

AN EXPLORATION OF GENDER DIFFERENCES IN STUDENTS' CREATIVE THINKING ABILITY IN SOLVING PROBLEMS BASED ON HIGHER ORDER THINKING SKILLS

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ARTICLE INFO

Article History:

Accepted: 26-12-2024

Approved: 02-04-2025

Keywords:

Creative thinking
Higher Order Thinking
Skills
Gender

ABSTRACT

Abstrak: Pengembangan kemampuan berpikir kreatif siswa menjadi bagian yang krusial di pendidikan terutama dalam bidang matematika. Penelitian ini bertujuan untuk mengeksplorasi perbedaan gender terhadap kemampuan berpikir kreatif siswa dalam menyelesaikan masalah berbasis HOTS. Metode yang digunakan dalam penelitian ini yaitu deskriptif kualitatif untuk mengkaji proses dan strategi pada setiap aspek berpikir kreatif siswa. Subjek penelitian terdiri dari enam siswa kelas V pada salah satu SD Negeri di Kota Malang. Data dikumpulkan melalui pemberian tes dan wawancara kemudian dianalisis menggunakan teknik coding. Hasil penelitian menunjukkan bahwa secara keseluruhan siswa perempuan lebih unggul pada aspek *fluency*, *originality*, dan *elaboration* sedangkan untuk aspek *flexibility* masih perlu dikembangkan oleh siswa laki-laki maupun perempuan. Pada penelitian ini dapat ditegaskan bahwa perbedaan gender memengaruhi kemampuan berpikir kreatif siswa.

Abstract: The development of students' creative thinking skills is a crucial part of education, especially in the field of mathematics. This study aims to explore gender differences in students' creative thinking skills in solving HOTS-based problems. The method used in this research is descriptive qualitative to examine the processes and strategies in each aspect of students' creative thinking. The research subjects consisted of six fifth grade students at one of the public elementary schools in Malang City. Data were collected through test administration and interviews and then analyzed using coding techniques. The results showed that overall female students were superior in the aspects of fluency, originality, and elaboration while the flexibility aspect still needed to be developed by both male and female students. In this study, it can be emphasized that gender differences affect students' creative thinking skills.

A. INTRODUCTION

Mathematics is a subject that is given since students are in elementary school. Mathematics lessons are part of an important component in the scientific world, especially in the 21st century because they are the basis for technological development and play an important role in various disciplines (Nufus et al., 2024). Therefore, the role of mathematics is not only limited to mastering theory but also as a place to develop students' thinking skills. This statement is in accordance with the opinion of Kadir et al., (2022) that mathematics learning given to students is not just a theory but also able to improve students' ability to think creatively, critically, and systematically.

The importance of thinking skills indicates the need to develop these skills through the learning process in the classroom (Faizah et al., 2023). Empowering students' thinking is very important to investigate phenomena and produce new knowledge (Mashfufah et al., 2020). Thus, mathematics is a basic science in the development of science and technology, increasing thinking power, and analytical skills.

Creative thinking skills are human thinking power that is needed to solve a problem. This statement is in accordance with the opinion of Ermayani et al., (2023) that creative thinking skills are very important for students to develop, especially in solving problems. According to Segundo-Marcos et al., (2023), creative thinking is an extension of the thinking aspect to solve problems. Maryanto &

Siswanto (2021) explain that the ability to think creatively is the ability to connect skills to produce various original ideas or develop something unique from what has existed before.

The results of research by Suherman & Vidákovich (2024) show that students' ability to think creatively can be developed through education, especially mathematics, because it can stimulate innovative student ideas. Torrance (dalam Suherman & Vidákovich, 2024) explained that the characteristics of a person's creative thinking ability can be measured from the aspects of fluency, flexibility, originality, and elaboration. Febrianingsih (2022) explained that problem solving done by thinking creatively can help students understand, master, and solve the problems they face.

Achieving this goal can be achieved by applying the right learning approach, one of which is Higher Order Thinking Skills (HOTS) based learning. Rohim (2019) stated that Higher Order Thinking Skills (HOTS) is a thinking process to solve complex problems by involving the skills of analyzing, evaluating, and creating. Higher Order Thinking Skills (HOTS) require creative and critical thinking in solving a problem. An individual is said to be able to think at a high level if they can analyze, connect, parse, and understand the meaning of a problem to find innovative solutions or ideas (Saraswati & Agustika, 2020).

According to Wulandari et al., (2020), Higher Order Thinking Skills (HOTS) can be developed by encouraging students to solve a problem through combining new and old information they have. One of the efforts to develop students' higher order thinking skills is to often present HOTS-based problems. HOTS-based questions are questions that contain cognitive domains at the C4 to C6 level (Ariyana et al., 2018). HOTS-based problems present real problems in everyday life so that students are expected to be able to solve problems using reasoning.

In addition, there are other factors that affect students' creative thinking skills, namely gender. Gender differences can show differences in the process of thinking, finding ideas, and communicating. This statement is in accordance with the opinion of Maryanto and Siswanto (2021), if there is a problem, male and female students tend to have different abilities in thinking creatively. Gender is a characteristic that is bound to different sexes so that

it affects different identities and social roles. Gender differences also indicate differences in the functions and distinctive characteristics of each gender (Astra et al., 2022).

Some previous studies have examined gender differences and creative thinking skills. The results of research conducted by Husain et al., (2022) show that of the four indicators of creative thinking ability, female students have higher thinking skills. In Agustini et al., (2020), male students have an advantage in solving investigative problems compared to female students. However, there is a difference from the results of Rafiah and Aulia's research (2021) which states that there is no significant difference in creative thinking ability between male and female students. In Astra et al's research (2022), gender factors do not significantly affect creative thinking skills but rather the greater influence of learning approaches. The difference in research results indicates that further study is needed. Therefore, this research is important to conduct in order to understand the role of gender in influencing various aspects of students' creative thinking when solving a complex problem.

In addition, the urgency of this research also stems from the need to develop HOTS-based learning approaches that are more adaptive to gender differences. Often, the application of HOTS-based learning approaches does not consider the differences in thinking processes between male and female students. In fact, this difference can affect the level of effectiveness of learning.

Previous research that has been conducted has not provided an in-depth study of students' thinking processes and strategies and does not specifically discuss HOTS-based problem solving. Therefore, this study examines the processes, strategies, and dynamics in each aspect of students' creative thinking. In this study, researchers did not only explore gender differences in creative thinking. Rather, it also focuses on the context of HOTS problem solving that requires the ability to analyze, evaluate, and innovate. Based on the previous explanation, it can be seen that it is necessary to identify differences in thinking patterns and strategies used by students in terms of gender differences. Therefore, this study aims to explore gender differences in students' creative thinking skills in solving HOTS-based problems.

B. RESEARCH METHODS

This study uses descriptive qualitative research to describe students' creative thinking skills in solving HOTS-based problems in terms of gender differences. This research explores the processes and strategies in each aspect of students' creative thinking in a contextual and in-depth manner. The research subjects were selected by purposive sampling based on math exam results and homeroom teacher recommendations. The subjects consisted of six fifth grade students at one of the public elementary schools in Malang City. The six students

included three male and three female students with certain characteristics relevant to the research focus.

The data collection technique was through giving tests and interviews to students to obtain a comprehensive understanding. Therefore, the instruments used consisted of tests, interview guidelines, and documentation. The tests given to students are contextual HOTS-based questions related to flat geometry material. The preparation of the test instrument was made systematically according to the grid according to Torrance modified by Liliawati (2011) **Table 1**.

Table 1. Creative Thinking Skills Instrument Grid

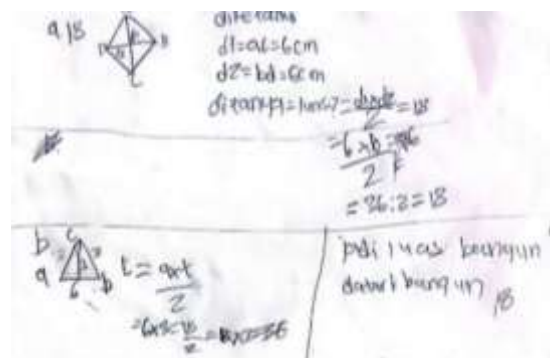
Aspects of Creative Thinking Skills	Creative Thinking Skills Indicator
Fluency	a. Responding with a number of answers to questions; b. Expresses ideas fluently;
Flexibility	c. Can quickly see the faults and weaknesses of an object or situation. a. Gives various interpretations to a picture, story, or problem; b. If given a problem usually thinks of many different ways to solve it;
Originality	c. Classifies things according to different divisions (Categories). a. After reading or hearing ideas, works to solve new ones
Elaboration	a. Seeks deeper meaning in answers or problem solving by going through detailed steps; b. Develops or enriches the ideas of others; c. Trying out/testing details to see which way to go.

The collected data was then analyzed using coding techniques. In the first process of coding analysis, it consists of the initial coding stage, followed by the focused coding stage (Hasan, 2023). According to Charmaz (2006), at the initial coding analysis stage, researchers identified and labeled each part that was relevant to the research focus. Then the researcher categorizes and refines the existing information to be understood. In this research, the data obtained must also be consistent. Therefore, data validity was carried out through method triangulation by comparing the results of tests and interviews with students.

C. RESULTS AND DISCUSSION

1. Creative Thinking Ability of Male Students

- a. Male Student with High Mathematical Ability (MGK)



Picture 1. Answers of Male Students with High Mathematical Ability (MGK)

Table 2. Results of Initial Coding Analysis (MGK)

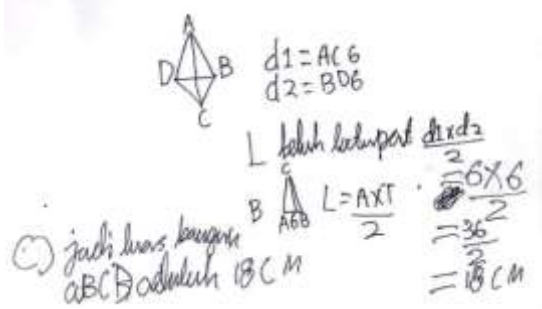
Aspects of Creative Thinking	Labeling Results
Fluency	Fluent subjects tried two ways The first way is done systematically There is a calculation error in the second way

Aspects of Creative Thinking	Labeling Results
Flexibility	Subject easily understood the problem Subject is able to use two different ways There is a misconception related to the value of diagonal 2 The subject experienced errors due to lack of accuracy
Originality	The subject can create alternative ways The solution method is different from what the teacher taught The subject felt relieved because the answer was the result of his own thinking
Elaboration	The subject gave the answer in detail until the second way The subject was able to conclude the result of the solution The subject can develop his ideas

After the labeling process according to Picture 1 and Table 2, the next step is the focused coding stage. In the fluency aspect, MGK was fluent in answering questions in two ways, namely the rhombus and triangle formulas. However, in the second way there was an error in the final calculation because the MGK multiplied the value that should have been divided.

When viewed from the flexibility aspect, MGK considers that the value of diagonal 2 is the same as diagonal 1. In the aspect of originality, MGK originally made new ideas by finding alternative answers other than the first way he used. In the elaboration aspect, MGK understood the answer he gave because he could complete the answer to the second way. Based on this explanation, MGK was able to fulfill the aspects of fluency, originality, and elaboration but the flexibility aspect still needed to be developed.

b. Male Students with Moderate Mathematical Ability (NA)



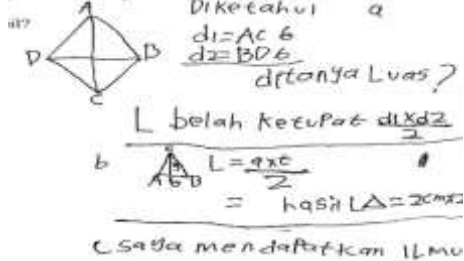
Picture 2. Answers of Male Students with Moderate Mathematical Ability (NA)

Table 3. Results of Initial Coding Analysis (NA)	
Aspects of Creative Thinking	Labeling Results
Fluency	The subject tried with two approaches The subject completed the first method systematically The subject only wrote the formula in the second way Problem is considered easy to understand
Flexibility	The subject misinterpreted the diagonal value The final result given by the subject was not correct The subject felt confused in the second way
Originality	The subject tried two different ways The solution used his own idea The subject was too focused on the first way because it was easier to understand
Elaboratio	The subject gave a detailed answer in the first way The subject gave a conclusion that matched the answer The subject could not solve the second way

After the labeling process according to Picture 2 and Table 3, the next step is the focused coding. In the fluency aspect, NA stated that the problem given was actually quite easy to understand. However, he felt too focused on the first way so he was confused when he wanted to answer the question in the second way. In the flexibility aspect, NA realized that there was an error in the calculation so he was not sure to solve his answer in the second way.

In the aspect of originality, NA said in the interview that he was confident in the first way and realized that the second way was not right because it was not finished. Based on this statement, it can be seen that NA was able to fulfill the aspects of originality and elaboration but still needed to improve his ability in the aspects of flexibility and fluency.

c. Male Student with Low Mathematical Ability (JA)



Picture 3. Answers of Male Students with Low Mathematical Ability (JA)

Table 4. Results of Initial Coding Analysis (JA)

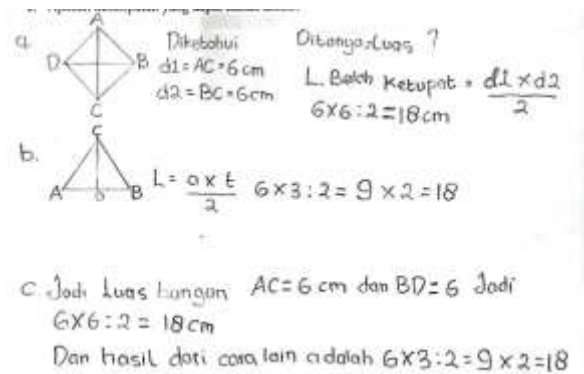
Aspects of Creative Thinking	Labeling Results
Fluency	The subject tried in two ways Answers are only based on memorization of formulas Ideas are still basic The subject has difficulty understanding the information in the problem
Flexibility	The subject assumes the value of diagonal 2 is the same as diagonal 1 The subject immediately worked on the second method when the first method was not finished Subject has difficulty solving the second way
Originality	The subject is already looking for alternative answers Limited understanding becomes an obstacle in finding results The subject has never worked on similar problems Subject lacks confidence in his answer
Elaboration	Subject had difficulty detailing each step of problem solving Subject did not solve both ways The subject did not recheck the answer

After the labeling process according to Picture 3 and Table 4, the next step is the focused coding. When viewed from the fluency aspect, JA only limited to writing the formula so that it does not have the final result. JA stated that the answer he gave was only based on memorizing the formula. In the flexibility aspect, JA stated that initially he only thought of using one way but because he could not solve the first way, he finally switched to the second way. Unfortunately, JA experienced confusion and could not solve both ways.

In the originality aspect, JA tried to develop his ideas by looking for alternative answers. The interview results showed that JA had never solved a similar problem so he was less confident in his answer. In the elaboration aspect, JA also did not re-evaluate his answer so that the conclusion given was not in accordance with the question. JA stated in the interview that he did not recheck his answer and felt unsure of his answer. Therefore, it can be concluded that the creative thinking aspects of JA students have not been fully achieved.

2. Creative Thinking Ability of Female Students

a. Female Students with Low Mathematical Ability (RAA)

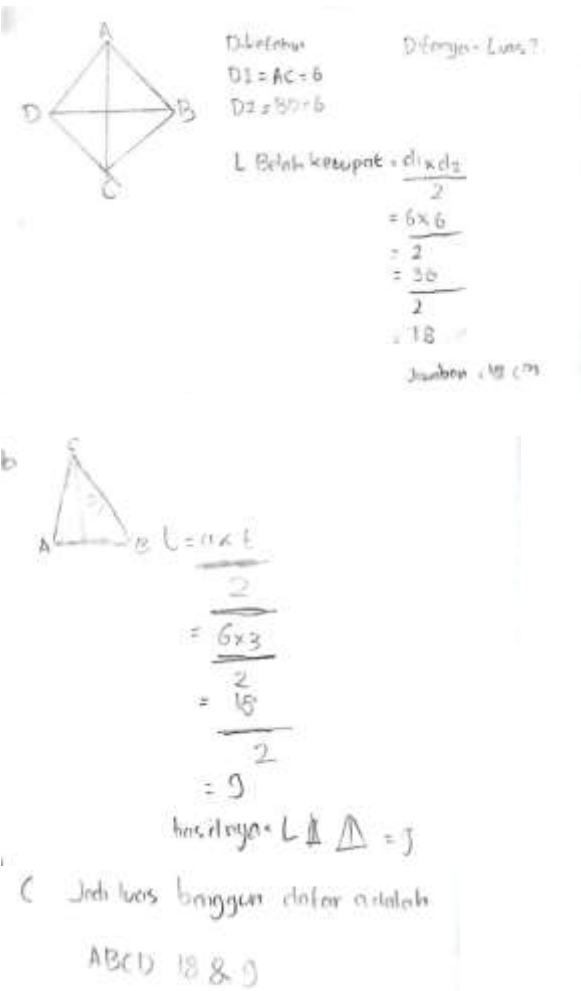
**Picture 4.** Answers of Female Students with Low Mathematical Ability (RAA)**Table 5.** Results of Initial Coding Analysis (RAA)

Aspects of Creative Thinking	Labeling Results
Fluency	The subject used two ways Completion in both ways is systematic The subject tried two ways to ensure that the answer was correct
Flexibility	Subject misinterpreted the information in the problem The subject assumes the value of diagonal 2 is the same as diagonal 1 The subject realized his mistake due to lack of thoroughness
Originality	The subject was able to develop his ideas by providing alternative answers The subject was able to input the value into the formula Problem solving came from his own thinking
Elaboration	Problem solving is done in detail The answer given is detailed with the conclusion The final result shows the same value in both ways

After the labeling process according to Picture 4 and Table 5, the next step is the focused coding. In the fluency aspect, RAA was able to convey his ideas well as seen from the answers that were completed systematically in the first way and the second way. In the flexibility aspect, RAA also assumed that the value of diagonal 2 in rhombus has the same value as diagonal 1.

In the aspect of originality, RAA stated that the problem solving idea he worked on arose from his own understanding. In the elaboration aspect, RAA gave his answer in detail as seen from the conclusion he gave. In the second way the answer obtained is the same as the first way. Based on this description, it is known that RAA has fulfilled the aspects of fluency, originality, and elaboration. As for the flexibility aspect, it still has to be developed by increasing its accuracy and understanding.

b. Female subject with moderate mathematical ability (NAR)



Picture 5. Answer of female subject with moderate mathematical ability (NAR)

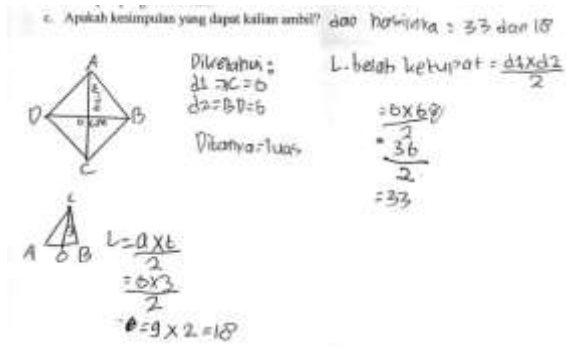
Table 6. Results of Initial Coding Analysis (NAR)	
Aspects of Creative Thinking	Labeling Results
Fluency	The subject used two solution methods The completion steps given are systematic The solution in the second method is less detailed

Flexibility	The subject assumes the value of diagonal 2 is the same as diagonal 1 The subject had difficulty determining the next step after obtaining the triangle area
Originality	The subject was able to provide alternative problem solving The subject did not solve the second way Subject had doubts on the second way
Elaboration	The subject gave a detailed answer in the first way The subject had difficulty in describing the next step in the second way

After the labeling process according to Picture 5 and Table 6, the next step is the focused coding. In the fluency aspect, NAR fluently conveyed his ideas as seen from the systematic steps in solving the problem. However, in the second way, NAR lacked details in understanding the problem so that the completion was not complete. In the flexibility aspect, NAR had difficulty determining the next step after obtaining the triangle area result.

In the originality aspect, NAR was able to develop his ideas by providing several problem solutions. However, the wrong diagonal value makes the final result less precise. When reviewing the elaboration aspect, NAR expressed confidence in the first answer but was less confident in the second way because the final answer was different. Based on the previous explanation, it can be seen that the NAR is able to fulfill the aspects of fluency and originality while the aspects of flexibility and elaboration still need to be improved.

a. Female Student with Low Creative Thinking Ability (NAH)



Picture 6. Answers of Female Subject with Low Mathematical Ability (NAH)

Table 7. Results of Initial Coding Analysis (NAH)

Aspects of Creative Thinking	Labeling Results
Fluency	The subject used two methods The answer given by the subject has not reached the final result The subject had difficulty in understanding problem solving
Flexibility	The subject misinterpreted the information in the problem The subject was not sure of the answer
Originality	Subject was able to create new ideas by providing alternative answers The idea came out directly when looking at the problem Subject felt confused and not confident with his answer
Elaboration	The subject was only able to input the value into the formula The subject did not detail each step of the solution The subject did not double-check his answer

After the labeling process according to Picture 6 and Table 7, the next step is the focused coding. In the fluency aspect, NAH was less precise in conveying his ideas because the answers given had not found the final result. Moreover, he also did not understand deeply about the concepts of multiplication and division arithmetic operations. When reviewing the flexibility aspect, NAH explained that she had never found a similar solution before and was unsure of her answer. He assumed the value of diagonal 2 was the same as diagonal 1 because the lengths looked the same.

In the aspect of originality, NAH was able to create new ideas by making more than one way of solving but could not finish it until the end. In the elaboration aspect, NAH could only enter the value in the formula without detailing each step of the solution until finding the final result. The interview results showed that NAH did not recheck his answers because he felt confused. Therefore, it can be concluded that all aspects of creative thinking in this student have not been fulfilled.

3. Differences in Creative Thinking Ability between Male and Female Students

a. Fluency

Fluency is one aspect that is an indicator of creative thinking ability. According to Dilekçi and Karata (2023), fluency is the ability of students to generate many ideas. When viewed from male students, it is known that JA subjects still have difficulty in generating complete and relevant ideas. In the NA subject, he tended to only focus on solving the problem in one way so that it was less than optimal in alternative answers. MGK was able to generate more ideas and complete almost all steps of the solution systematically. According to Widiyanto (2021), a person's creative thinking ability can be seen from the number of different answers in solving problems.

When looking at female subjects, it can be seen that subject NAH also experienced obstacles in completing her answers according to her ideas. Meanwhile, subjects NAR and RAA have tried to solve with two alternatives more systematically even though one of the methods used is incomplete. Based on the description above, it can be seen that in the fluency aspect, female students are more consistent and detailed in conveying their ideas while male students focus more on one way.

b. Flexibility

Flexibility can be interpreted as a change in problem-solving strategies. Flexibility occurs when students are able to develop multiple perspectives on a subject (Dilekçi & Karatay, 2023). Acesta (2020) explained that mathematics learning can encourage students to create innovative ideas, fluent in expressing their ideas, and these ideas can solve problems. When viewed from male students, it is known that they have tried to try new strategies but are still wrong in interpreting and understanding concepts, especially for JA and NA. While the MGK was able to be more flexible but still mistaken in understanding the information in the problem as a whole. Wilkie (2024) explained that students' persistence in creative thinking can create a mindset that wants to continue to develop, especially regarding their skills.

In female students, it can be seen that subject NAH has difficulty changing her strategy due to a lack of conceptual understanding of the information in the problem. Whereas in the

subjects of NAR and RAA, they are more able to use various solutions even though there are ways that are less precise due to imperfect concept understanding. Students' ability to think creatively can be influenced by their level of intelligence, knowledge, thinking style, personality, motivation, and environment (Ma et al., 2024). Febrianingsih (2022) explained that students are expected to be able to provide a variety of creative when analyzing and solving mathematical problems so that the completion is correct. Based on this description, it can be seen that female students have consistency in trying different approaches while male students tend to change strategies more quickly even though sometimes they are less effective.

c. Originality

Originality means novelty created in creative thinking. The novelty does not have to be something completely new but also the result of a combination of various ideas that have been applied so that it becomes something new from before (Zakiah et al., 2020). Febrianingsih (2022) explained that each student through creative thinking can find different ideas and solutions because the abilities that students have must be different. When reviewing from male students, it can be seen that JA subjects lack confidence and find it difficult to develop new ideas. Subjects NA and MGK were able to create alternative solutions but focused more on one way that they considered easier.

Whereas for female students, it is known that subject NAH came up with her own problem solving ideas but was not sure she could solve it. In NAR and RAAs, they were able to produce alternative solutions with more complete steps than men. According to Kadir et al., (2022), Creative thinking is original and reflective so the results are more complex. Students who have been able to be creative with their mathematical ideas will gain a better understanding (Fatur Rahman, 2020).

Based on this description, it can be seen that female students are more capable of generating diverse and complete new ideas. Meanwhile, male students tend to have higher confidence in the solutions they believe in. This condition is in

accordance with the statement (Hora et al., 2021) that men are more dominant in having creative self-efficacy so that they can support the optimization of creative performance. When their creative thinking skills develop, students are expected to have the courage to solve their problems in their own way in the form of various alternative answers (Febrianingsih, 2022).

d. Elaboration

Elaboration refers to the development of new concepts from concepts that students have previously by developing details of problem solving to make it more effective (Chen et al., 2020). Creative thinking skills are carried out by combining various ideas, generating new ideas, and analyzing their effectiveness (Kadir et al., 2022). In male students, it can be seen that JA subjects had difficulty in detailing each step of problem solving and tended to be hasty in completing their answers. NA and Subject MGKs were able to provide more detailed answers in the first way but less optimal in the second way.

Meanwhile, female students showed more thorough and detailed abilities, especially for subjects NAR and RAA. They were able to develop their ideas to find conclusions even though there were still answers that were less precise. Febrianingsih (2022) stated that students' creative thinking ability is not only determined by the number of answers given but the quality and variety of these answers. Therefore, it can be seen that female students are superior in detailing each step of the solution compared to male students. Maryanto and Siswanto research (2021) found that female students have the ability to provide answers that are more detailed and thorough than male students. Meanwhile, male students have more flexibility in thinking when solving a math problem.

This is also in line with research conducted by Ermayani et al., (2023) that male students have low performance related to accuracy in solving problems so that they cannot detail the solution of a problem. Meanwhile, female students are able to think clearly in providing many answers, flexible in seeing a problem from various points of view, and original when conveying something.

D. CONCLUSIONS AND SUGGESTIONS

This study was conducted to explore gender differences in students' creative thinking when solving HOTS-based problems. When viewed from the fluency aspect, female students are more detailed in conveying ideas. Meanwhile, male students are less optimal in generating alternative solutions. In the flexibility aspect, male students are faster in changing strategies while female students are more consistent in trying various ways even though there are still errors. In the originality aspect, female students have an advantage in generating new ideas that are varied and more systematic than male students. However, male students had higher confidence in the answers they gave. In the elaboration aspect, female students were more thorough in describing each step of problem solving in the problem even though the final result was less precise. In contrast, male students had difficulty in detailing their answers especially when they felt rushed.

Based on the previous description, it can be concluded that overall female students are superior in the aspects of fluency, originality, and elaboration while the flexibility aspect still needs to be developed by both male and female students. In this study, it can be emphasized that gender differences affect students' creative thinking skills. Therefore, it is very important for mathematics lessons to be tailored to the needs of students so as to maximize the creative potential of each gender. Suggestions for further research are to examine effective learning strategies to improve students' critical thinking skills by reviewing aspects of gender differences.

ACKNOWLEDGMENTS

The researcher would like to thank the principal at the school where the research was conducted. In addition, the researcher would also like to thank the teachers and students involved in this research. The researcher would also like to thank all the lecturers who have helped this research until it is completed.

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