mathematical ideas (Firdaus et al., 2019; Juniati, 2022). When solving problems, students will explore mathematical concepts in various relevant situations (Budayasa & Juniati, 2019). The main thing that influences someone in solving problems is the student's understanding of the concepts contained in the problem, the fluency of the procedure in solving the problem, the use of the right strategy, logically justifying the steps used, and believing that the problem can be solved so that this study will examine students' mathematical proficiency in solving problems based on gender.

Mathematics learning requires students to understand building new knowledge that comes from existing knowledge (Rahman & Juniati, 2023). Understanding is related to previous knowledge, namely new understanding is formed because of the relationship between ideas that form a network concept of existing knowledge (Setyawati, 2020). With good conceptual understanding, students can understand the importance of mathematical ideas and can use them in various contexts. Procedural fluency is described as the ability of students to link an algorithmic process to a problem so that problem-solving can be done correctly. Through algorithms, the fact that mathematics is structured (highly organized, full of patterns, predictable), and if the procedure is well developed then it can be a tool used to solve a problem. Therefore, procedural fluency also stimulates a person's reasoning power in solving a problem. Strategic competence is the ability of students to use the chosen strategy to formulate, represent, and solve problems. Adaptive reasoning can be used to provide a logical explanation related to the strategy used. Success in solving mathematical problems is also influenced by a positive attitude towards mathematics. When students have a positive attitude, they students will view that studying mathematics will be very useful for their future. A positive attitude of students in learning mathematics is a tendency to feel happy about certain materials or things during the learning process which can affect their learning outcomes.

Mathematics is an important subject to develop in students because mathematics is directly related to everyday life. However, based on the results of observations of one of the high schools in Kendari City, it was found that many students still think that solving problems related to mathematics is difficult compared to other subjects. This makes students feel lazy and insecure, so they do not have good skills in learning mathematics. Several researchers have found that mathematical proficiency affects mathematics learning outcomes but have not linked this to the influence of gender (Abdo & Elsayed, 2022; Yang & Kaiser, 2022). High school students consist of two genders, namely male and female with their respective characteristics. Different characteristics will make the mathematical proficiency possessed by students different. The study analyzed data from more than 2 million children aged 8 to 16 in rural India and found that male students scored higher in math than female students, with the gap widening with age

(Das & Singhal, 2023). Mathematical proficiency encompasses abilities that support analytical thinking processes and strategies for solving various mathematical problems. Conceptual understanding can be used by students to connect known concepts with problem situations, then procedural fluency is related to calculations used efficiently to solve problems. Strategic competence is related to how to choose and then applying strategies that are appropriate to problem situations while adaptive reasoning is related to choosing strategies logically in solving problems. In addition, productive disposition is related to positive attitudes and perseverance in learning that can affect students' success in solving problems. Thus, mathematical proficiency that is used effectively will also improve the ability to analyze, understand, and solve problems. Male students are generally more confident in taking risks and experimenting with various approaches to solving problems, while female students tend to be more thorough and follow procedures regularly (Widyawati et al., 2013). Gender shows differences in how students apply their problem-solving skills. Therefore, further research is essential to explore the relationship between math skills, gender, and students' problem-solving abilities.

The purpose of this study was to describe the mathematical proficiency of students who have different genders. Research on the relationship between gender and mathematical proficiency shows that gender differences can affect various aspects of students' mathematical proficiency. This is in line with the results of the study that problem-solving abilities in men and women have differences, namely accuracy or analysis (Setyawati et al., 2020). This is also in line with the results of the study that women have higher accuracy and can put together words to explain the answers obtained from the results of the analysis and more strategies in answering questions (Firdaus et al., 2019). Men express the interpretation of the answers obtained in incomplete sentences and through picture illustrations and tend to make mistakes in analyzing a question (Hafidz, 2019). For example, one study found that female students excelled in overall mathematical communication skills compared to male students (Nugraha & Pujiastuti, 2019). In terms of visualization, male students were better at drawing, while female students were more proficient in expressing mathematical ideas in writing (Al-Mutawah, 2019). Other studies have shown that male students tend to be more confident in taking risks and exploring different approaches to problem-solving, whereas female students are more meticulous and follow procedures systematically (Anwar et al., 2023). However, these findings show inconsistencies in the context of mathematical problem-solving. Additionally, there appears to be a lack of research specifically examining the application of mathematical proficiency in problem-solving across different genders.

2. Research Method

2.1 Type of Research/Design

This study aims to describe the mathematical proficiency of high school students who have different genders and equivalent mathematical performance or abilities in solving geometry problems. The research approach used is qualitative research with a descriptive design, namely conducting an in-depth examination of the process of students' mathematical proficiency in solving problems based on gender by observing, collecting data, analyzing data, and reporting the results. The process of mathematical proficiency goes through the stages of choosing a concept in mathematics that is appropriate to the problem situation, formulating the problem, representing the problem, choosing the right procedure to solve the problem, explaining the relationship between concepts and procedures to the problem situation, having confidence in being able to solve the problem, and enjoying the process of learning mathematics.

2.2 Research Subjects

This study involved 350 students from SMA Negeri 4 Kendari. The sample selection process began with the use of cluster random sampling, where all students were grouped based on their interest programs (natural sciences and social sciences) and age (15, 16, and 17 years old). Then, 131 students were selected using simple random sampling. The subjects were chosen through purposive sampling, considering their communication skills and willingness to be interviewed. Two subjects were selected based on gender: one male student with moderate mathematical performance and one female student with moderate mathematical performance.

2.3 Instruments

In this study, the researcher serves as the primary instrument, supported by auxiliary instruments, including a mathematical proficiency test, a mathematical proficiency test, an interview guide, and a productive disposition questionnaire. The mathematical proficiency test is a written essay test consisting of 10 questions covering various high school mathematics topics, namely a three-variable linear equation system, a two-variable linear inequality system, composition and inverse functions, trigonometry, linear programming, matrices, geometry, circle equations, sequences and series, and transformations. To assess mathematical proficiency, a test is administered with two geometry problems that must be solved. These problems involve determining the maximum number of jars with a diameter of 10 cm that can be placed on a rectangular tray measuring 41 cm × 19 cm and calculating the height of a cone-shaped bottle, where, when the pointed part is at the top, the distance to the water surface is 10 cm, and when the base of the cone is at the top, the distance to the water surface is 6 cm. The interview guide used in this study was developed based on mathematical proficiency indicators. The productive disposition questionnaire consists of closed-ended statements using a Likert scale and open-ended questions. The secondary instruments in this study have been validated and deemed reliable. Additionally, the auxiliary instruments have undergone validity and reliability testing and are considered suitable for use.

2.4 Procedure/Data Collection

A mathematical ability test was given to all 11th-grade students majoring in natural sciences. The results of the math ability test showed that 6 students had abilities equivalent to students who were male more than female. In the next step, the subjects were selected based on the considerations of the mathematics subject teachers who taught in 11th grade majoring in natural sciences so that two subjects were obtained, namely a male student and a female student. The analysis of this research data analysis which is divided into three stages, namely (1) data reduction which is focused on test answers and interview results which refer to indicators of visual-spatial intelligence by providing coding to the subjects; (2) data presentation which is carried out by systematically compiling test answers and interview transcript results in the form of a narrative whose meaning can be understood; and (3) conclusion drawing/verifying, namely the process of drawing conclusions and verification by assessing the achievement of students' visual-spatial intelligence indicators in solving geometry problems. To determine the validity of the data obtained, technical triangulation was applied. Technical triangulation refers to the use of various data collection techniques within a single research method to study a phenomenon. In this case, a combination of interviews and observations was used to obtain a more comprehensive perspective.

3. Results and Discussion

3.1 Results

The following are the results of the analysis of the mathematical proficiency process in both subjects:

Male Subject (S1)

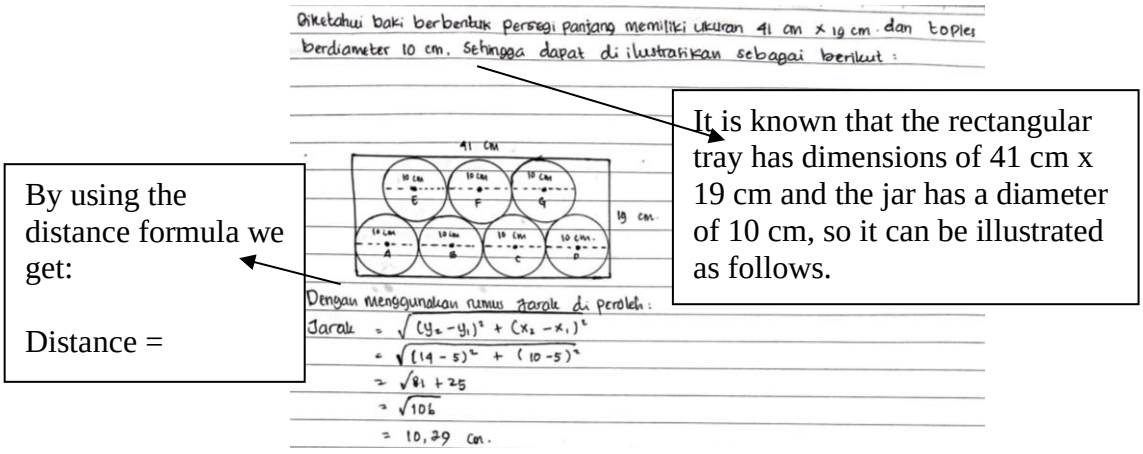

Figure 1. Solution S1 of Question 1

Based on Figure 1, it obtained that S1 can formulate the given problem by providing important information in question, namely what is known and asked. S1 shows that the question has information related to the length of the tray, the width of the tray, and the diameter of the jar and is asked to determine the number of jars on the tray. S1 can determine that the question is related to several concepts in mathematics, namely rectangles, circles, and the distance between two points. S1 calculates the number of jars contained on the surface of the tray by making circles whose diameters do not exceed the length and width of the tray. Then to ensure that the diameters of the circles do not overlap, the center point between the circles must be greater than or equal to the diameter of the circle. S1 can choose and apply procedures correctly so that he can solve the problem correctly.

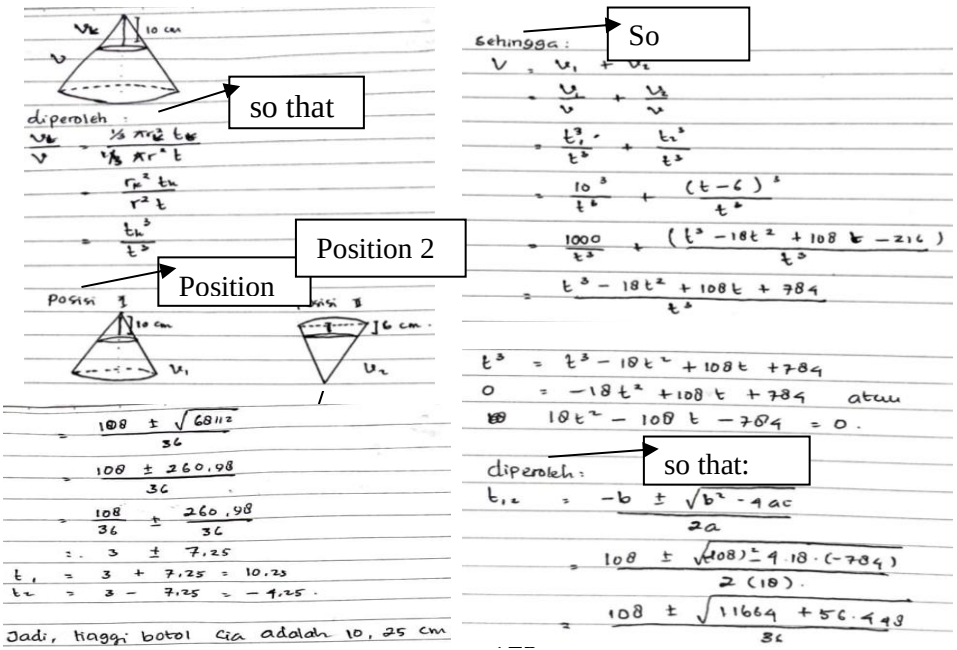

Figure 2. Solution S1 of Question 2

In the second question, S1 can find out important information, namely information that is known and asked in the question and then represent it in Figure 2. S1 relates this question to the concept of a cone in mathematics. S1 chooses a procedure and applies it correctly, namely calculating the volume of the cone by adding the volume of the cone when the pointed part is below and above. After that, S1 uses the quadratic equation formula to find out the height of the bottle. S1 can solve the given problem correctly. The summary of the interview results between the researcher (R) and the Subject (S1) is as follows:

R: *Are there any concepts in mathematics that are related to the problem? What concepts are related to the problem situation?*
S1: *Yes, this problem is related to mathematics. Hmmm... the concept of a circle, a rectangle, and the distance between two points.*
R: *Why are these concepts related to each other?*
S1: *I see a picture of a rectangle, a circle, and the center point of the circle. They are all related because they are part of geometry material.*
R: *How do you apply the procedure you choose to solve this problem?*
S1: *I calculate the distance between the center points of the jars using the formula* $\sqrt{(y_2 - y_1)^2 + (x_2 - x_1)^2}$ *. I determine the center point of each jar and then I enter it into the formula.*

The results of the researcher's interview with S1 showed that S1 remembered the material that had been obtained previously, could understand the concept in mathematics related to the problem, could choose the procedure correctly, could explain the concept and procedure to the problem situation so that the problem could be solved, besides that S1 had high confidence that he could solve the problem and a sense of pleasure in working on the problem.

Based on the explanation of the stages of the mathematical proficiency process of S1 in solving problems, it can be concluded in Table 1.

Table 1. Analysis of S1 mathematical proficiency

No	Mathematical Proficiency Indicators	S1 Responses
Conceptual Understanding		
1	Choosing a concept	S1 chooses a concept in its entirety by reading the question twice and then interpreting important information to form a picture related to the appropriate and correct concept through concrete objects.
Strategic Competence		
1	Formulating problems	S1 formulates problems by reading the question twice, choosing keywords in the question to obtain important information, namely information that is known and asked
2	Representing problems	S1 can present problems in the form of images based on important information obtained, namely information that is known and asked appropriately.
Procedural Fluency		
1	Choosing the right procedure	S1 knows the right procedure by paying attention to the concept that is appropriate to the problem and then adjusting it to previous experience.
Adaptive Reasoning		
1	Explaining the relationship between concepts and problem situations	S1 explains logically the relationship between concepts and problem situations using their language and concrete objects
2	Explaining the relationship between procedures and problem situations	S1 explains that each part that forms the chosen concept is identified logically and applied to the right formula

Disposition Productive		
1	Having confidence in being able to solve the problem	Very confident that the problem given can be solved because they know the important information contained in the problem
2	Enjoying the process of solving problems	S1 really enjoy solving problems because it can increase insight in learning mathematics

Based on the mathematical proficiency process of S1 in solving problems in numbers 1 and 2, it can be concluded that S1 can form a mental picture and mathematical model of the given problem, know important information in the problem then give meaning and function it completely and comprehensively to form a suitable and precise concept picture, information known and asked in the problem can be presented in the form of images, procedures can be selected and applied analytically through images, can explain the relationship between concepts and procedures to problem situations, have confidence and enjoy the process of solving problems so that they do not give up easily and keep trying to solve the problem.

Female Subject (S1)

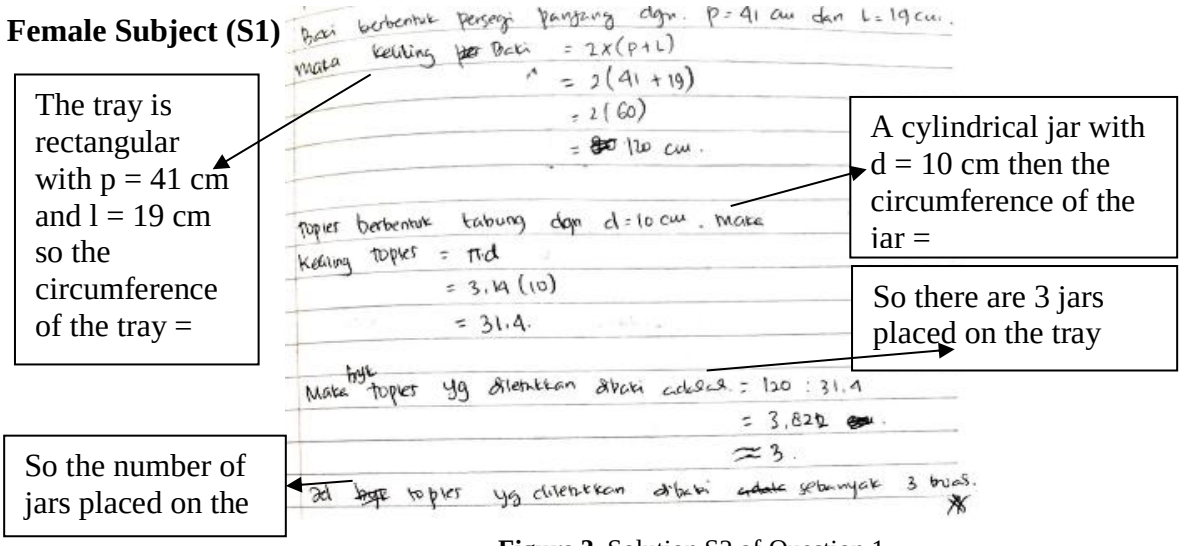

Figure 3. Solution S2 of Question 1

In Figure 3, it is found that S2 understands that there is a rectangular tray with a length of 41 cm and a width of 19 cm, there is also a jar with a circular base with a diameter of 10 cm, and it will be known how many jars can be placed on the tray. S2 can determine that the problem is related to several concepts in mathematics, namely rectangles and circles. S2 calculates the number of jars that fit on the surface of the tray by calculating the circumference of the tray and then calculating the circumference of the base of the jar. The number of jars that fit on the tray is known by dividing the circumference of the tray and the circumference of the base of the jar. S2 chooses the wrong procedure so that the problem cannot be solved correctly.

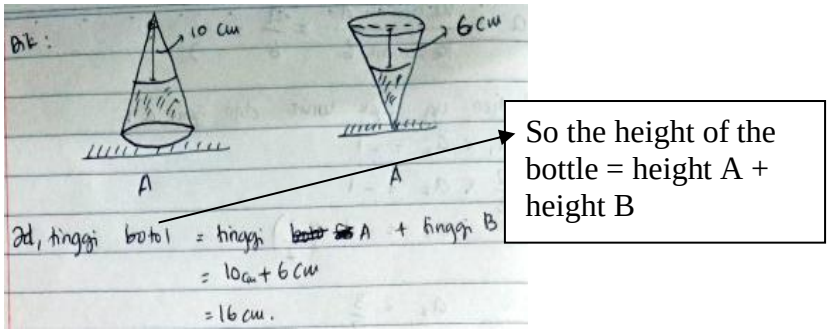

Figure 4. Solution S2 of Question 2

In question number 2, S2 knows that the known information is the difference between the water surface and the top of the bottle, and the information asked is the height of the bottle. S2 can determine that this question is related to the concept of a cone. Like the solution to number 1, S2 is not quite right in choosing the procedure so the solution obtained for the question is also not quite right. The summary of the interview results between the researcher (R) and the Subject (S2) is as follows:

R: *Are there any concepts in mathematics that are related to the problem? What concepts are related to the problem situation?*
S2: *It seems like there are, oh yes, there are… related to the concept of rectangle and circle*
R: *Why are these concepts related to each other?*
S2: *because the jar is circular, and the tray is rectangular*
R: *How do you apply the procedure you chose to solve this problem?*
S2: *I calculate the circumference of the tray using the formula for the circumference of a rectangle, which is 120 cm, and then I calculate the circumference of the jar using the formula for the circumference of a circle, which is 31.4 cm. Then I calculate 120 cm: 31.4 cm to get the number of trays, which is 3.*

The results of the interview between the researcher and S2, obtained that S2 remembered the material that had been obtained previously, could not understand the concept in mathematics related to the problem, could not choose the procedure correctly, could not explain the concept and procedure to the problem situation, besides that S2 had less confidence that he could solve the problem and did not feel happy in working on the problem. Based on the explanation of the mathematical proficiency process of S2 in solving problems, it can be concluded in Table 2.

Table 2. Analysis of S2 mathematical proficiency

No	Mathematical Proficiency Indicators	S2 Responses
Conceptual Understanding		
1	Choosing a concept	S2 chooses a concept by reading the question three times and then identifying it directly using concrete objects.
Strategic Competence		
1	Formulating problems	S2 formulates the problem by reading the question 3 times, drawing each sentence, the known information is formulated with a picture, the information asked is formulated verbally and not sequentially.
2	Representing problems	S2 can present problems in the form of pictures and formula symbols by considering every influencing element but ignoring areas that are not understood.
Procedural Fluency		
1	Choosing the right procedure	S2 knows the correct procedure by observing the picture and then thinking about and imagining everything related to the appropriate formula and then using knowledge from previous experiences.
Adaptive Reasoning		
1	Explaining the relationship between concepts and problem situations	S2 explains the relationship between concepts and problem situations using one's own language based on everyday life and concrete objects.
2	Explaining the relationship between procedures and problem situations	S2 explains procedures based on what is thought and imagined based on everyday life.
Disposition Productive		
1	Having confidence in being able to solve the problem	Not confident that he can solve the problem before understanding the problem given
2	Enjoying the process of solving problems	Less happy in solving problems because they do not know the right way to solve them

Based on the mathematical proficiency process of S2 in solving problems in numbers 1 and 2, it can be concluded that based on his experience she can form a mental picture and mathematical model of the given problem, knows important information in the problem but does not function it completely and comprehensively to form a suitable and precise concept picture, the information known and asked in the problem can be presented in the form of pictures and formula symbols, procedures cannot be selected and applied correctly, explain the relationship between concepts and procedures based on what is thought and imagined, have low self-confidence and do not enjoy the process of solving problems so that they are lacking and give up easily in solving problems.

3.2 Discussion

The study results show that, despite having equal mathematical performance, gender differences influence the application of mathematical proficiency in problem-solving. Gender differences can affect an individual's way of thinking when addressing problems. Gender has a relationship with students' ability to solve mathematical problems (Firdaus et al., 2019). In solving problems, men use less time than women (Anwar et al., 2023). Male subjects can visualize the information contained in the problem with high motivation, while female subjects use media or tools to understand the problem situation with high motivation (Rahman & Juniati, 2023). Variations in students' problem solving can be caused by differences in student gender. This study indicates that male subjects can effectively solve problems by maximizing their mathematical proficiency, while female subjects have not yet applied them optimally, resulting in difficulties in solving given problems. Additionally, male subjects tend to provide solutions through more complete visual representations compared to female subjects. In this case, men demonstrate better problem-solving skills than female subjects. This aligns with previous research findings, which suggest that men are generally better at solving problems than women (Firdaus et al., 2019). Gender differences contribute to the adoption of different strategies in problem-solving.

Male subjects are fully able to use mathematical proficiency. This ensures more complex strategies for problem-solving. Demonstrate conceptual understanding by selecting the right concept for the situation in question, reading the question first, and then explaining it to understand the mathematical concept. Strategic competence is demonstrated by efficiently extracting important information from the problem. This takes a minimum of time. This can be explained by reading the question twice, explaining it through visualization, and presenting the information using diagrams and equation symbols that allow you to select related concepts and procedures. Procedural fluency is used by visual representation, allowing you to correctly select and apply problem-solving procedures. Adaptive thinking is demonstrated in his ability to provide logical explanations of the relationship between concepts and concrete objects and problems. For example, the description of a table as a tray, a coin as a glass, or a pen as an inverted cone. In addition, the male subject explains the relationship between the problem process and concrete objects by describing a cone that can physically manipulate the coin and move the pen to be inverted. Furthermore, a productive attitude with your belief in your abilities has been shown to stop your problems and your joy in solving problems. This result follows the result that using mathematical proficiency allows problems to be divided into smaller, more easily solved pieces (Hamid et al., 2020). Mathematical proficiency plays a very important role in solving various types of problems in everyday life. Mathematical proficiency includes several important aspects such as conceptual understanding, numeracy skills, problem-solving, logical reasoning, and the ability to use mathematical models in real situations. The application of mathematical proficiency can help in solving various problems with a logical, systematic, and data-based approach. By applying mathematical proficiency as a whole, students can

improve their critical thinking skills, make better decisions, and solve problems effectively in various aspects of life (Oyoo, 2022).

Female subjects are unable to fully apply their mathematical proficiency, resulting in less-than-optimal problem-solving. They demonstrate their conceptual understanding by only partially comprehending the problem situation, leading to the selection of mathematical concepts that do not align with the given problem. Their conceptual understanding is applied by taking more time to extract key information from the problem, reading it three times before identifying the known and required information. Additionally, female subjects represent the problem situation using incomplete diagrams and symbols, preventing them from selecting appropriate concepts and procedures. Procedural fluency is applied based on an incomplete understanding of the problem, leading to the use of formulas that do not accurately match the problem situation. Adaptive reasoning is demonstrated by explaining the relationship between concepts and problem situations using real objects adapted from everyday life. Furthermore, female subjects attempt to connect problem-solving procedures to real-life situations through illustrations and contextual examples. However, productive disposition is lacking, as they exhibit low confidence in their ability to solve problems and do not enjoy the problem-solving process due to uncertainty about the correct approach. The results of this study align with previous findings that the incomplete application of mathematical proficiency can cause students to struggle with problem-solving due to a lack of deep conceptual understanding, limited logical reasoning abilities, and difficulty in modeling problems effectively (Rahman & Juniati, 2023). If students merely memorize formulas without understanding their meaning, they will struggle to apply them in different situations. Additionally, weak numeracy skills can lead to calculation errors, even when the underlying concept is understood (Rakhmawati & Mustadi, 2022). A lack of logical thinking skills also causes students to become confused when faced with more complex problems that require multiple steps to solve (Khalid, 2020). So, students are unable to solve problems effectively because there is no systematic and comprehensive mathematical approach. The application of incomplete mathematical proficiency hinders students' ability to understand, reason, and solve problems efficiently. Therefore, it is important for students to develop a strong conceptual understanding, solid numeracy skills, and critical and logical thinking skills to successfully solve various mathematical problems.

Studies on gender-specific differences in solving mathematical problems have yielded mixed results. In some studies, male students tend to perform better in certain aspects such as visual-spatial skills, while accuracy and organizational students are better (Nurcholis et al., 2021). However, other studies have shown no significant difference between males and females in overall mathematical proficiency (Bartlett & Camba, 2023). In addition, some results suggest that differences in mathematical proficiency between men and women are more influenced by social and psychological factors than biological factors. Gender-specific differences in mathematical proficiency are generally small and insignificant, with men tending to solve spatial problems, while women show stronger conceptual understanding (Soenarjadi, 2020). Furthermore, males generally exhibit higher self-confidence in mathematics, even when their skill levels are similar to those of females (Hanifah et al., 2020). PISA data also show that variations in mathematics services across countries depend on learning environments and social expectations rather than gender differences between students. Therefore, promoting integrated education and eliminating gender stereotypes can help minimize mathematics disparities, allowing all students to reach their full potential.

4. Conclusion

Based on the research on the process of mathematical proficiency in solving geometric problems, we found a problem that solves the problem between male and female subjects. In terms of conceptual understanding, male and female topics can understand the concept by identifying important information in the problem. However, while male subjects are encouraged to choose and select the correct concept, female subjects are completely wrong. In terms of strategic competence, male subjects take less time to understand the question compared to female subjects. Male subjects can visualize the intended information and represent it through diagrams, while female subjects can represent inappropriate information. Regarding procedural fluency, male subjects were better at selecting and applying the correct procedure to solve the problem correctly, whereas female subjects tended to choose and apply less appropriate procedures. In the aspect of adaptive reasoning, both male and female subjects were able to explain the relationship between concepts and procedures in problem situations using their own words. In terms of productive disposition, male subjects exhibited greater confidence and enjoyment in solving problems compared to female subjects. However, based on the researcher's observations of both subjects' behavior at each stage, they shared a similarity—both generated problem-solving ideas based on their daily experiences.

This study was conducted specifically for students, emphasizing the importance of teachers knowing how to select and apply effective teaching strategies. Additionally, gender is a key concern in this study, as it can influence students' problem-solving outcomes. Gender differences may lead to variations in students' information processing and understanding. Therefore, further research is needed to explore whether students' abilities are influenced by gender or by their existing conceptual understanding. Teachers should incorporate a non-routine problem-solving approach in their teaching to help students enhance their mathematical proficiency. This study focuses solely on students with different genders; hence, further research is required to examine mathematical proficiency from other perspectives.

5. References

Abdo, S., & Elsayed, M. (2022). The effectiveness of learning mathematics according to the STEM approach in developing the mathematical proficiency of second graders of the intermediate school. *Education Research International*, *2022*(1), 5206476. https://doi.org/10.1155/2022/5206476

Al-Mutawah, M. A., Thomas, R., Eid, A., Mahmoud, E. Y., & Fateel, M. J. (2019). Conceptual understanding, procedural knowledge and problem-solving skills in mathematics: High school graduates work analysis and standpoints. *International Journal of Education and Practice*, 7(3), 258–273. https://doi.org/10.18488/journal.61.2019.73.258.273

Altarawneh, A. F., & Marei, S. T. (2021). Mathematical proficiency and preservice classroom teachers' instructional performance. *International Journal of Education and Practice*, 9(2), 354–364. https://doi.org/10.18488/journal.61.2021.92.354.364

Anwar, I. N., Hidayati, S. A., Fadilah, J. R., & Sukirwan, S. (2023). Studi Investigasi Matematis Siswa: Perbandingan Antara Kepribadian Ekstrovert dan Introvert. *Journal of Authentic Research on Mathematics Education (JARME)*, *5*(1), 85-98. https://doi.org/10.37058/jarme.v5i1.6256

Bartlett, K., & Camba, J. D. (2023). Gender Differences in Spatial Ability: a Critical Review. *Educational Psychology Review*, 35(8). https://doi.org/10.1007/s10648-023-09728-2

Budayasa, I. K., & Juniati, D. (2019). The Influence of Cognitive Style on Mathematical Communication of Prospective Math Teachers in Solving Problems. *Journal of Physics: Conference Series*, 1417(1). https://doi.org/10.1088/1742-6596/1417/1/012056

Cerbito, A. F. (2020). Comparative Analysis of Mathematics Proficiency and Attitudes Toward Mathematics of Senior High School Student. *International Journal of Scientific and Research Publications (IJSRP)*, 10(05), 211–222. https://doi.org/10.29322/ijsrp.10.05.2020.p10125

Das, U., & Singhal, K. (2023). Solving it correctly: Prevalence and persistence of gender gap in basic mathematics in rural India. *International Journal of Educational Development*, 96(02), 102703. https://doi.org/10.1016/j.ijedudev.2022.102703

Firdaus, A. M., Juniati, D., & Wijayanti, P. (2019). Generalization Pattern's Strategy of Junior High School students based on Gender. *Journal of Physics: Conference Series*, 1417(1). https://doi.org/10.1088/1742-6596/1417/1/012045

Hafidz, A. A. (2019). Pengaruh Jenis Kelamin Terhadap Hasil Belajar Matematika Siswa. *Buana Matematika : Jurnal Ilmiah Matematika dan Pendidikan Matematika*, 9(2:), 69–72. https://doi.org/10.36456/buanamatematika.v9i2:.2118

Hamid, H., Angkotasan, N., Jalal, A., Muhtadi, D., & Sukirwan. (2020). Students' mathematical proficiency in solving calculus problems after Maple implementation. *Journal of Physics: Conference Series*, 1613(1). https://doi.org/10.1088/1742-6596/1613/1/012025

Hanifah, Waluya, S. B., Asikin, M., & Rochmad. (2020). Analisis Self-Efficacy Dalam Pembelajaran Matematika Dilihat Dari Gender. *Prosiding Seminar Nasional Pascasarjana (PROSNAMPAS)*, 3(1), 262–267. https://proceeding.unnes.ac.id/index.php/snpasca/article/view/612

Juniati, D. (2022). The effect of learning style on problem solving strategies of prospective mathematics teachers. *AIP Conference Proceedings*, 2577(1). https://doi.org/https://doi.org/10.1063/5.0096017

Khalil, I., & Alnatheer, M. (2020). Developing a Learning Unit in Light of the Integration Between the Mathematical Proficiency and the 21St Century Skills. *INTED2020 Proceedings*, 1(April), 2501–2506. https://doi.org/10.21125/inted.2020.0761

Nugraha, T. H., & Pujiastuti, H. (2019). Analisis Kemampuan Komunikasi Matematis Siswa Berdasarkan Perbedaan Gender. *Edumatica : Jurnal Pendidikan Matematika*, 9(1), 1–7. https://doi.org/10.22437/edumatica.v9i1.5880

Nurcholis, R., Azhar, E., & Miatun, A. (2021). Matematis Siswa Ditinjau Dari Perbedaan Gender. *Euclid*, 8(1), 41–50. https://doi.org/10.33603/e.v8i1.3205

Oyoo, P. O. (2022). Exploring Students' Proficiency in Mathematical Symbolization. *International Journal of Advanced Research*, 5(1), 117–130. https://doi.org/10.37284/ijar.5.1.774

Rahman, M. & Juniati, D. (2022). Strategic competence in solving-problem and productive disposition of high school students based on cognitive styles. *AIP Conference Proceedings*, 1(2577(1):020053). https://doi.org/http://dx.doi.org/10.1063/5.0096029

Rahman, M.S & Juniati, D. (2023). The quality of mathematical proficiency in solving geometry problem: difference cognitive independence and motivation. *Pegem Journal of Education and Instruction*, 13(3), 255–266. https://doi.org/10.47750/pegegog.13.03.27

Rakhmawati, Y., & Mustadi, A. (2022). The circumstances of literacy numeracy skill: Between notion and fact from elementary school students. *Jurnal Prima Edukasia*, 10(1), 9–18. https://doi.org/10.21831/jpe.v10i1.36427

Rittle, J. B., & Siegler, R. S. (2021). The relation between conceptual and procedural knowledge in learning mathematics: A review. *The Development of Mathematical Skills*, January 1998, 75–110. https://doi.org/10.4324/9781315784755-6

Schulz, A. (2023). Assessing student teachers' procedural fluency and strategic competence in operating and mathematizing with natural and rational numbers. *Journal of Mathematics Teacher Education*, 27(6), 981–1008. https://doi.org/10.1007/s10857-023-09590-7

Setyawati, D. U., Febrilia, B. R. A., & Nissa, I. C. (2020). Profil Kemampuan Berpikir Kritis Mahasiswa dalam Menyelesaikan Soal Pemecahan Masalah Matematika Ditinjau dari Jenis Kelamin. *Jurnal Didaktik Matematika*, 7(1), 90–104. https://doi.org/10.24815/jdm.v7i1.15709

Soenarjadi, G. (2020). Profil Pemecahan Masalah Siswa dalam Menyelesaikan Masalah Geometri ditinjau dari Perbedaan Jenis Kelamin dan Gaya Belajar. *Jurnal Riset Pendidikan Dan Inovasi Pembelajaran Matematika (JRPIPM)*, 3(2), 78. https://doi.org/10.26740/jrpipm.v3n2.p78-91

Widyawati, E. P. A. L., Arifin, N., Farhah, A., Nurul, C., & Amalina. (2013). Perspektif Gender Dalam Pembelajaran Matematika. *Marwah: Jurnal Perempuan, Agama Dan Jender*, 12(1), 15. https://doi.org/10.24014/marwah.v12i1.511

Yang, X., & Kaiser, G. (2022). The impact of mathematics teachers' professional competence on instructional quality and students' mathematics learning outcomes. *Current Opinion in Behavioral Sciences*, 48, 101225. https://doi.org/10.1016/j.cobeha.2022.101225

Zhang, Z., Chen, J., & Yang, D. (2024). Darg: Dynamic evaluation of large language models via adaptive reasoning graph. *arXiv preprint arXiv:2406.17271*. https://doi.org/10.48550/arXiv.2406.17271