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COMPARATIVE STUDY OF STUDENTS' VISUAL-SPATIAL INTELLIGENCE IN GEOMETRY PROBLEMS FROM A GENDER PERSPECTIVE

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ABSTRACT

This study aims to analyze visual-spatial intelligence in the subject of solid geometry from a gender perspective. The research employs a qualitative approach with a descriptive method. The subjects of this study were eighth-grade students at a public junior high school in Tasikmalaya City. The primary instrument of this research was a geometry test designed to measure visual-spatial intelligence through aspects such as imagination, conceptualization, problem-solving, and pattern recognition. The findings revealed significant differences between male and female students in visual-spatial intelligence. Male students demonstrated superior visual-spatial intelligence compared to female students, as evidenced by their better performance in the aspects of imagination, conceptualization, problem-solving, and pattern recognition. On the other hand, female students only excelled in conceptualization and problem-solving. The implications of this study suggest that gender-based differences in visual-spatial intelligence require special attention in the development of teaching methods that can help reduce this gap, particularly in areas that present challenges for female students.

Penelitian ini bertujuan untuk menganalisis kecerdasan visual spasial pada materi bangun ruang sisi datar dari perspektif gender. Penelitian ini menggunakan pendekatan kualitatif dengan metode deskriptif. Subjek penelitian adalah peserta didik kelas VIII di salah satu SMP negeri di Kota Tasikmalaya. Instrumen utama penelitian ini adalah soal tes geometri yang dirancang untuk mengukur kecerdasan visual spasial dengan aspek-aspek: pengimajinasian, pengkonsepan, pemecahan masalah, dan pencarian pola. Hasil penelitian mengungkapkan adanya perbedaan signifikan antara peserta didik laki-laki dan perempuan dalam kecerdasan visual spasial. Peserta didik laki-laki menunjukkan kecerdasan visual spasial yang lebih unggul dibandingkan dengan peserta didik perempuan. Hal ini terlihat dari kemampuan mereka yang lebih baik dalam memenuhi aspek pengimajinasian, pengkonsepan, pemecahan masalah, dan pencarian pola. Di sisi lain, peserta didik perempuan hanya memenuhi aspek pengkonsepan dan pemecahan masalah. Implikasi dari penelitian ini menunjukkan bahwa perbedaan kecerdasan visual spasial berdasarkan gender perlu mendapatkan perhatian khusus dalam pengembangan metode pengajaran yang dapat membantu mengurangi kesenjangan tersebut, khususnya pada aspek-aspek yang menjadi tantangan bagi peserta didik perempuan.

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1. INTRODUCTION

Visual-spatial intelligence is one of the essential components in the Multiple Intelligences theory proposed by Howard Gardner (Fadhil & Prastiwi, 2024). This intelligence involves an individual's ability to effectively understand, interpret, and manipulate visual information, which is highly relevant in fields such as mathematics and architecture, where visual understanding and spatial relationships play a key role (Kusumaningtyas & Dewi, 2023; Tiwari et al., 2024). In the context of mathematics education, visual-spatial intelligence allows students to imagine objects in space, recognize patterns, and understand diagrams or maps, all of which are crucial in learning geometry (Naufal & Juandi, 2024; Herrera et al., 2024). However, not all students possess the same visual-spatial abilities, and one factor that influences this variation is gender (Tsigeman et al., 2023). Previous research has shown significant differences between males and females in visual-spatial intelligence, with males generally showing higher abilities in tasks requiring spatial understanding (Ferrández et al., 2019; Yurmalia & Hasanah, 2021; Fioriti, 2024).

This issue is of significant concern because visual-spatial intelligence strongly correlates with mathematical achievement, particularly in studying geometry, one of the branches of mathematics most reliant on this ability (Lowrie et al., 2019; Novitasari et al., 2021; Triutami et al., 2021). If there is a disparity in visual-spatial intelligence between males and females, it could create a gap in learning outcomes (Reilly, 2019). A study by Harris et al. (2023) found that visual-spatial intelligence positively correlates with performance in mathematical tasks, especially those involving geometric concepts. This difference in ability can affect students' learning experiences in the classroom, potentially leading to inequality in learning opportunities and academic achievement, which ultimately impacts overall performance in mathematics education (Ramírez-Uclés & Ramírez-Uclés, 2020).

The educational context in Indonesia adds urgency to further investigate this issue. Based on the results of the PISA (Programme for International Student Assessment) 2022, Indonesia ranked low in global mathematical ability, scoring 366, far below the OECD average of 465-475 (OECD, 2022). One of the main factors contributing to this poor performance is the weak understanding of geometry content among students, which heavily relies on visual-spatial intelligence (Utami, 2019; Masfingatin et al., 2020; Prihandika et al., 2022). Gender differences in visual-spatial intelligence could be one of the causes of this imbalance (Marhaeni et al., 2023). Therefore, researchers and educators need to understand the extent to which these differences affect learning outcomes so that more effective and inclusive teaching strategies can be developed.

Although several studies have examined gender differences in visual-spatial intelligence and its impact on mathematics learning, there remains a gap in the literature that integrates these two aspects in the context of learning geometry, particularly on the topic of polyhedrons. Research by Zakelj & Klančar (2022) revealed that visual-spatial intelligence plays an important role in geometry learning, especially in understanding three-dimensional representations. However, this study focused more on the influence of visual-spatial intelligence in general without considering the gender factor. On the other hand, research by Silitonga et al. (2024) found significant gender differences in visual-spatial ability, with males showing superior performance in certain tasks. However, this study did not directly link it to geometry learning. Meanwhile, the study conducted by Chamizo et al. (2023) highlighted the importance of specifically designed interventions to improve visual-spatial intelligence in female students, showing that gender differences in this ability can be minimized through appropriate learning methods. Another study by Aziz et al. (2020) indicated that higher visual-spatial intelligence in male students could have a positive impact on their geometry achievement; however, this research was limited to mathematical analysis without including specific contexts such as polyhedrons.

Therefore, there is still little research that comprehensively explores how gender differences in visual-spatial intelligence affect geometry learning on specific topics, such as polyhedrons, which are an essential part of the mathematics curriculum. This study aims to fill that gap with a more in-depth and comprehensive approach. The focus of this research is to analyze visual-spatial intelligence in male and female students in the context of geometry learning on the topic of polyhedrons. Very few studies specifically examine both of these aspects within an integrated study framework, so this research is expected to make a significant contribution to the development of more inclusive and effective teaching strategies. As such, the results of this study are not only important for educators seeking to improve the quality of mathematics learning but also for policymakers striving to enhance Indonesian students' mathematics achievement on the international level, particularly in the field of geometry.

2. METHODS

This study employs a qualitative approach to describe students' visual-spatial intelligence, particularly in the context of polyhedrons. A qualitative approach was chosen because it provides flexibility in deeply exploring phenomena and allows researchers to gain a richer understanding of students' thought processes (Adhikari & Timsina, 2024). In line with Pranajaya's (2024) opinion, this approach helps researchers explore the meanings and interpretations of students' experiences, thereby uncovering the cognitive strategies they use in solving problems related to spatial visualization.

2.1. Research Subject

The subjects of the study were students from class VIII-G who were selected purposively. The selection of subjects was conducted based on specific considerations, taking into account recommendations from the mathematics teacher. According to Dejonckheere et al. (2024), purposive sampling is a technique in which subjects are chosen based on specific considerations and objectives, allowing researchers to focus on individuals most relevant to the research questions. In the context of this study, subjects were chosen from both male and female students who demonstrated good performance in mathematics. This decision was based on research showing that academic achievement can be an important indicator of understanding gender differences in mathematical understanding (Lu et al., 2023). The criteria for subject selection were based on class rankings and achievement of scores that met the minimum competency criteria (KKM) in mathematics, as students who reached the KKM are considered to have a sufficient basic understanding to participate in more complex tests (Sarah et al., 2022).

2.2. Data Collection

The main instrument used in this research is a geometry test designed to measure students' visual-spatial intelligence. This test is created to assess the ability to imagine, conceptualize, solve problems, and identify patterns, particularly in the context of polyhedrons. Handayani (2023) explains that visual-spatial intelligence is the ability to process visual and spatial information effectively, which is crucial in understanding geometry. The test is supported by previous research findings indicating that tasks involving visualization and manipulation of spatial objects can reveal significant differences in the level of visual-spatial intelligence between individuals (Herawati & Hariyani, 2024).

In this study, data collection techniques involve administering a geometry test designed to measure indicators of visual-spatial intelligence and conducting unstructured interviews. The main instrument used is the researcher, who acts as the key to collecting and analyzing data to minimize subjectivity and avoid bias in the research results. The researcher serves as the planner, data collector, analyst, and data processor (Sukmawati et al., 2019). Supporting instruments used in this research include the visual-spatial intelligence test, which has undergone validation and is deemed appropriate for use. This test instrument is prepared based on the visual-spatial intelligence indicators proposed by Haas (2003), namely imagining, conceptualization, problem-solving, and pattern recognition. Another instrument is the interview guide. Additionally, an interview guideline in the form of a question outline is prepared, allowing questions to evolve according to the student's responses. With this approach, it is hoped that the collected data will provide an accurate and comprehensive depiction of students' visual-spatial intelligence in the context of geometry.

2.3. Data Analysis

The data analysis techniques used in this research align with qualitative research data analysis techniques. Data analysis, as simply described by Auerbach & Silverstein (2003), is outlined in three stages: data reduction, data display, and conclusion drawing and verification.

3. RESULTS AND DISCUSSION

3.1. Results

The researcher analyzed students' visual-spatial intelligence using data obtained from test results and interviews. This analysis was conducted by separating students' responses based on gender, specifically male and female students. The analysis process covered aspects of visual-spatial intelligence, including imagination, conceptualization, problem-solving, and pattern recognition, as follows.

Imagination

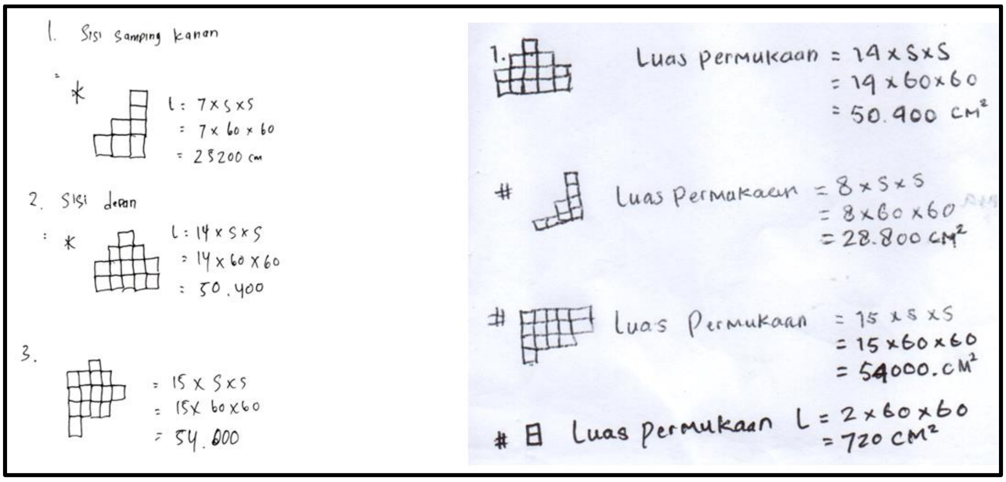

Figure 1. Male Students' Test Answers on the Imagining Indikator

Based on Figure 1, male students demonstrated good imagination skills. The students were able to effectively utilize the images to solve problems, particularly in drawing the two-dimensional projection of a cube. This process shows that they not only drew the cube accurately but also deeply understood how the object appears from various perspectives. This ability reflects their visual-spatial intelligence, which allows them to imagine and manipulate objects in space effectively. Furthermore, the students could accurately depict problem-solving through perspective shifts from various angles, demonstrating proficiency in adapting views and understanding visual transformations of objects. This highlights how their visual-spatial intelligence supports their ability to process and visualize spatial information in a complex manner, as reinforced by the interviews conducted by the researchers with the male students as follows:

R : Do you understand the meaning of question number 1? Try to explain!

MS : Yes, Miss. The question is asking us to find the parts that are visible but blocked by the wall, so we need to look from the front, the right side, and the top.

R : Can you imagine the stack of boxes from the sides mentioned?

MS : Yes, Miss. I imagine that from the front side, there are 14 visible objects, then I calculate the area by multiplying the number of boxes by the formula for the area of a square, so this is 14 times 60 times 60, which equals 50,400 cm².

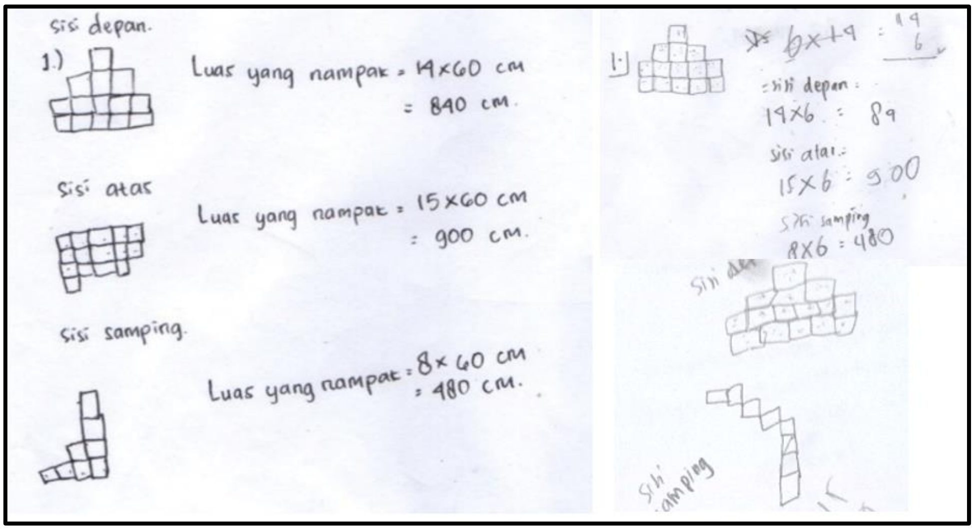

Figure 2. Female Students' Test Answers on the Imagining Indicator

Based on Figure 2, female students show limitations in the characteristic of imagining, which is a crucial component of visual-spatial intelligence. The student's inability to depict a cube from various viewpoints indicates difficulty in manipulating and visualizing objects mentally, an essential skill in spatial thinking. Additionally, their failure to effectively use images to solve problems shows that the visual-spatial skills needed to understand and address problematic situations have not yet been fully developed. To confirm these results and gain a deeper understanding of the students' visual-spatial thinking processes, the researcher conducted follow-up interviews with female students.

R	:	*Do you understand what number 1 means? Try to explain it!*
FS	:	*Drawing which looks the same and calculating the surface area.*
R	:	*How do you draw it?*
FS	:	*Do the part that is visible in the front first, then the side and the top. For the front part, there are 14, so multiply it by s.*
R	:	*Were you able to draw it according to the given position?*
FS	:	*It was a bit difficult, Miss.*

Conceptualization

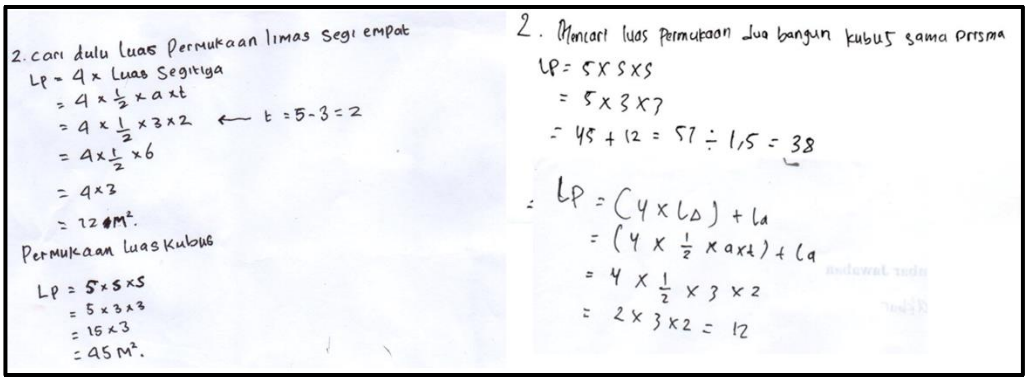

Figure 3. Male Students' Test Answers on the Conceptualizing Indicator

Based on Figure 3, male students exhibit strong visual-spatial intelligence characteristics in their conceptualizing abilities. They can accurately identify relevant concepts to solve the given problems, demonstrating a deep understanding of the relationship between known data and previously learned concepts. Additionally, the students present the information obtained from the problems in a structured and logical manner, reflecting their ability to connect and visualize data effectively in their minds. This indicates that the students possess good visualization skills, allowing them to see relationships and patterns that may not be immediately apparent to others, which is a hallmark of visual-spatial intelligence. To confirm these results and further understand the students' visual-spatial thinking processes, the researcher then conducted interviews with the male students.

R	:	*How about question number 2, do you understand what it means?*
MS	:	*For question number 2, you need to find out how much money is needed to build the tent.*
R	:	*How did you solve it?*
MS	:	*There are two shapes, Miss, a pyramid and a cube. First, find the surface area of the pyramid, then find the surface area of the cube.*
R	:	*What does 't equals 5 minus 3' mean?*
MS	:	*The height of the tent here is 5 meters, and the size is 3 meters (while pointing at the picture of the cube), so the height of the pyramid is 2 meters*

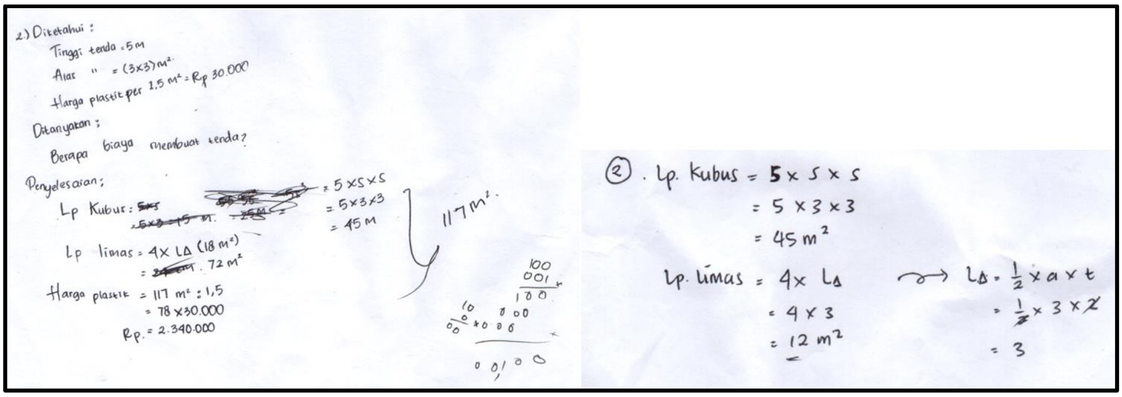

Figure 4. Female Students' Test Answers on the Conceptualizing Indicator

Based on Figure 4, the female student demonstrates good conceptualization characteristics, reflecting her visual-spatial intelligence. This is evident from her ability to accurately record the necessary data to solve the problem and correctly apply that data in calculating the surface area of a cube and a pyramid. Although there was an error in recording the data related to the area of the triangle, which led to inaccuracies in the final calculation, the student displayed a high level of self-awareness by recognizing and correcting the mistake. This awareness indicates strong visual-spatial intelligence and metacognitive abilities that support a deeper conceptual understanding. The evidence of this awareness and understanding is confirmed through the following interview.

R : *Do you understand what number 2 is asking?*

FS : *Um... we need to find out how much it will cost Anggi to make the tent.*

R : *How did you calculate it?*

FS : *I found the surface areas one by one, the surface area of the cube, and the surface area of the pyramid.*

R : *What does this triangle area ($18m^2$) mean?*

FS : *18 was the result of the triangle's area, Miss, but I made a mistake because the formula is half times the base times the height. The base is 3 and the height is 2. So the area of the triangle should be 2, ma'am.*

Problem-Solving

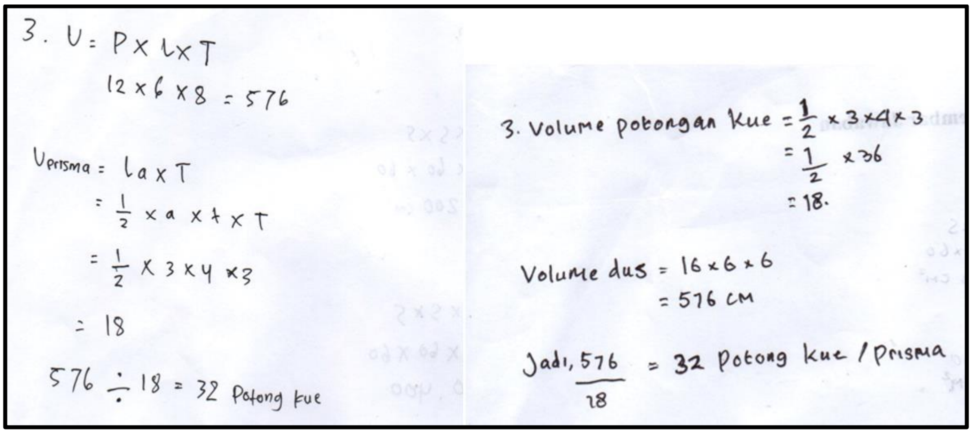

Figure 5. Male Students' Test Answers on the Problem-Solving Indicator

Based on Figure 5, the male student demonstrates good visual-spatial intelligence by successfully solving the problem accurately. The student can clearly express his ideas, reflecting his ability to visualize and organize information. He systematically outlines the steps to solve the problem, starting with identifying the key elements and data needed to solve it. The student then arranges these steps in a logical sequence, including relevant calculation methods and the application of appropriate concepts. This process reflects the student's ability to efficiently plan and execute solutions, as well as to organize information in a structured manner to achieve the correct result. The researcher then interviewed the male student to further explore his visual-spatial intelligence, as follows.

R : *Do you understand what the number 3 means? Try to explain!*

MS : *Yes, it's about calculating the number of cake pieces in a box. The cake pieces are shaped like a prism.*

R : *How did you calculate it?*

MS : *First, I found the volume of the box, which is 576, and then I found the volume of the prism, which is 18. Then, I just divided them to get the result: 32 cake pieces or prisms.*

R : *Where did you get the length, width, and height of the box from?*

MS : *The size of the prism is 1 (while pointing at the problem), this part is 3, the length of the box is 4, so I multiplied them to get the length, which is 12. Then, the width is 3 multiplied by 2, so it's 6, and then this part is 4, so the height is multiplied by 2, making it 8.*

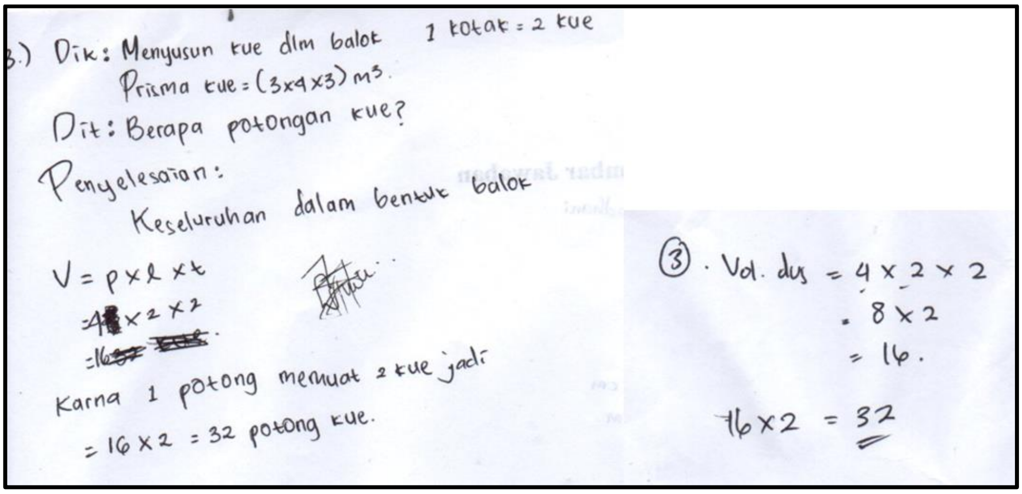

Figure 6. Female Students' Test Answers on the Problem-Solving Indicator

Based on Figure 5, the female student demonstrates a significant ability to view problems from multiple perspectives. In the problem-solving process, she chose an alternative approach by applying the concept of the volume of a prism, which is half the volume of a rectangular block. Despite using a different approach, the student still arrived at the correct answer. This indicates that she possesses strong visual-spatial intelligence, enabling her to visualize and understand the relationships between mathematical concepts innovatively. However, there is a weakness in her ability to systematically organize the steps in the problem-solving process. She did not present the problem-solving process in a structured sequence, which is important for ensuring understanding and transparency in the solution. To ensure the accuracy and comprehension of the student's work, the researcher interviewed to further explore her visual-spatial intelligence, as well as to confirm and clarify the approach she used in solving the math problem.

R : *Do you understand the question for problem number 3?*

FS : *The question is related to calculating the number of cake pieces needed by Mrs. Rudi.*

R : *How did you calculate it?*

FS : *So, the calculation is similar to finding the volume. We have a box with a length of 4, a width of 2, and a height of 2. So, the volume is 4 times 2 times 2. Since it's a square shape, we multiply it again by 2, so 4 times 2 times 2 times 2, which equals 32.*

Pattern Recognition

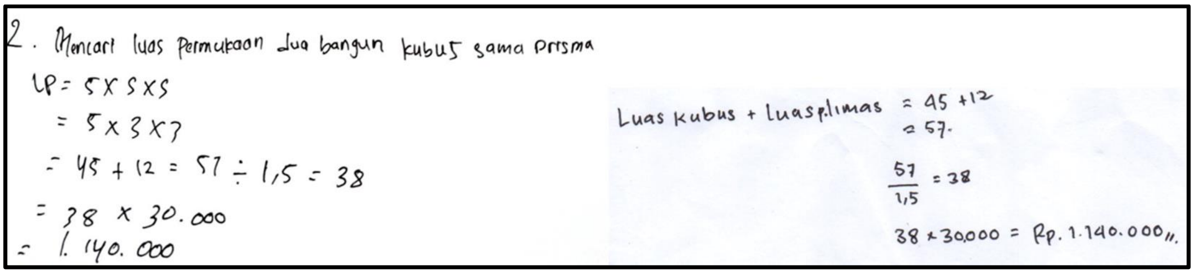

Figure 7. Female Students' Test Answers on the Pattern Recognition Indicator

Based on Figure 7, the male student demonstrates characteristics of visual-spatial intelligence in pattern recognition. The student can identify patterns in the calculations needed to accurately solve the math problem. During this process, he can recognize the relationships between elements and the underlying patterns of the mathematical operations, allowing him to effectively apply these patterns. With this ability, the student not only solves the problem correctly but also shows skills in systematically understanding and utilizing mathematical patterns. His visual-spatial intelligence is evident in his ability to intuitively recognize and leverage patterns, contributing to accurate and efficient problem-solving. The researcher then interviewed the male student as follows:

R	:	*Do you understand the question? Can you explain it?*
MS	:	*Yes, it's about calculating the cost of making a tent.*
R	:	*How do you calculate it?*
MS	:	*First, I find the surface area of the prism and the cube.*
R	:	*Is this a prism?*
MS	:	*Oh, sorry, I meant a pyramid.*
R	:	*After that?*
MS	:	*After that, I add the surface areas of the prism and the pyramid, which gives 38, and then divide by 1.5. Then, I multiply by the price of plastic per meter, which is 30,000. So the total cost is 1,140,000.*

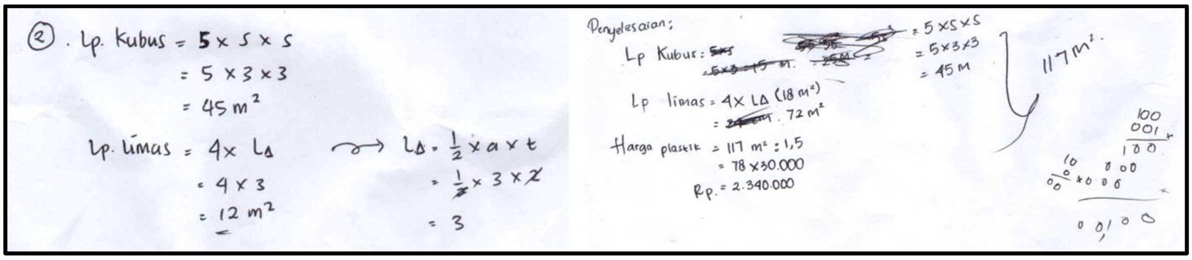

Figure 8. Female Students' Test Answers on the Pattern Recognition Indicator

Based on Figure 8, the female student demonstrates less effective pattern recognition characteristics. The student struggles to identify the correct patterns needed to solve the problem, which impacts the accuracy of her calculations and results in incorrect answers. This indicates that the student has not yet developed one of the important aspects of visual-spatial intelligence, namely the ability to find relevant patterns in the problem-solving process. Therefore, the researcher interviewed the female student to further explore her visual-spatial intelligence, particularly regarding her pattern recognition characteristics, as follows.

R : *Do you understand the meaning of the problem? Can you explain it?*
FS : *Yes, the problem is about finding the surface area of a cube and a pyramid. For the cube, the surface area is 6 times the square of the side length. For the pyramid, we calculate the surface area by adding 4 times the area of the triangle. The area of the triangle is calculated as 1/2 times the base times the height. Here, the height is 5 minus 3, so it's 2 meters. Thus, the area of the triangle is 3 square meters.*
R : *So, what should be done next to calculate the cost?*
FS : *Well, that's where I'm a bit confused. After calculating the area, I don't know what to do next to determine the cost.*

3.2. Discussion

Based on the description and interview results above, the male student demonstrates better-imagining abilities compared to the female student. This finding is consistent with research conducted by Halpern & Wai (2019) and Giofrè et al. (2022), which states that males tend to excel in tasks that require forming and manipulating images in the mind, including tasks involving visual-spatial working memory. The male student is not only able to visualize concepts or ideas in a visual form but also to alter and manipulate these images in his mind to solve problems effectively (Darmadi et al., 2020; Azizah et al., 2021). Furthermore, his ability to see and understand geometric objects from various perspectives also reflects a deep spatial thinking ability. This goes beyond merely seeing shapes physically to understanding perspective changes and how these changes affect the overall appearance of objects (Frick & Pichelmann, 2023). Conversely, the female student struggles with visualizing geometric objects from different perspectives. This is in line with the research by Yurmalia & Hasanah (2021), which found that many students, particularly females, exhibit limitations in visual-spatial abilities, directly affecting their ability to effectively visualize geometric objects. Nugroho et al. (2024) note that female students tend to struggle with depicting geometric objects due to their skeptical approach, where they are more likely to doubt the correctness of their work and incorrectly alter results that should be correct.

In the aspect of conceptualizing, both male and female students demonstrate equivalent abilities in identifying and connecting relevant concepts to the given problems. Research findings show no significant differences between genders in understanding concepts and relating them to available data (Utami & Anitra, 2020; Winata & Friantini, 2020; Pebrianti & Puspitasari, 2023). Students from both gender groups are effectively able to integrate new information with existing knowledge, reflecting a similar level of understanding of the concepts being studied. This aligns with the findings of Kuteesa et al. (2024) and Martin (2022), which suggest that gender equality in conceptual learning can be achieved when students have equal opportunities in supportive and inclusive learning environments. Furthermore, Kheloui et al. (2023) reinforce the idea that cognitive differences between males and females do not significantly impact their conceptualizing abilities, especially in educational contexts that encourage active interaction and collaboration among students. Hadiprayitno et al. (2022) also add that both male and female students have equal potential to develop concept-based problem-solving skills through effective and relevant learning approaches. This reinforces the understanding that conceptualizing ability is a cognitive aspect that is not dependent on gender but rather influenced by the learning environment and experiences.

The next aspect of visual-spatial intelligence is problem-solving. Based on test results and interviews, both male and female students demonstrate adequate problem-solving abilities. Interestingly, both gender groups use different approaches in structuring their problem-solving steps. Both males and females possess valuable skills that contribute to problem-solving, although through different methods (Setyawati et al., 2021; Bahtiar et al., 2023; Borgonovi et al., 2023). Male students tend to utilize the data presented explicitly in the problems to create more structured problem-solving steps. They often focus more on logical aspects and sequential order, resulting in clearer and more aligned final solutions with the given instructions (Salam & Salim, 2020). This is consistent with the findings of Darmadi et al. (2020), which suggest that male students' problem-solving approaches align with Polya's theory, emphasizing systematic methods for solving math problems, including understanding the problem, devising a plan, carrying out the plan, and reviewing the solution. Meanwhile, female students use conceptual mastery skills as a foundation for problem-solving. Nurhayati & Aripin (2020) reveal that female students tend to use more flexible conceptual mastery skills when solving problems, especially in situations requiring analytical and intuitive thinking. Research by Rubianti et al. (2022) also supports this finding, indicating that female students more often rely on a deep understanding of concepts rather than direct data-based approaches. They frequently depend on intuition and can identify relationships between concepts in problems, leading to solutions through potentially less obvious approaches (Cai Shi & Lucietto, 2022). As a result, they produce more creative or unconventional solutions, which can sometimes be more effective in certain situations.

In the aspect of pattern recognition, male students show an advantage over female students in identifying problem-solving patterns. Male students are significantly more capable of recognizing patterns in the calculations needed to solve mathematical problems accurately. Research by Madhuri & Yawan (2023) reveals that the personality and spatial abilities of male students often explain their superior performance in mathematics education, allowing them to be more skilled in pattern recognition. This ability contributes to efficiency in solving complex problems, as male students can use these patterns as a basis for more effective problem-solving strategies (Taufik et al., 2024). Consistent with these findings, Ramírez-Uclés & Ramírez-Uclés (2020) demonstrate that male students tend to have more developed visual-spatial intelligence, enabling them to visualize and utilize patterns more intuitively. Conversely, female students face difficulties in finding the correct patterns to solve problems. Research by Danindra et al. (2022) and Widiyasari (2023) indicates that female students tend to face challenges in recognizing and applying mathematical patterns as effectively as male students. Additionally, Siagian et al. (2022)

show that female students often struggle with tasks requiring a deep understanding of mathematical patterns, which can hinder their ability to solve problems quickly and accurately. Furthermore, research by Minnigh & Coyle (2023) emphasizes that differences in pattern recognition abilities may be linked to self-efficacy, with males generally demonstrating higher levels of self-efficacy compared to females.

Based on the description, male students meet all aspects of visual-spatial intelligence, while female students only meet the aspects of conceptualizing and problem-solving. This indicates that, in general, male students have a higher level of visual-spatial intelligence compared to female students. Research conducted by Castro-Alonso and Jansen (2019), Qian et al. (2022), and Sokolowski et al. (2024) supports this statement by showing that gender affects academic performance, with male students often excelling in solving problems involving visual and spatial elements compared to female students. This difference may be due to socio-cultural factors, as male students frequently have more opportunities to develop visual and spatial skills compared to female students (Silitonga et al., 2024). Malkogeorgou and Duffy (2022) indicate that social norms and gender expectations can influence the access and support received by males and females in developing their visual-spatial intelligence. The gap in visual-spatial intelligence between the two gender groups can be reduced through the implementation of structured and targeted interventions (Collado, 2019). Gender-based differences in visual-spatial intelligence, particularly in geometry problems, need special attention in developing teaching methods that can help bridge this gap, especially in aspects that challenge female students.

4. CONCLUSION

Based on the data analysis, it can be concluded that male students generally have superior visual-spatial intelligence compared to female students. Male students demonstrate better abilities across all aspects of visual-spatial intelligence, namely imagining, conceptualization, problem-solving, and pattern recognition. In contrast, female students only meet two aspects: conceptualization and problem-solving. Male students show an advantage in using imagery to find patterns and solve problems using concepts they have mastered. Therefore, it is recommended that teachers work on enhancing visual-spatial intelligence by considering gender differences and applying teaching methods that can increase both male and female students' interest and motivation to learn.

REFERENCES

Adhikari, R., & Timsina, T. P. (2024). An Educational Study Focused on the Application of Mixed Method Approach as a Research Method. *OCEM Journal of Management, Technology &Amp; Social Sciences*, *3*(1), 94–109. https://doi.org/10.3126/ocemjmtss.v3i1.62229

Ainurrahmah, A., Helena, G., & Handayani, R. (2023). ANALISIS KEMAMPUAN SPASIAL VISUALIZATION SISWA SEKOLAH DASAR DALAM PEMECAHAN MASALAH

GEOMETRI. *Didaktik: Jurnal Ilmiah PGSD STKIP Subang*, *9*(1), 717-725. https://doi.org/10.36989/didaktik.v9i1.663

Auerbach, C. & Silverstein, L. (2003). *Qualitative Data: An Introduction to Coding and Analysis*. New York, USA: New York University Press. https://doi.org/10.18574/nyu/9780814707807.001.0001

Aziz, J. A., Juniati, D., & Wijayanti, P. (2020, November). Student's reasoning with logical-mathematical and visual-spatial intelligence in geometry problem-solving. In *International Joint Conference on Science and Engineering (IJCSE 2020)* (pp. 203-207). Atlantis Press. https://doi.org/10.2991/AER.K.201124.038

Azizah, N., Budiyono, B., & Siswanto, S. (2021). Students' conceptual understanding in terms of gender differences. *Journal of Mathematics and Mathematics Education*, *11*(1), 41-47. https://doi.org/10.20961/JMME.V11I1.52746

Bahtiar, B., Maimun, M., & Ibrahim, I. (2023). Analysis of collaboration, communication, critical thinking, and creative thinking ability of students in solving science problems in terms of gender. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *11*(2), 379-400. https://doi.org/10.24815/jpsi.v11i2.29065

Borgonovi, F., Han, S. W., & Greiff, S. (2023). Gender differences in collaborative problem-solving skills in a cross-country perspective. *Journal of Educational Psychology*, *115*(5), 747. https://doi.org/10.1037/edu0000788

Cai Shi, M., & Lucietto, A. M. (2022). The Preference of the Use of Intuition over Other Methods of Problem Solving by Undergraduate Students. *European Educational Researcher*, *5*(3), 253-275. https://doi.org/10.31757/euer.532

Castro-Alonso, J.C., Jansen, P. (2019). Sex Differences in Visuospatial Processing. In: Castro-Alonso, J. (eds) Visuospatial Processing for Education in Health and Natural Sciences. Springer, Cham. https://doi.org/10.1007/978-3-030-20969-8_4

Chamizo, V. D., Bourdin, P., Mendez-Lopez, M., & Santamaria, J. J. (2023). From paper and pencil tasks to virtual reality interventions: improving spatial abilities in girls and women. *Frontiers in Virtual Reality*, *4*, 1286689. https://doi.org/10.3389/frvir.2023.1286689

Collado, R. C. (2019, August). Reducing the gender gap in spatial skills in high school physics. In *Journal of Physics: Conference Series* (Vol. 1286, No. 1, p. 012013). IOP Publishing. https://doi.org/10.1088/1742-6596/1286/1/012013

Danindra, L. S., Masriyah, M., & Hanifah, U. (2022). Computational Thinking Processes of Junior High School Students in Solving Problems of Number Patterns in Terms of Gender Differences. In *SHS Web of Conferences* (Vol. 149, p. 01012). EDP Sciences. https://doi.org/10.1051/shsconf/202214901012

Dejonckheere, E., Verdonck, S., Andries, J., Röhrig, N., Piot, M., Kilani, G., & Mestdagh, M. (2024). Real-time incentivizing survey completion with game-based rewards in experience sampling research may increase data quantity but reduce data quality. *Computers in Human Behavior*, *160*, 108360. https://doi.org/10.1016/j.chb.2024.108360

Fadhil, M., & Prastiwi, Y. (2024). INDICATORS OF MULTIPLE INTELLIGENCE THEORY IN THE KARATE KID MOVIE (2010): PSYCHOLOGY EDUCATION. *Language Literacy:*

Journal of Linguistics, Literature, and Language Teaching, *8*(1), 244-255. https://doi.org/10.30743/ll.v8i1.9182

Ferrandez, D., Recalde, I., Moron, C., & Yedra, E. (2019). Study of spatial abilities in high-school students. *EDULEARN Proceedings*, pp. 3759-3765. https://doi.org/10.21125/EDULEARN.2019.0973

Fioriti, C. M., Martell, R. N., Daker, R. J., Malone, E. P., Sokolowski, H. M., Green, A. E., Levine, S. C., Maloney, E. A., Ramirez, G., Lyons, I. M. (2024). Examining the Interplay between the Cognitive and Emotional Aspects of Gender Differences in Spatial Processing. *Journal of Intelligence*, *12(3)*, 30. https://doi.org/10.3390/jintelligence12030030

Frick, A., & Pichelmann, S. (2023). Measuring spatial abilities in children: a comparison of mental-rotation and perspective-taking tasks. *Journal of Intelligence*, *11*(8), 165. https://doi.org/10.3390/jintelligence11080165

Giofrè, D., Allen, K., Toffalini, E., & Caviola, S. (2022). The impasse on gender differences in intelligence: A meta-analysis on WISC batteries. *Educational Psychology Review*, *34*(4), 2543-2568. https://doi.org/10.1007/s10648-022-09705-1

Hadiprayitno, G., Lestari, N., Kusmiyati, K., Sukri, A., & Irawan, J. (2022). An analysis of student's problem-solving skills and scientific literacy based on higher-order thinking skills (HOTS) viewed from gender. *Jurnal Penelitian Pendidikan IPA*, *8*(5), 2508-2512. https://doi.org/10.29303/jppipa.v8i5.2287

Halpern, D. F., & Wai, J. (2020). Sex differences in intelligence. *The Cambridge handbook of intelligence*, 317-345. https://doi.org/10.1017/9781108770422.015

Harris, D., Logan, T., & Lowrie, T. (2023). Spatial visualization and measurement of area: A case study in spatialized mathematics instruction. *The Journal of Mathematical Behavior*, *70*, 101038. https://10.1016/j.jmathb.2023.101038

Herawati, H., & Hariyani, M. (2024). Spatial Thinking Ability in Elementary School. *PIONIR: JURNAL PENDIDIKAN*, *13*(1), 157-168. https://doi.org/10.22373/pjp.v13i1.23002

Kheloui, S., Jacmin-Park, S., Larocque, O., Kerr, P., Rossi, M., Cartier, L., & Juster, R. P. (2023). Sex/gender differences in cognitive abilities. *Neuroscience & Biobehavioral Reviews*, 105333. https://doi.org/10.1016/j.neubiorev.2023.105333

Kusumaningtyas, P., & Dewi, E. R. (2021). Analysis of Visual-Spatial Intelligence of First Grade Students in Mathematics Subjects. *Indonesian Journal of Mathematics Education*, *4*(2), 74-82. https://doi.org/10.31002/ijome.v4i2.6346

Kuteesa, K. N., Akpuokwe, C. U., & Udeh, C. A. (2024). Gender equity in education: addressing challenges and promoting opportunities for social empowerment. *International Journal of Applied Research in Social Sciences*, *6*(4), 631-641. https://doi.org/10.51594/ijarss.v6i4.1034

Lowrie, T., Logan, T., & Hegarty, M. (2019). The influence of spatial visualization training on students' spatial reasoning and mathematics performance. *Journal of Cognition and Development*, *20*(5), 729-751. https://doi.org/10.1080/15248372.2019.1653298

Lu, Y., Zhang, X., & Zhou, X. (2023). Assessing gender difference in mathematics achievement. *School Psychology International*, *44*(5), 553-567. https://doi.org/10.1177/01430343221149689

Malkogeorgou, S., & Duffy, G. (2022). The influence of gender stereotypes on women's spatial abilities and their underrepresentation in the field of engineering. In *Towards a new future in engineering education, new scenarios that European alliances of tech universities open up* (pp. 2059-2065). Universitat Politècnica de Catalunya. https://doi.org/10.5821/conference-9788412322262.1379

Marhaeni, N. H., Pratama, U. N., Nuryadi, N., Dangin, D., & Khuzaini, N. (2023). ANALYSIS OF GENDER DIFFERENCES IN THE MAKING OF MATHEMATICAL CROSS-STITCH ART SYMBOLS AND LEARNING OUTCOMES OF HIGH SCHOOL STUDENTS. *Kwangsan: Jurnal Teknologi Pendidikan*, *11*(1), 206-215. https://doi.org/10.31800/jtp.kw.v11n1.p206—215

Martin, M. (2022). Gender equity in the classroom. *Early Years Educator*, *23*(17), 34-35. https://doi.org/10.12968/eyed.2022.23.17.34

Masfingatin, T., Maharani, S., Rufiana, I. S., & Sanwidi, A. (2020, August). Mathematics Communication of Middle School Students in Solving Geometry Problems Based on Spatial Intelligence. In *SEMANTIK Conference of Mathematics Education (SEMANTIK 2019)* (pp. 151-160). Atlantis Press. https://doi.org/10.2991/ASSEHR.K.200827.135

Mashuri, S., & Yawan, H. (2023). Gender Differences Influence Students' Performance in Learning Math in Secondary Schools. *International Journal Of Education, Social Studies, And Management (IJESSM)*, *3*(1), 1-12. https://doi.org/10.52121/ijessm.v3i1.114

Medina Herrera, L. M., Juárez Ordóñez, S., & Ruiz-Loza, S. (2024, February). Enhancing mathematical education with spatial visualization tools. In *Frontiers in Education* (Vol. 9, p. 1229126). Frontiers Media SA.

Minnigh, T. L., & Coyle, T. R. (2023). Gender differences in self-efficacy partially explain the female underprediction effect. *Journal of Research in Personality*, *105*, 104385. https://doi.org/10.1016/j.jrp.2023.104385

Naufal, N., & Juandi, D. (2024). Spatial Ability in Learning Mathematics: Systematic Literature Review (SLR). *KnE Social Sciences*, 349-357. https://doi.org/10.18502/kss.v9i13.15935

Novitasari, D., Nasrullah, A., Triutami, T. W., Apsari, R. A., & Silviana, D. (2021, February). High level of visual-spatial intelligence students in solving PISA geometry problems. In *Journal of Physics: Conference Series* (Vol. 1778, No. 1, p. 012003). IOP Publishing. https://doi.org/10.1088/1742-6596/1778/1/012003

Nugroho, P. B., Meilasari, V., Apriza, B., & Basri, H. (2024). PERAN SKEPTIS MAHASISWA DALAM MEMECAHKAN MASALAH GEOMETRI DITINJAU BERDASARKAN GENDER. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *13*(2). http://dx.doi.org/10.24127/ajpm.v13i2.8389

Nurhayati, A. S., & Aripin, U. (2020). Students thinking process in solving the problems of social arithmetic stories test based on gender. *MaPan: Jurnal Matematika dan Pembelajaran*, *8*(1), 103-113. https://doi.org/10.24252/mapan.2020v8n1a8

OECD (2022). *PISA 2022: Insight and Interpretation.* OECD Publishing.

Pebrianti, W., & Puspitasari, N. (2023). Kemampuan Pemahaman Konsep pada Materi Sistem Persamaan Linear Dua Variabel Ditinjau dari Perbedaan Gender Siswa SMP

Kelas VIII. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, *2*(1), 55-70. https://doi.org/10.31980/pme.v2i1.1400

Pranajaya, A. A. (2024, February). Spatial and visual ability of postgraduate math students. In *AIP Conference Proceedings* (Vol. 3046, No. 1). AIP Publishing. https://doi.org/10.1063/5.0194612

Prihandika, Y. A., Triyanto, T., & Saputro, D. R. (2022, November). Analysis of students' representation skills on geometry material viewed from the spatial intelligence level. In *AIP Conference Proceedings* (Vol. 2566, No. 1). AIP Publishing. https://doi.org/10.1063/5.0114186

Qian, Y., Berenbaum, S. A., & Gilmore, R. O. (2022). Vision contributes to sex differences in spatial cognition and activity interests. *Scientific reports*, *12*(1), 17623. https://doi.org/10.1038/s41598-022-22269-y

Reilly, D. (2019). *Sex Differences in Cognitive Abilities and Educational Outcomes: Examining The Contribution of Sex-Role Identification*. Queensland: Griffith University. https://doi.org/10.25904/1912/2503

Rubianti, N. S., Usodo, B., & Subanti, S. (2022, November). The difference in mathematical reasoning between male and female students. In *AIP Conference Proceedings* (Vol. 2566, No. 1). AIP Publishing. https://doi.org/10.1063/5.0117121

Salam, M., & Salim, S. (2020). Analysis of mathematical reasoning ability (MRA) with the discovery learning model in gender issues. *Journal of Educational Science and Technology (EST), 6(2), 137-150.* https://doi.org/10.26858/est.v6i2.13211

Sarah, S., Rahminawati, N., & Hayati, F. (2022, August). Strategi Guru dalam Meningkatkan Pencapaian Nilai KKM Mata Pelajaran PAI Siswa Kelas IX di SMPN 1 Kotabaru Kabupaten Karawang. In *Bandung Conference Series: Islamic Education* (Vol. 2, No. 2, pp. 477-484). https://doi.org/10.29313/bcsied.v2i2.3773

Setyawati, Y., Afandi, A., & Titin, T. (2020). Mourtos's problem-solving skills: A view based on gender. In *International Journal of Science and Applied Science: Conference Series* (Vol. 4, No. 1, pp. 91-98). https://doi.org/10.20961/IJSASCS.V4I1.49461

Siagian, Q. A., Herman, T., Darhim, D., & Khairunnisa, K. (2022). Student Errors in Solving Number Patterns, Sequences, and Series HOTS Types Based on Newman's Theory in Terms of Gender. *Edumatica: Jurnal Pendidikan Matematika*, *12*(02), 170-179. https://doi.org/10.22437/edumatica.v12i02.15611

Silitonga, R. Y., Ratumanan, T. G., & Telaumbanua, E. (2024). GENDER DIFFERENCE IN MATHEMATICAL SPATIAL ABILITY AND FACTORS THAT MAY AFFECT IT. *MaPan: Jurnal Matematika dan Pembelajaran*, *12*(1), 87-99. https://doi.org/10.24252/mapan.2024v12n1a6

Sokolowski, H. M., Fan, C. L., Yu, J.-C., Daker, R. J., Lyons, I. M., Zeman, A., Abdi, H., & Levine, B. (2024). Visual imagery and STEM occupational attainment: Gender matters. In *PsyArXiv*. https://doi.org/10.31234/osf.io/c5uey

Taufik, M., Inam, A., & Susanti, R. D. (2024). Computational thinking in mathematical problem solving: Pattern recognition. *International Journal of Multidisciplinary: Applied Business and Education Research*, *5*(3), 791-797. https://doi.org/10.11594/ijmaber.05.03.05

Tiwari, S., Shah, B., & Muthiah, A. (2024). A Global Overview of SVA—Spatial–Visual Ability. *Applied System Innovation*, *7*(3), 48. https://doi.org/10.3390/asi7030048

Triutami, T. W., Hariyanti, U., Novitasari, D., Tyaningsih, R. Y., & Junaidi, J. (2021). High Visual-Spatial Intelligence Students' Creativity in Solving PISA Problems. *JTAM (Jurnal Teori dan Aplikasi Matematika)*, *5*(1), 36-49. https://doi.org/10.31764/JTAM.V5I1.3280

Utami, C. T. P. (2019, February). The identification of visual representation ability of junior high school students in solving geometry problems. In *Journal of Physics: Conference Series* (Vol. 1180, No. 1, p. 012014). IOP Publishing. https://doi.org/10.1088/1742-6596/1180/1/012014

Utami, C., & Anitra, R. (2020). Kemampuan Pemahaman Konsep Siswa Berdasarkan Gender pada Pembelajaran Realistic Mathematics Education Berbantuan Alat Peraga PANDU. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *6*(3), 475-489. https://doi.org/10.33394/jk.v6i3.2872

Widiyasari, R. (2023). Metacognition patterns of the students in solving mathematical problems: Analyzed from adversity quotient and gender. *Al-Jabar: Jurnal Pendidikan Matematika*, *14*(2), 449-465. https://doi.org/10.24042/ajpm.v14i2.17795

Wihardjo, E., & Prayitno, S. (2020, May). Male students' visual reasoning in solving mathematical problems. In *Journal of Physics: Conference Series* (Vol. 1538, No. 1, p. 012086). IOP Publishing. https://doi.org/10.1088/1742-6596/1538/1/012086

Wihardjo, E., & Prayitno, S. (2020, May). Male students' visual reasoning in solving mathematical problems. In *Journal of Physics: Conference Series* (Vol. 1538, No. 1, p. 012086). IOP Publishing. https://doi.org/10.1088/1742-6596/1538/1/012086

Winata, R., & Friantini, R. N. (2020). Kemampuan pemahaman konsep matematika siswa ditinjau dari minat belajar dan gender. *AlphaMath: Journal of Mathematics Education*, *6*(1), 1-18. https://doi.org/10.30595/alphamath.v6i1.7385

Yurmalia, D., & Hasanah, A. (2021, March). Student spatial visual in geometry: The case of gender differences. In *Journal of Physics: Conference Series* (Vol. 1806, No. 1, p. 012083). IOP Publishing. https://doi.org/10.1088/1742-6596/1806/1/012083

Žakelj, A., & Klancar, A. (2022). The Role of Visual Representations in Geometry Learning. *European Journal of Educational Research*, *11*(3), 1393-1411. https://doi.org/10.12973/eu-jer.11.3.1393