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Students' Metacognitional Ability in Solving Higher Order Thinking Skills Mathematics Problems Based On Gender at Madrasah Ibtidaiyah

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Abstract: This study aims to describe and compare the metacognitive abilities of male and female students in solving Higher Order Thinking Skills (HOTS) mathematics problems in fifth grade at MIN Tulungagung. This study is grounded in the importance of mastering 21st-century skills, including higher-order thinking skills, which involve awareness, regulation, and evaluation of the thinking process. This study employs a qualitative case study approach. The study includes 75 students selected through purposive sampling: 39 males and 36 females. Data collection techniques include essay-based HOTS tests, observation, in-depth interviews, and documentation. The instruments are based on Magiera and Zawojewski's metacognitive indicators. The results indicate that female students have more systematic and reflective metacognitive abilities than male students. Females excel in planning, monitoring, and evaluating strategies, while males tend to solve problems quickly without re-verification. The most notable difference was observed in the indicators of strategy correction and reexamination. Theoretically, this study contributes to understanding gender differences in metacognitive skills in HOTS problem solving, particularly in awareness, regulation, and evaluation. Practically, the findings suggest the need for differentiated metacognitive instruction that strengthens planning, reflection, alternative-strategy exploration, and strategy transfer for both male and female students.

Keywords: Gender, higher-order thinking skill, mathematics, metacognitive ability

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A. Introduction

Metacognitive skills are essential for effective learning because they enable students to recognize, monitor, regulate, and evaluate their own thinking processes. In mathematics learning, metacognition plays a particularly important role in solving HOTS problems, which require students to analyze information, select appropriate strategies, justify their reasoning, and reflect on the solutions obtained. Strong metacognitive skills help students become more independent, strategic, and flexible problem solvers rather than merely relying on memorized procedures. Therefore, developing metacognition from the elementary level is crucial to fostering students' higher-order thinking, problem-

solving abilities, and capacity to apply learned strategies to new and complex situations. Teachers' success in strengthening students' 21st-century skills is assessed based on their ability to communicate, share, and use information to solve complex problems (Dendodi et al., 2024; Kartini & Hidayah, 2024).

Furthermore, students must adapt, innovate, respond to new demands, and expand their knowledge through technology to meet 21st-century challenges. This demonstrates that facing 21st-century challenges requires students not only to master material but also to possess higher-order thinking skills (Pebriani et al., 2025). Therefore, the learning process needs to be designed to help students recognize, control, and evaluate their own thinking processes in various problem-solving situations. Metacognition is an important indicator of how students regulate their cognition (Azizah & Nasrudin, 2021).

According to Wilson and Clarke, a person's metacognitive process during assignments can be assessed through awareness, regulation, and evaluation (Almeida & Castro, 2023). Awareness relates to a person's awareness during the learning process, specifically regarding problem-solving, their specific knowledge, and their knowledge of their own learning or problem-solving strategies. Regulation is seen when a person applies metacognitive skills to control their knowledge and thinking. Evaluation refers to an individual's assessment of their thinking processes, capacities, and limitations, as they operate in specific situations (Riani et al., 2022). These three components are crucial when students work on HOTS problems, as they require critical, reflective thinking and the ability to manage their thinking processes strategically (Azlika et al., 2025).

In practice, students' ability to solve Higher Order Thinking Skills (HOTS) problems is influenced by various factors, including gender differences (Basri et al., 2022). Research conducted by Nugraha and Pujiastuti showed significant differences between male and female students in solving mathematics problems. The results showed that female students' mathematical communication skills were 9% higher than male students', indicating a gender bias in mathematical thinking and communication (Nugraha & Pujiastuti, 2019).

Furthermore, Isnaniah et al. specifically examined how gender differences influence students' mathematical literacy skills. Their findings confirmed that gender shapes how students understand and solve literacy-based mathematical problems (Isnaniah et al., 2021). Meanwhile, Rahmawati et al. analyzed mathematical literacy misconceptions in solving PISA problems from metacognitive and gender perspectives. Both studies demonstrated that metacognitive aspects of mathematical thinking are inseparable from students' gender identities (Rahmawati et al., 2021).

Furthermore, Fatima et al. at Al-Falah Pesanggrahan Jangkar Middle School examined students' metacognitive abilities in solving problems using TIMSS from a gender perspective. The study highlighted differences in metacognitive thinking strategies between male and female students when facing complex, multilevel problems (Fatima et al., 2021). A similar study by Hidayah and Nabila found that students exhibit

diverse gender-based thinking patterns when facing challenges in mathematics learning (Hidayah & Nabila, 2022).

Research conducted by Anggun Vita Loka and Rini Setianingsih further enriches the discourse by highlighting the metacognitive profile of high school students in solving word problems on systems of linear equations in three variables, from a mathematical perspective (Loka & Setianingsih, 2021). This research was conducted at SMAN 1 Kota Probolinggo and illustrates that students' metacognitive abilities are influenced not only by gender but also by their level of mathematical ability. Overall, this research demonstrates that gender differences are closely related to students' metacognitive thinking skills and mathematical literacy. Rahman et al. stated that students with high learning metacognition had higher mathematical problem-solving abilities in the problem-based learning group than in the expository method group. Students with low learning metacognition had lower mathematical problem-solving abilities in the problem-based learning group than in the expository method group (Rahman et al., 2018). Nurislah et al. stated that learning models that can be used to develop metacognitive skills in elementary school students include self-regulated learning-based learning, guided inquiry learning, and meaningful instruction design (MID) learning models (Laesti Nurishlah et al., 2023). However, few studies have explicitly examined this phenomenon at the elementary school level, particularly in the Islamic school (madrasah) environment.

Therefore, this research seeks to fill this gap by using a case study at MIN 3 Tulungagung to broaden understanding of student metacognition within the framework of gender differences at the Madrasah Ibtidaiyah (Islamic elementary school) level. In addition, this research examines the relationship between students' metacognitive abilities in solving HOTS mathematics problems, with attention to gender differences, to support the inclusive development of 21st-century skills. This study's novelty lies in its in-depth examination of fifth-grade students' metacognitive abilities in solving HOTS mathematics problems from a gender perspective in the context of Islamic elementary education. Rather than focusing solely on students' problem-solving outcomes, this study analyzes three interconnected dimensions of metacognition, awareness, regulation, and evaluation to reveal how male and female students differ in managing their thinking processes when addressing complex mathematical problems. In addition, the study identifies students' capacity to explore alternative strategies and transfer problem-solving strategies across different contexts, providing a more comprehensive understanding of metacognitive development in HOTS mathematics learning at the elementary madrasah level. Therefore, this study aims to analyze and compare the metacognitive abilities of male and female fifth-grade students at MIN 3 Tulungagung in solving HOTS mathematics problems, particularly in terms of awareness, regulation, evaluation, and the use and transfer of problem-solving strategies.

B. Method

This research used a qualitative case study approach (Bassey, 2019; Yin, 2023). This approach was chosen because it provides an in-depth understanding of students'

metacognitive abilities in solving Higher Order Thinking Skills (HOTS) mathematics problems, while considering gender differences. The subjects were 75 fifth-grade students at a public Islamic elementary school, MIN 3 Tulungagung, consisting of 39 boys and 36 girls. The study used purposive sampling (Mertens, 2024), which involves deliberately selecting subjects based on their relevant characteristics and their ability to provide the information needed for the study. Selecting fifth-grade students at MIN 3 Tulungagung means selecting students who are approaching the end of elementary school and have developed metacognitive abilities.

Table 1. Indicators of Students' Metacognitive Abilities

Components	Description (Coding)
Awareness	1. Think about what is already known and what is being asked in the question (MA1) 2. Recall whether you have solved a similar problem before (MA2) 3. Think about whether prior knowledge can help you solve the problem (MA3) 4. Connect what is already known and what is being asked in the question with prior knowledge (MA4) 5. Think about whether all the information obtained can be used to solve the problem (MA5)
Regulation	1. Thinking about solution steps related to prior knowledge (MR1) 2. Selecting solution steps that are appropriate to the information contained in the problem (MR2) 3. Applying the selected solution steps to solve the problem (MR3) 4. Identifying new problems that may arise so they can be resolved immediately (MR4) 5. Making corrections if there is a discrepancy between the problem solution and the initial information (MR5)
Evaluation	1. Recheck whether all solution steps have been applied to solve the problem (ME1) 2. Decide that the steps used are appropriate and the solution obtained is correct (ME2) 3. Identify whether there are other ways to solve the problem (ME3) 4. Use existing information to solve the problem in a different way (ME4) 5. Determine the relevance of the problem-solving steps used to other problems (ME5)

Data collection was conducted through several techniques, including observation, written tests, interviews, and documentation (Syahputra & Mulyani, 2025). The tests used HOTS mathematics problems in descriptive form, designed to reveal students' metacognitive abilities based on three components: awareness, regulation, and evaluation. This study also used supporting instruments in the form of indicators of metacognitive ability in problem-solving, adapted from the metacognitive activity indicators proposed by Magiera and Zawojewski. They are awareness, regulation, and evaluation. Awareness

refers to students' understanding of the given information, the task goals, and relevant prior knowledge. Regulation involves planning, monitoring, and controlling strategies during problem solving. Evaluation focuses on reviewing the solution process and results, judging the effectiveness of strategies used, and reflecting on possible improvements or alternative approaches (Çini et al., 2023). The indicators of metacognitive activity proposed by Magiera and Zawojewski emphasize that effective problem solving depends not only on conceptual knowledge but also on students' ability to consciously reflect on, regulate, and evaluate their own thinking processes. In-depth interviews were conducted to obtain more comprehensive information regarding the students' thinking styles and strategies for solving problems.

The following table shows the indicators used to measure students' metacognitive abilities (Riani et al., 2022). The table presents the components and indicators of students' metacognitive ability in problem solving, which are categorized into three main components: Awareness, Regulation, and Evaluation. Each component consists of five indicators that describe different aspects of students' metacognitive processes. Awareness refers to students' ability to recognize and understand the information, knowledge, and demands involved in a problem. The indicators include identifying what is already known and what is being asked, recalling similar problems that have been solved previously, considering the usefulness of prior knowledge, connecting the given information with prior knowledge, and determining whether all available information can be used to solve the problem.

Regulation describes students' ability to manage and control their thinking during the problem-solving process. This component includes considering solution steps based on prior knowledge, selecting appropriate strategies according to the information provided, applying the selected strategies, identifying new problems that may emerge during the process, and making corrections when the solution is inconsistent with the initial information.

Evaluation concerns students' ability to review and assess the effectiveness and correctness of their problem-solving process. The indicators include rechecking whether all solution steps have been implemented, determining whether the strategies and solutions are appropriate, identifying alternative ways to solve the problem, using existing information to develop different solutions, and determining whether the problem-solving strategies used are relevant to other problems.

Overall, the table indicates that students' metacognitive ability is viewed as a cyclical process involving awareness before and during problem solving, regulation throughout the problem-solving process, and evaluation after obtaining a solution. These three components provide a framework for examining how students understand problems, control their strategies, monitor their progress, and reflect on the solutions they produce.

Data validity was tested using four criteria: credibility, transferability, dependability, and confirmability (Creswell, 2024). Data analysis was conducted using descriptive qualitative methods, including data reduction, data presentation, and

conclusion drawing. The researchers analyzed the data by categorizing student responses and interview results based on metacognitive indicators and comparing them by gender.

C. Result and Discussion

Result

The results indicate differences in metacognitive abilities between male and female students when working on Higher Order Thinking Skills (HOTS) questions.

Table 2. Metacognitive Ability Test Results Based on Gender

Metacognitive Component	Male Students (n = 39)	Female Students (n = 36)	Mean Difference
Awareness	68.4	78.9	10.5
Regulation	64.7	80.3	15.6
Evaluation	60.2	75.6	15.4
Overall Mean Score	**64.4**	**78.3**	**13.9**

Table 2 presents the results of the metacognitive ability test based on gender, involving 39 male students and 36 female students. The results show that female students obtained higher mean scores than male students across all three metacognitive components. In the awareness component, female students achieved a mean score of 78.9, compared with 68.4 for male students, resulting in a mean difference of 10.5 points. In regulation, female students recorded a mean score of 80.3, while male students obtained 64.7, with a mean difference of 15.6 points. Similarly, in evaluation, female students achieved 75.6 compared with 60.2 for male students, producing a mean difference of 15.4 points. Overall, the female students obtained a mean metacognitive score of 78.3, whereas the male students obtained 64.4, indicating an overall mean difference of 13.9 points. These results indicate that female students demonstrated higher average performance in awareness, regulation, and evaluation when solving HOTS problems.

Table 3. Level of Metacognitive Ability in Solving HOTS Problems

Category	Male Students (%)	Female Students (%)
High	23.1	52.8
Moderate	48.7	38.9
Low	28.2	8.3
Total	**100**	**100**

Table 3 describes the distribution of students' metacognitive ability levels in solving HOTS problems according to gender. Among male students, 23.1% were categorized as having a high level of metacognitive ability, 48.7% were at the moderate level, and 28.2% were at the low level. In contrast, among female students, 52.8% were categorized as having a high level, 38.9% were at the moderate level, and only 8.3% were at the low level. Thus, the distribution shows that more female students belonged to the high metacognitive ability category, while more male students belonged to the moderate and low categories. The percentages for each gender total 100%, indicating that all students were classified into one of the three metacognitive ability levels.

Data were obtained through HOTS tests, in-depth interviews, and observations of students' thought processes while working on the questions. The study subjects consisted

of fifth-grade students at MIN 3 Tulungagung, selected based on gender and relatively equal academic ability. The following scenario presents a metacognitive question in the form of a HOTS question:

Mr. Nico has three delivery trucks.
Truck A departs for deliveries every three days.
Truck B departs for deliveries every six days.
Truck C departs for deliveries every eight days.

If all three trucks departed at the same time today, how many times will all three trucks depart for deliveries at the same time?

In the next 100 days, how many times will all three trucks depart at the same time?

This difference in responses suggests that: Male students, although able to understand the question prompt, tend to rely on intuition and make decisions quickly without reflection or reexamination. Female students have more comprehensive metacognitive abilities, including problem awareness, step planning, strategy execution, and outcome evaluation.

Male Students' Metacognition

In the Awareness component, male students tended to read quickly and react spontaneously by looking up or mumbling as they recalled the concept of the Least Common Multiple (LCM). They identified that "3 days, 6 days, and 8 days" was a recurring pattern that required finding the time point. This reflects an initial orientation process toward the problem to be solved. In this stage, students identified known and questionable information (MA1), related prior knowledge (MA2), and considered how prior knowledge could help solve the problem. They assessed the relevance of their information to solving the problem (MA4).

In the Regulation component, male students immediately attempted to find the LCM of 3, 6, and 8 using a quick method, but without estimating the steps in writing. They tended not to verify whether the answer "24 days" was an LCM. This indicates that male students were able to predict the solution steps (MR1) and did not correct any errors that occurred (MR5). However, they selected an appropriate solution strategy (MR2) and implemented it relatively well (MR3). This indicates that their self-regulation skills are still suboptimal.

In the Evaluation component, male students did not double-check their entire work process. They felt confident in their answers because they believed they had worked on similar problems before. These students did not double-check the solution steps they had taken (ME1). Despite this, they still expressed confidence that their answers were correct. This confidence was based on the assumption that their solution steps were correct (ME2). However, students also failed to identify possible alternative strategies that could be used to solve the same problem (ME3).

Female Students' Metacognition

In the Regulation component, female students wrote down multiples of each number and explicitly found the LCM. After discovering that the LCM of 3, 6, and 8 is 24, they rechecked it with the multiples of each number to confirm. Then, they continued counting how many times 24 fits into 100 days, as follows: "100:24 = 4, 100:24 = 4, 100:24 = 4, remainder 4." Therefore, the answer is 4 times. This indicates that the female students could design solution steps (MR1), select and implement strategies (MR2, MR3), and make corrections (MR5). However, they had not yet anticipated new problems (MR4).

In the Evaluation component, female students rechecked their calculations, ensured that the division result "100 ÷ 24 = 4" has a remainder, and concluded that the trucks will depart together four times in 100 days. However, they did not explore whether similar problems could be solved using other methods (e.g., time diagrams or timeline visualizations). This indicates that female students double-checked (ME1), confirmed the appropriateness of their strategy (ME2), but could not explore alternative solutions (ME3), use existing information to solve the problem differently (ME4), or transfer their solution to another problem (ME5).

Differences in Metacognitive Abilities

A summary of the differences in male and female metacognitive abilities can be seen in the following table 4. In the awareness component, female students demonstrated deeper metacognitive understanding and awareness than male students. They read the problems carefully, using inner speech, noting important information, and consciously linking the information to relevant prior knowledge, such as the concept of LCM. Meanwhile, male students tended to read quickly and spontaneously, focusing only on significant figures without noting or clarifying the questions. Although they could also recall prior knowledge, they did so intuitively rather than systematically. This suggests that female students are stronger at recognizing, managing, and integrating initial information as a basis for thinking.

In the regulation component, differences were also striking. Female students planned a strategy by writing down the multiples of each number and matching them one by one until they found the LCM accurately. They also calculated how many times the LCM fit within the 100-day range and corrected any errors. This demonstrates active thought regulation, including monitoring and improving the solution process. In contrast, male students tended to solve the problem immediately using the method they perceived as quickest, without writing down the steps or re-verifying them. Although the results were correct, their solution process did not demonstrate mature strategic control. Thus, female students demonstrated better self-monitoring and control, while male students demonstrated limited planning and revision.

In the evaluation component, female students again performed better. They double-checked their results and strategies, ensuring that the steps they took were consistent with the information in the problem. Although they did not explore alternative strategies or transfer them to different problem contexts, they at least demonstrated basic reflection on

their solutions. In contrast, male students did not demonstrate adequate evaluative activity. They did not double-check their answers and were confident simply because they had worked on similar problems. They made no apparent effort to evaluate the strategy's effectiveness or consider other, potentially more efficient approaches. This indicates a tendency toward overconfidence and low metacognitive reflection.

Table 4. Differences in Metacognitive Abilities

Components	Indicators	Male Students	Female Students	Difference Analysis
Awareness	MA1 – Determine known & asked information	Fulfilled, but not written	Fulfilled explicitly	Women are more systematic and take notes; men only mention things verbally.
	MA2 – Remembering similar experiences	Intuitively fulfilled	Reflective	Men rely on intuition, women relate to previous experiences.
	MA3 – Assess prior knowledge assistance	Not visible	Fulfilled	Women are more aware that the KPK concept helps solve problems.
	MA4 – Assess the relevance of information	Part	Fulfilled	Women select information consciously; men are less thorough.
	MA5 – Assess all available information	Not visible	Partly visible	Women are more critical, but have not yet mentioned all the information
Regulation	MR1 – Designing steps	Are not done	Done in writing and systematically	Women make explicit moves, men respond immediately
	MR2 – Choosing the appropriate step	Fulfilled	Fulfilled	Both chose the right strategy, although their approaches differed.
	MR3 – Implementing the strategy	Fulfilled	Fulfilled	Both apply strategies, but women are more consistent.
	MR4 – Anticipating new problems	Not visible	Not visible	Neither of them has yet to demonstrate this ability.
	MR5 – Correction if there is an error	Not visible	Fulfilled	Only women check and revise answers.
Evaluation	ME1 – Re-examination	Are not done	Done	Men are confident without double-checking; women are reflective.
	ME2 – Conclude strategic suitability	Fulfilled by faith	Fulfilled based on verification	Women are evidence-based, men are experience-based.
	ME3 – Exploration of alternative strategies	Not visible	Not visible	Neither of them has shown divergent thinking skills.
	ME4 – Use information for different strategies	Not visible	Not visible	Need training on both.

	ME5 – Transfer to another question	Not visible	Not visible	Not yet appeared in either gender.

Overall, the main difference between male and female students lies in their reflective and systematic engagement in thinking. Female students demonstrated better abilities in planning, monitoring, and evaluating problem-solving strategies. They were more aware of their thinking processes and demonstrated metacognitive steps consistent with established indicators (Aktar, 2020; Katyal & Fleming, 2024). Meanwhile, male students relied more on intuition and past experience, tending to solve problems quickly but less reflectively.

Discussions

Male Students' Metacognition

This phenomenon indicates a weakness in the metacognitive evaluation process, which, according to Paris and Winograd, is crucial to improving learning effectiveness through reflection on thinking and decision-making processes (Ramadhanti et al., 2019). Effective evaluation should include reviewing work, assessing the appropriateness of the strategies used, and exploring more efficient or relevant alternative approaches. Kamid's study revealed that male students tended to immediately conclude that answers were correct without thoroughly reviewing them (Sitas, 2023).

Thus, it can be concluded that in the Evaluation component, male students demonstrated limitations in metacognitive reflection. They tended to be confident in their results without balancing this confidence with verification and exploration of alternative solution strategies.

Female Students' Metacognition

This demonstrates reflective awareness, which is crucial for making informed decisions during problem-solving. This evaluative ability aligns with Paris and Winograd's view that metacognitive evaluation involves assessing the effectiveness of the strategy used and considering whether the approach taken can produce optimal results. Evaluation is also an important part of self-control in the learning process(Antonopoulou et al., 2020).

However, female students did not fully demonstrate the ability to explore alternative solutions to the same problem (ME3), use available information to solve the problem differently (ME4), and transfer their solution strategy to other contexts or problems (ME5). These three aspects indicate that students' reflective thinking skills and cognitive flexibility still need development.

Thus, although female students' internal evaluation is quite good, in-depth reflection, exploration of alternatives, and knowledge transfer remain areas for improvement through learning that encourages flexible and creative thinking.

Differences in Metacognitive Abilities

This conclusion is consistent with findings from previous studies. Research by Veenman, Van Hout-Wolters, and Afflerbach indicates that female students tend to demonstrate stronger metacognitive regulation, particularly in planning, monitoring, and evaluating their learning processes (Veenman et al., 2006). Similarly, Zohar and Dori found that female students generally exhibit higher levels of self-reflection and strategy monitoring when engaging in higher-order thinking tasks. Studies in mathematics education have also reported that female learners are more likely to verbalize their thinking, check their work, and revise strategies, which are key indicators of metacognitive evaluation (Thi-Nga et al., 2024).

In contrast, several studies suggest that male students often rely more on intuitive and direct problem-solving approaches. For example, Mehar and Sigh noted that male students tend to prioritize speed and efficiency in decision-making, sometimes at the expense of reflective verification. While this tendency can be advantageous in certain contexts, it may limit the development of deeper metacognitive control if instructional strategies do not support monitoring and evaluation (Mehar & Sigh, 2025).

Overall, previous research supports the conclusion that gender differences influence metacognitive performance, with female students showing stronger regulatory and evaluative skills, and male students demonstrating strengths in rapid response but weaknesses in reflective and flexible thinking. These findings further reinforce the importance of instructional approaches that intentionally foster metacognitive awareness, monitoring, and evaluation for all students, while being responsive to gender-related learning tendencies.

This finding aligns with Malimban's statement that metacognitive knowledge encompasses an individual's awareness of what is known, when, and how it is effectively used in problem-solving (Malimban, 2025). Furthermore, Damayanti et al. found that male students generally accessed prior knowledge but were inconsistent in integrating it reflectively during the problem-solving process (Damayanti et al., 2023).

Zimmerman explains that self-regulation involves planning, monitoring, and reflection as key components of metacognitive strategies (Zimmerman, 2020). Research results also support this finding: male students tended to choose a quick approach to solving problems without thoroughly reanalyzing the suitability of the solution used (Aulia & Murtiyasa, 2023; Karlina & Sari, 2024).

In the Awareness component, female students tended to read problems silently while thinking, reflecting the use of inner speech as an internal thinking strategy, underlining important information, and writing down known and questionable points. They linked information to prior knowledge about the LCM more systematically (Hartiningrum & Abdul Wahab, 2024). This aligns with Vygotsky's view that inner speech plays a crucial role in shaping an individual's cognitive and metacognitive control. This silent reading activity indicates that female students engaged in a conscious cognitive orientation process before solving problems (Vygotsky, 1978).

Furthermore, they connected information to prior knowledge (MA2, MA3) and assessed relevance (MA4). This aligns with Brown's argument that students with high metacognitive abilities are more aware of their thinking processes (Malimban, 2025). Other research found that female students tend to read carefully and develop strategies from the beginning, reflecting high metacognitive awareness (Aloqleh & Teh, 2019).

This suggests that female students used active cognitive monitoring and control skills during the problem-solving process. This view aligns with Schraw and Dennison's theory, which states that metacognitive regulation encompasses three main aspects: planning, monitoring, and evaluating or controlling ongoing thought processes. The female students' ability to design and refine solution steps demonstrates their involvement in the effective monitoring process.

However, students have not yet fully demonstrated the ability to anticipate new problems related to the problem or the chosen solution strategy (MR4). This indicates that the predictive control or anticipatory control aspect of metacognition has not yet developed optimally. This finding is reinforced by Utami's research, which concluded that female students tend to excel in monitoring and control but remain weak in their ability to project new variables in a mathematical problem (Utami et al., 2023). Similarly, research by Lestari & As'ari shows that female students are more structured in carrying out solution steps but are less accustomed to predicting possible changes or expansions of the problem and are weak in their ability to project new variables in a mathematical problem (Lestari et al., 2021).

These findings are supported by research by Istiana, who found that although female students tend to be meticulous in examining and evaluating their work processes, they often struggle to develop alternative strategies or transfer them to different problem contexts (Istiana et al., 2024). Similar findings were also described by Hasby and Munandar, who showed that most female students are stronger in procedural consistency but lack the skills to think divergently and find more than one way to solve a problem (Hasybi & Munandar, 2021).

The results indicate significant differences in metacognitive abilities between male and female students in solving mathematics-based Higher Order Thinking Skills (HOTS) problems, particularly in the context of Least Common Multiples (LCM) problems. These differences can be seen through the three main components of metacognition: awareness, regulation, and evaluation, based on established indicators.

This finding is supported by several previous studies, such as Hanggara et al. (2022) which showed that female students tend to be more thorough and reflective in their mathematical thinking processes. Research by Utami et al. (2023) and Lestari et al. also indicated that female students excel in monitoring and control. However, they still need to strengthen their ability to anticipate new problems and transfer strategies to other problems (Lestari et al., 2021).

Thus, it can be concluded that female students have more comprehensive metacognitive abilities than male students, especially in the regulation and evaluation

components. Meanwhile, male students show potential in rapid decision-making but still need to improve in reflection, monitoring, and flexibility in strategic thinking.

D. Conclusion

This study reveals a significant difference in metacognitive abilities between male and female fifth-grade students at MIN 3 Tulungagung in solving Higher Order Thinking Skills (HOTS) problems. The differences appear across the three metacognitive components: awareness, regulation, and evaluation. Female students show higher awareness of problem information, plan and control problem-solving strategies systematically, and regularly reflect on and verify their answers. In contrast, male students tend to rely more on intuition, solve problems without explicit planning, and show limited evaluation and correction of their work.

However, neither group has yet demonstrated the ability to explore alternative strategies or transfer problem-solving strategies to different contexts. Overall, female students exhibit more structured and comprehensive metacognitive skills, while male students tend to make quicker decisions but are weaker in reflection. The findings imply that HOTS instruction should explicitly foster students' metacognitive skills through planning, monitoring, evaluation, reflection, and strategy transfer. Teachers should provide greater scaffolding for male students in planning and self-evaluation while encouraging female students to develop greater flexibility in exploring alternative strategies and applying them across different contexts. Theoretically and empirically, this study contributes to the understanding of gender differences in metacognitive skills by showing that differences are evident not only in problem-solving outcomes but also in students' awareness, regulation, and evaluation processes. The findings also indicate that both male and female students need more opportunities to develop alternative-strategy exploration and transfer, extending understanding of metacognition in HOTS problem solving at the elementary madrasah level.

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