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Gender-Based Differences in Students' Critical Thinking on Math Sequences

Muthiah Fildzah Noverli[1]*, Rieno Septra Nery[2], Muhamad Sofian Hadi[3]
[1*]Mathematics Education Program, Universitas Singaperbangsa Karawang
Jalan HS. Ronggo Waluyo, Puseurjaya, East Telukjambe, Karawang, West Java 41361
[2]Mathematics Education Program, Universitas Muhammadiyah Palembang
Jalan Jenderal Ahmad Yani, 13 Ulu, Kec. Seberang Ulu II, Palembang, South Sumatera 30263
[3]Elementary Education Study Program, Universitas Muhammadiyah Jakarta
Jalan K.H. Ahmad Dahlan, Cireundeu, Kec. Ciputat Tim., South Tangerang, Banten 15419
[1*]muthiah.fildzah@fkip.unsika.ac.id; [2]rieno.fkip@umpalembang.ac.id; [3]muhamad.sofian@umj.ac.id

ABSTRAK

Berpikir kritis merupakan kompetensi penting dalam pembelajaran matematika abad ke-21, membantu peserta didik menganalisis, mengevaluasi, dan memecahkan masalah secara logis. Penelitian ini membandingkan kemampuan berpikir kritis peserta didik laki-laki dan perempuan pada materi barisan dan deret aritmetika di MTs Jamiatul Qurro Palembang. Desain penelitian yang digunakan adalah deskriptif kualitatif dengan sampel purposif-kelas VIII A dan VIII D dari lima kelas yang ada. Data dikumpulkan melalui dokumentasi, tes uraian berdasarkan indikator berpikir kritis, dan wawancara. Analisis data dilaksanakan dalam tiga tahap: reduksi data, penyajian data, dan penarikan kesimpulan. Hasil menunjukkan bahwa peserta didik perempuan umumnya memiliki kemampuan berpikir kritis lebih tinggi, sedangkan peserta didik laki-laki unggul sekitar 10% pada indikator membuat kesimpulan. Kedua kelompok setara dalam indikator memberikan penjelasan lebih lanjut. Temuan ini menekankan pentingnya strategi pembelajaran yang responsive berbasis gender untuk mengoptimalkan pengembangan berpikir kritis peserta didik.

Kata Kunci: kemampuan berpikir kritis; gender; barisan dan deret aritmetika

ABSTRACT

Critical thinking is a key competency in 21st-century mathematics education, supporting students in analyzing, evaluating, and solbing problems logically. Research has shown that gender may influence students' critical thinking abilities which can impact learning outcomes. This study aimed to compare students' critical thinking skills based on gender in the context of arithmetic sequences and series at MTs Jamiatul Qurro Palembang. Using a qualitative descriptive design, the study involved one purposively selected class (VIII A and VIII D) from a population of five classes. Data were collected through documentation, essay tests based on critical thinking indicators, and interviews. The analysis followed three stages: data reduction, data presentation, and conclusion drawing. The findings revealed that female students generally demonstrated stronger critical thinking skills, possibly due to more complex cognitive patterns. However, male students outperformed female students by approximately 10% in the indicator of drawing conclusions, likely due to a greater interest in theoretical concepts. Both groups showed similar abilities in providing further explanations. These results highlight the importance of gender-responsive teaching strategies to support the development of students' critical thinking skills more effectively.

Keywords: critical thinking skills; gender; arithmetic sequence and series

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1. INTRODUCTION

Mathematics is discipline that plays a fundamental role in shaping students' abilities to think logically, critically, and systematically. Its structured and rule-based nature provides opportunities for students to develop reasoning skills essential for both academic and real-life contexts. In today's education landscape, mathematics is not only viewed as a core academic subject but also as a medium to foster higher-order thinking, especially critical thinking (Evendy & Verawaty, 2021).

Critical thinking is considered one of the essential 21st century competencies needed for individuals to succeed in a global society (American Management Association, 2019; Harahap et al., 2020; World Economic Forum, 2020). It is one of the core components of the 4c framework-critical thinking, creativity, collaboration, and communication-that supports meaningful engagement with both natural and social environments (Mahanal et al., 2019). According to Ennis (2018), critical thinking involves rational and reflective thought aimed at determining what to believe or do. This skill has also been recognized as a core competency in the OECD's Future of Education and Skills 2030 framework and is emphasized in the 2016 Indonesian Ministry of Education and Culture Regulation No. 21 as a target outcome of mathematics instruction.

Mathematics learning should therefore not only focus on mastering content but also on cultivating students' critical thinking so they can analyze problems, reason systematically, and make well-informed decisions (Nugroho, 2017; Muhali, 2019; Muhali, 2019). Despite being a natural capacity in individuals (Syafruddin & Pujiastuti, 2020), critical thinking needs to be nurtured through intentional practice. In mathematics education, this can be done through the use of Higher-Order Thinking Skills (HOTS) questions, which challenge students to transfer knowledge, analyze information, and draw logical conclusions (Raharjo et al., 2019; Rizqiyah, Aripin, & Puji, 2023). Similarly, Risah et al. (2021), emphasize that cultivating mathematical critical thinking habits in students is essential, as it enables them to find solutions to various real-life problems. In the context of mathematics education, critical thinking skills can be effectively developed and assessed through higher-order thinking questions (HOTs), particularly those related to arithmetic sequences and series. Arithmetic sequences and series have been identified as a suitable topic such questions due to their structured patterns and potential for conceptual exploration.

At the same time, gender differences in mathematics learning have been widely reported in educational research. Studies have found that male and female students often exhibit different cognitive and learning traits. There are significant differences between male and female students in learning mathematics (Karmila, 2018). For example, male students are believed to be stronger in abstract reasoning, while female students tend to demonstrate

greater accuracy and diligence (Santrock in Suswandi, Sujadi, & Riyadi, 2016; Nafi' an, 2021). Other research highlights that female students often show more active participation in problem-solving tasks, whereas male students may be less engaged in classroom activities (Patricia & Zamzam, 2019). Some scholars argue that gender differences also lead to phsycological and psychological variations in learning processes (Nugraha & Pujiastuti, 2019). These differences are not only cognitive but also influenced by daily activities and social roles that affect learning behaviors and thinking development (Saadah, 2020).

Although numerous studies have explored gender differences in mathematical performance or general critical thinking, there is a lack of research that integrates these two aspects within a specific mathematical topic such as arithmetic sequences and series. Most existing literature tends to address these areas separately, leaving a gap in understanding how gender may influence students' critical thinking processes in mathematics.

To address this gap, the present study aims to examine and compare the mathematical critical thinking skills of male and female students when solving HOTs-type problems on arithmetic sequences and series. The results are expected to contribute to mathematics education both theoretically-by offering insights into gender responsive pedagogical practices-and practically-by assisting educators in designing effective instructional strategies that promote critical thinking in a balanced and inclusive manner.

2. METHOD

This study employed a descriptive qualitative research design aimed at exploring the critical thinking skills of students in a natural classroom context. Qualitative research focuses on the depth and richness of data, highlighting meaning and understanding of phenomena as they occur in real-life situations (Satori & Komariah, 2009). This approach was chosen to allow the researcher to describe in detail the differences in critical thinking abilities between male and female students regarding arithmetic sequences and series.

The study was conducted at MTs Jamiatul Qurro Palembang, during the odd semester of the 2023/2024 academic year. The research subjects were 30 students from class VIII, consisting of 15 male and 15 female students, selected through purposive sampling. According to Raco (2010), purposive sampling involves selecting participants based on specific characteristics aligned with the research objectives. The criteria for participant selection were students had demonstrated above, averages, and low mathematical performance based on the most recent midterm assessment.

Three data collection techniques were employed documentation, test, and semi-structured interviews. Documentation was used to gather background information on students' academic profiles and mathematics scores as supporting data. Written tests were

developed based on indicators of critical thinking (Ennis, 2018), including formulating problems, making inferences, drawing conclusions, and providing further explanations. The test consisted of 5 essay questions centered on arithmetic sequences and series. Semi-structured nterviews were conducted to gain deeper insights into students' thought processes, interpretations of test items, and attitudes toward the material. Interview guides were prepared in advance but remained flexible to allow follow-up questions.

Data analysis techniques were conducted through the following steps: 1) data reduction which all collected data (test answers and interview transcripts) were reviewed, categorized, and coded based on the four indicators of critical thinking. 2) Data display which students' responses were organized in matrices and tables to show gender-based comparisons. For instance, a table was created to present the number and percentage of students meeting each critical thinking indicator. 3) Scoring and quantification, each test item was scored using a rubric that reflected critical thinking indicators. The total score per student was converted into a percentage score. 4) Descriptive percentage analysis, the percentage of students meeting each indicator was calculated using the formula:

$$Percentage = \left(\frac{Number\ of\ students\ meeting\ indicator}{Total\ number\ of\ students}\right) x\ 100\%$$

The result was then categorized qualitatively (e.g., very good, good, fair, poor) to interpret the levels of critical thinking for each gender group. 5) Conclusion drawing and verification, the findings were interpreted based on patterns observed in the data, followed by triangulation between test results, documentation, and interviews to ensure credibility.

3. RESULTS AND DISCUSSION

Based on the analysis of the students' answers to the critical thinking skill test questions on the topic of arithmetic sequences and series in class VIII of MTs Jamiatul Qurro Palembang, the results of the students' critical thinking skill test are presented in Table 1.

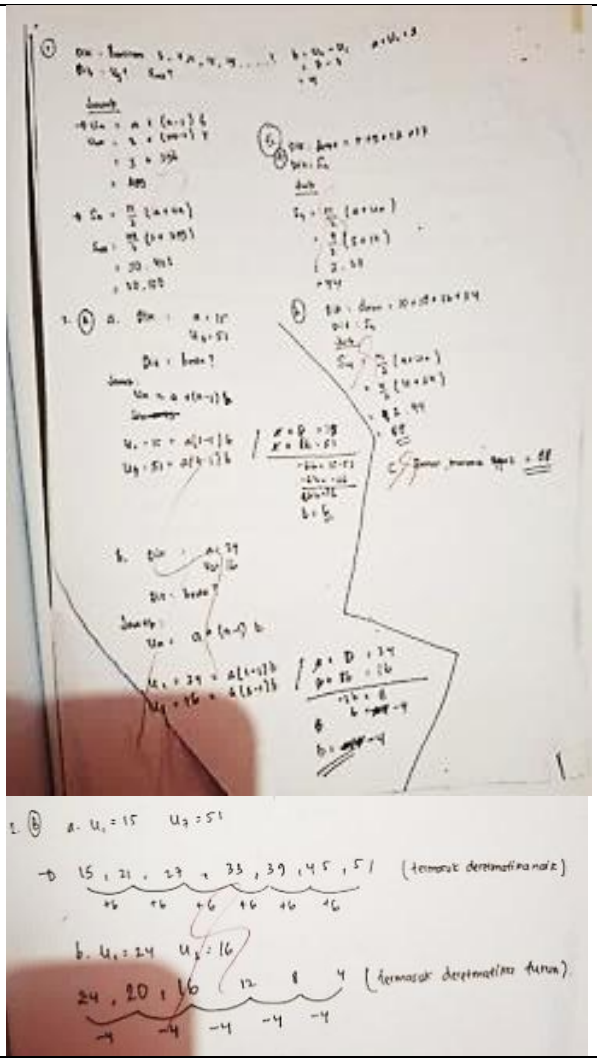
Table 1. Results of The Students' Critical Thinking Skill Test

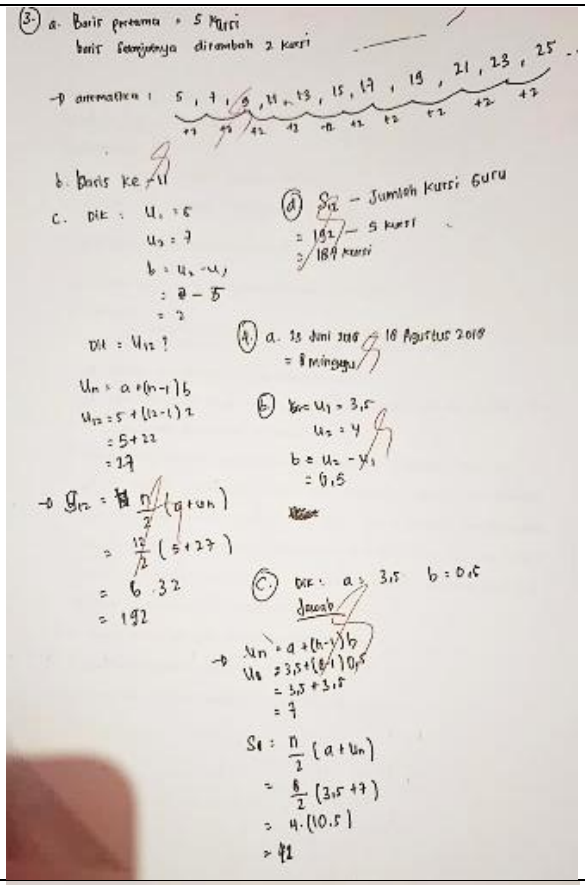
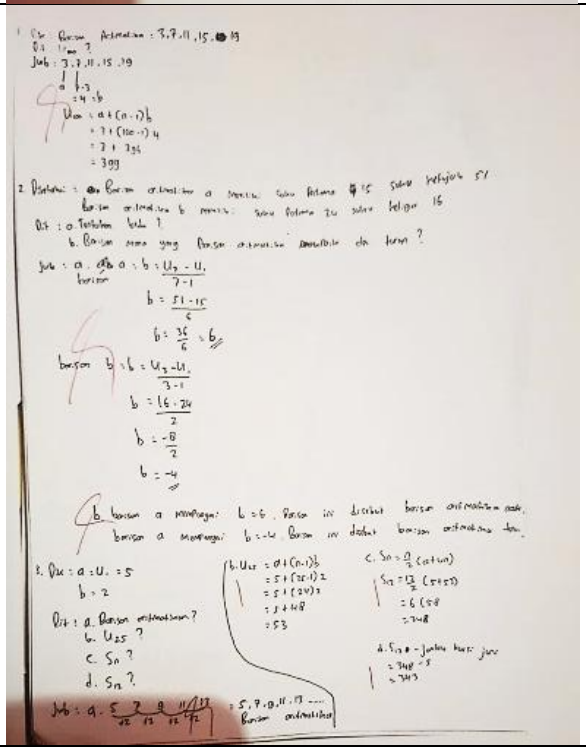
Score (X)	Category	Frequency						Percentage					
		Male			Female			Male			Female		
		A	B	C	A	B	C	A	B	C	A	B	C
$81{,}25 < x \leq 100$	Very High	3	1	-	4	3	-	60%	20%	-	80%	60%	-
$71{,}5 < x \leq 81{,}25$	High	2	3	-	1	2	1	40%	60%	-	20%	40%	20%
$62{,}5 < x \leq 71{,}5$	Moderate	-	1	5	-	-	4	-	20%	100%	-	-	80%
$43{,}75 < x \leq 62{,}5$	Low	-	-	-	-	-	-	-	-	-	-	-	-
$0 < x \leq 43{,}75$	Very Low	-	-	-	-	-	-	-	-	-	-	-	-

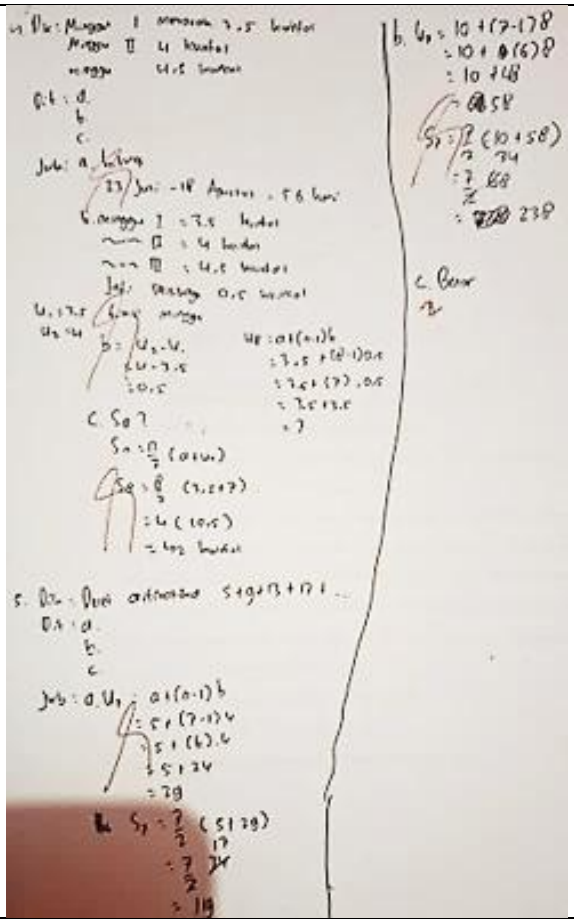
From Table 1, it can be seen that there are no students with critical thinking abilities in the very low category. The students' critical thinking skills are distributed across four categories: very high, high, moderate, and low.

To illustrate the students' critical thinking skills, selected responses from both male and female students are presented in Table 2.

Table 2. Students' critical Thinking Skills Selected Responses

Student Gender	Response	Analysis
Female		The student clearly identifies the pattern in the sequence and applies the correct formula with appropriate reasoning. The response shows a structured and logical process, indicating strong procedural understanding. This also indicates efficient problem-solvng strategy and awareness of alternative methods.

Student Gender	Response	Analysis
		
Male		The student demonstrates accurate inference and conclusion drawing based on given data. Reflects high-level deductive reasoning. The response shows understanding of conceptual justification beyond simple calculation. Reflect equal depth compared to female responses.

Student Gender	Response	Analysis
		

The critical thinking skill of female students is higher than male students, as indicated by the comparison of the frequency of students is greater than that of male students. On the other hand, in the low category, the frequency of male students is higher than that of female students. Meanwhile, in the high and moderate categories, there is no significant difference in frequency between male and female students. The percentage of critical thinking skills of male and female students per indicator can be seen in Figure 1.

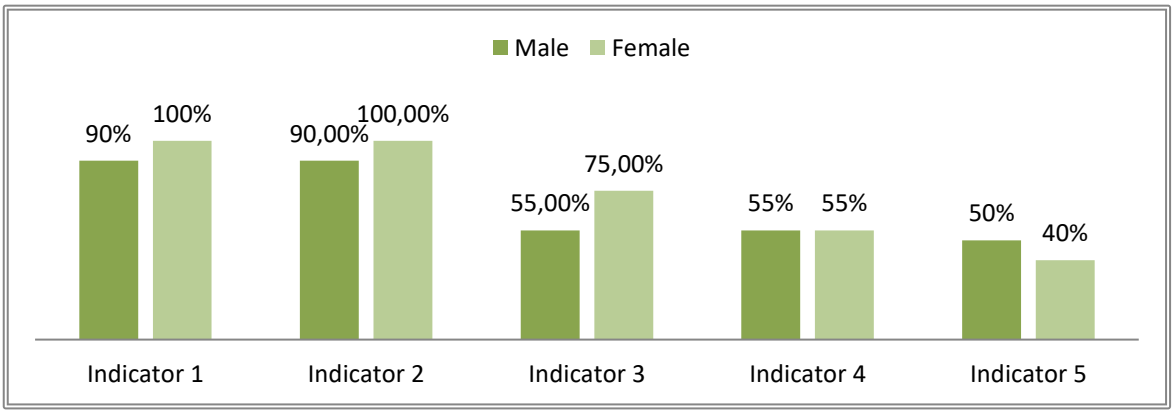


Figure 1. Results of The Students' Critical Thinking Skill Test

Explanation:
Indicator 1: Providing simple explanations
Indicator 2: Building basic skills
Indicator 3: Determining strategies and tactics
Indicator 4: Providing further explanations
Indicator 5: Making conclusions

Referring to the Figure 1, female students demonstrated superior performance in three indicators of critical thinking skills: providing simple explanations, building basic skills, and determining strategies and tactics, when compared to their male counterparts. Meanwhile, the percentage scores for the "providing further explanations" indicator were evenly distributed between male and female students. These results will be discussed in greater detail in the subsequent section to examine the potential factors behind these differences and their educational implications.

1. Providing simple explanations

The high achievement in the indicator of "providing simple explanations" can be attributed to supportive learning aids available in the classroom, such as calendar, which assisted students in responding to questions involving days and dates. Both male and female students generally demonstrated strong performance in this area. However, three males struggled to provide accurate explanations, as evidenced by errors in their responses.

Effectively offering simple explanations requires students to concentrate critically on the specific problem presented. The strong performance on this indicator is further reinforced by interview data. Students who were categorized in the "very high" achievement level were able to clearly articulate the distinctions between different types of arithmetic sequences, demonstrating their understanding through precise and relevant explantions.

2. Building basic skill

The indicator of building basic skills shows that female students slightly outperform their male counterparts in terms of percentage achievement. This disparity can be attributed to the fact that more male students encountered difficulties when responding to the test items. Interview findings further support this observation, revealing that a larger number of male students struggled to fully grasp the meanings of mathematical symbols and formulas related to arithmetic sequences and series.

Additionally, this difference appears to stem from distinct problem-solving approaches between genders. Female students tend to engage in a more reflective process by interpreting the problem twice-first during the initial reading and again after devising a solution strategy-whereas male students typically only analyze the problem once. This repeated engagement helps female students assess the accuracy and credibility of the information presented, which is

a hallmark of critical thinking. As a result, their ability to build foundational skills is strengthened through a deeper and more thorough understanding of the problem context.

3. Determining strategies and tactics

Both female and male students encountered difficulties in the indicator determining strategies and tactics, primarily due to a limited understanding of the various formulas associated with arithmetic sequences and series. This issue was evident in the interview findings, where nearly all students could only recall and explain a single formula, of the the same one.

However, male students demonstrated a lower percentage of achievement in this indicator compared to female students. This gap can be attributed to their frequent misunderstandings of the problems and a tendency t engage less in activities aimed at fully comprehending the questions. The absence of multiple problem-understanding stages increases the likelihood of errors in selecting appropriate strategies and tactics. In contrast, female students, who typically engage more thoroughly with the problem-solving process, are better able to develop effective strategies.

Furthermore, interview responses support these results. Female students generally provided more elaborate answers than male students. For instance, when asked about alternative formulas for calculating the sum of the first n terms in an arithmetic series, female students made an effort to recall the formula-even if they were ultimately unsuccessful-while male students tended to give up more quickly. This persistence in female students reflects a more active engagement with the problem-solving process, which positively impacts their ability to determine strategies and tactics effectively.

4. Providing further explanations

In terms of the indicator providing further explanations, both male and female students demonstrated similarly low levels of accuracy. This resulted in comparable levels of critical thinking performance for this particular indicator across genders. The findings suggest that students, regardless of gender, struggled to articulate extended reasoning or detailed justification when faced with questions requiring deeper explanations. This observation is further supported by the interview results, which revealed that neither male nor female students were able to provide clear and accurate explanations regarding concepts related to arithmetic sequences. The lack of depth in their responses indicates a general weakness in this aspect of critical thinking, highlighting the need for instructional strategies that explicitly target students' ability to elaborate on mathematical reasoning.

5. Making conclusions

For the indicator making conclusions, male students outperformed female students, despite providing responses that were generally less accurate and incomplete. This higher

achievement among male students can be attributed to the fact that many female students chose not to answer the question at all. The interview data further reinforce this finding, revealing that several female students expressed the belief that the conclusion presented in the test item would no longer be valid if the terms in the arithmetic sequence were multiplied by another number. Such responses indicate that these students have not yet developed a solid understanding of underlying concepts of arithmetic sequences and continue to face challenges in formulating logical conclusions. This suggests a need for targeted support to strengthen students' abilities in synthesizing information and deriving valid conclusions in mathematical contexts.

4. CONCLUSION

Based on the theoretical framework and analysis of the research findings, it can be concluded that female students demonstrated higher overall critical thinking skills compared to male students in the context of arithmetic sequences and series. Female students showed superior performance in the indicators of providing simple explanations, building basic skills, and determining strategies and tactics, which may be attributed to their tendency toward more detailed and complex thought processes. Conversely, male students performed slightly better on the indicator of drawing conclusions, likely due to a stronger inclination toward abstract and theoretical reasoning. Meanwhile, both male and female students showed equal ability in the indicator of providing further explanations, indicating a comparable level of understanding when elaborating on ideas.

This study contributes to the development of equitable and responsive mathematics education in Indonesia by highlighting how gender-related cognitive tendencies can affect students' critical thinking skills. These insights are valuable for teachers and curriculum developers in designing instructional strategies that are more inclusive and tailored to the needs of different learners, ensuring that both male and female students are equally challenged and supported in developing higher-order thinking skills.

Based on these findings, the following suggestions are proposed: Teachers should design varied learning activities that stimulate all indicators of critical thinking, with special attention to tasks that strengthen gemale students' abstract reasoning and male students' explanation skills; Differentiated instruction and gender-responsive pedagogy should be implemented to accommodate diverse thinking patterns and learning preferences among students; and future studies are encouraged to explore interventions or teaching models that can balance students' critical thinking development across genders and to extend the investigation to other mathematical topics or education levels. By addressing these areas, educators can contribute to enhancing the overall quality of mathematics education and

support the development of critical thinkers who are better prepared for the challenges of the 21st century.

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AUTHOR BIOGRAPHY

Muthiah Fildzah Noverli, M.Pd.

She is a Lecturer in Department of Mathematics Education, Universitas Singaperbangsa Karawang. She was graduate in Universitas Islam Negeri Raden Fatah Palembang in 2019, then continue her study in Universitas Pendidikan Indonesia for magister. Her research focuses on mathematics teaching and learning, critical thinking skill, and gender.

Rieno Septra Nery, S.Si., M.Pd.

He is Lecturer at Universitas Muhammadiyah Palembang. He was graduate in Universitas Sriwijaya in 2009, then continue his study in the same university for magister. His research focuses on mathematics teaching and learning, learning instrument, and mathematics skill.

Dr. Muhamad Sofian Hadi, S.S., M.Pd.

He is a Lecturer at Universitas Muhammadiyah Jakarta. He was graduate in Universitas Islam Negeri Maulana Malik Ibrahim in 2009, then continue his study in Universitas Negeri Jakarta for magister and doctor. His research focuses on english teaching and learning, gamification method, and technology.