International Journal of Multicultural and Multireligious Understanding

http://ijmmu.com
editor@ijmmu.com
ISSN 2364-5369
Volume 12, Issue 7
July, 2025
Pages: 328-337

Flexibility of Mathematical Thinking in Solving Hots Problems on Number Operation Material in Terms of Gender

Putri Dwi Arianti; Muhammad Iqbal Rifqy; Ulfa Masamah

Tadris Matematika, Faculty of Education and Teacher Training, UIN Maulana Malik Ibrahim Malang, Jl. Gajayana No. 50, Kota Malang, Jawa Timur, Indonesia

http://dx.doi.org/10.18415/ijmmu.v12i7.6853

Abstract

This study aims to describe the flexibility of students' mathematical thinking in solving HOTS (Higher Order Thinking Skills) problems on number operations material, by considering gender differences. The research was conducted with a qualitative approach, using tests and in-depth interviews with four students (two boys and two girls) in class VII at MTs N Kota Batu. The results showed that only some subjects were able to fulfill the indicators of mathematical thinking flexibility thoroughly. Subjects who have high flexibility use more than one strategy in solving problems, showing diversity, accuracy, and efficiency. In contrast, subjects with low flexibility tended to use a single strategy. The findings showed that female subjects had high mathematical thinking ability by fulfilling all flexibility indicators, namely using more than one strategy, solving problems correctly, and choosing effective and efficient strategies. In contrast, male subjects tend to use a single strategy, which shows limited flexibility of thinking. This study concludes that flexibility in mathematical thinking is an important ability that needs to be developed to improve students' success in solving HOTS problems.

Keywords: *Flexibility Thinking; HOTS; Mathematics; Thinking*

Introduction

Mathematics learning in modern times now emphasizes not only the ability to calculate, but also the development of higher order thinking skills. This is in line with the demands of the curriculum which requires students to be able to solve problems that test HOTS (Higher Order Thinking Skills). HOTS questions are designed to encourage students not only to understand basic concepts, but also to analyze, evaluate, and create innovative solutions in various contexts. Therefore, the ability to think critically and creatively is very important in the process of learning mathematics (Melawati et al., 2022) & (Widana, 2018).

Creative thinking in mathematics involves the ability to look at a problem from multiple points of view and come up with a variety of possible solutions. This ability not only supports complex problem solving, but also helps students to develop flexibility in thinking. Creativity in mathematics can be measured through fluency, flexibility and novelty in thinking, all of which are important indicators of high mathematical thinking ability (de Vink et al., 2022) & (Akgül & Kahveci, 2016). Research shows that divergent thinking can improve students' performance in solving mathematical problems, as it allows them to generate different and original solutions (de Vink et al., 2022).

Flexibility in mathematical thinking is the ability to change approaches or strategies in solving mathematical problems. This flexibility allows students to adapt to different types of problems and find new ways to reach the correct solution. Research indicates that flexibility of thinking is very important in solving complex mathematical problems, because it allows students to use various strategies and adjust their approach according to the needs of the problem (Purwasih et al., 2019) & (Ratnaningsih, 2017). Thus, the development of mathematical thinking flexibility should be a focus in mathematics learning (Rizalno & Purwanto, 2022).

Gender differences in mathematics education have been a significant research topic. Several studies have shown that there are differences in how males and females solve math problems. Males tend to excel in tasks that require spatial thinking, while females are better at tasks that require verbal and detail skills (Abdullah et al., 2015). However, the results of these studies are still mixed, and it is important to further explore how gender affects students' mathematical thinking flexibility in the context of HOTS problems (Supriadi, 2019).

Although there have been many studies that address mathematical thinking flexibility and the role of gender in problem solving, there are still some gaps that need to be filled. Previous studies tend to focus on general contexts or on one type of math problem only. In addition, many of the studies were conducted abroad with different cultural and educational contexts. Therefore, this study aims to fill the gap by focusing on the flexibility of students' mathematical thinking in solving HOTS problems on number operations, by considering gender differences (Artikasari & Saefudin, 2017).

Based on this background, this study is expected to contribute significantly to the understanding of how mathematical thinking flexibility and gender differences affect students' ability to solve HOTS problems. The results of this study can serve as a basis for designing more effective and inclusive learning strategies, so as to help all students, both male and female, to achieve their maximum potential in learning mathematics.

Based on this background, this study is expected to contribute significantly to the understanding of how mathematical thinking flexibility and gender differences affect students' ability to solve HOTS problems. The results of this study can serve as a basis for designing more effective and inclusive learning strategies, so as to help all students, both male and female, to achieve their maximum potential in learning mathematics.

Methods

The purpose of this study, which uses a qualitative approach, is to describe and explore the flexibility profiles of male and female junior high school students in solving HOTS problems on number operations. The students selected for this study were students who were in grade seven of the first semester at MTs N Kota Batu. Non-probability (non-random) sampling was conducted. Non-random sampling was conducted on students of class VII H MTs N Kota Batu. The number of students in class VII H at this school is 32 students. Sampling of each student's mathematical ability was carried out using Purposive Sampling technique, namely the selection of samples based on certain characteristics that are considered to have a connection with the characteristics of the population that are already known in advance and based on recommendations from the VII H class teacher. These students have good math skills and can communicate orally and in writing. This study was chosen because students with this ability can usually solve problems and show flexibility. Four subjects, two boys and two girls, were selected based on these requirements.

Flexible thinking ability data were obtained from tests with flexible thinking ability components and interviews. The instruments used have been validated by material experts, namely lecturers. The data that has been collected is analyzed with a qualitative approach. The data processing stages included data reduction, data presentation, and conclusion drawing.

According to Goleman (1995) flexibility is the ability to provide various solutions and approaches in solving problems. In line with Amina et al. (2020) that the main characteristic of flexibility in thinking is knowing and using several strategies. Someone who has cognitive flexibility in him will solve problems efficiently and effectively and can ensure the correctness of the answers generated through several methods that have been used, meaning they can solve correctly. So the indicators used in order to determine the flexibility profile of junior high school students in solving HOTS problems in number operation material can be observed in table 1 below:

Table 1. Indicators of Flexibility in Mathematical Thinking

Measured ability	Indicator
Flexibility Of Mathematical Thinking	• Uses more than one strategy/method • Solve the problem correctly • Shows the most effective and efficient strategy based on the results

Results and Discussion

The research results were obtained based on tests and in-depth interviews conducted with 2 male and 2 female students of MTs N Kota Batu regarding the ability of mathematical thinking flexibility in solving HOTS-based problems. The following are the results of student work based on the tests given:

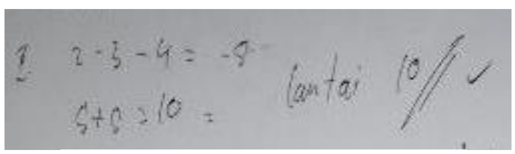

Figure 1. M-1 Answer number

Based on Figure 1, it shows that subject M-1 only used one strategy, namely simple arithmetic operations, with steps $2 - 3 - 4 = -5$ and added the results to the final position of the floor $5 + 5 = 10$, thus obtaining the correct answer, which is the 10th floor. Although the subject managed to solve the problem correctly and used a fairly efficient strategy, the answer given by the subject did not show the flexibility of mathematical thinking because the subject did not try to use more than one way, such as the algebraic equation method or visual representation using a number line. Thus, it shows that the subject can solve the problem correctly and show an efficient strategy, but has not fulfilled the indicator of using more than one strategy. This is corroborated by the interview as follows:

P_1 : Can you explain how you solved this problem and why you chose this method?

M-1: I only used simple arithmetic operations, such as adding and subtracting numbers. For example, I calculated $2 - 3 + 4 = 5$ and then added the result to the final floor, so that $5 + 5 = 10$

P_1: Did you think of any other ways besides this?

M-1: No

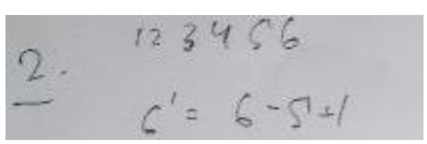

Figure 2. M-1 Answer number 2

Figure 2 presents the response of subject M-1. Based on the written answer, the subject used the numbers 6, 5, and 1 to form the operation $6 - 5 + 1$, which results in a value of 2, aligning with the given problem's objective. However, this solution does not fully comply with the information provided in the problem, as it only utilizes three different numbers and does not incorporate three operators. The solution relies solely on basic mathematical calculations without demonstrating exploration of alternative strategies or methods, thus failing to reflect flexibility.

Although efficient in terms of computation, the strategy employed is not entirely effective since it does not fulfill all the problem's requirements, making the answer not entirely correct. Therefore, based on the provided response, it can be concluded that subject M-1 has not yet demonstrated flexibility in solving the problem. This finding is further supported by the interview results presented below.

P_2: Can you explain how you solved this problem? What led you to use the numbers 6, 5 and 1 for the operation $6 - 5 + 1$?

M-1: I chose that number because I thought the result would match the objective of the problem, which was to get a score of 2. I tried to calculate in a simple way, and it worked immediately.

P_2: Are there any other ways?

M-1: Not considered.

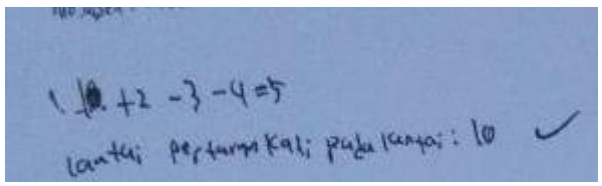

Figure 3. M-2 Answer number 1

Based on the answer in Figure 3, subject M-2 uses an arithmetic operation strategy with the steps $x + 2 - 3 - 4 = 5$, then solves the equation to $x = 10$. In this case the subject can show the correct answer and use a way that is easy to understand, but the subject has not been able to provide more than one way of solving. This is corroborated by the results of the interview as follows.

P1 : How did you solve problem number 1?

M-2: Understanding the information contained in the problem, it is known to go up 2 floors, down 3 floors and down 4 floors. meaning that the total subtraction is 7 and the addition is 2. Then I guessed for example the first time on the 10th floor, up 2 floors = on the 12th floor, then down 3 floors = on the 9th floor and down 4 floors = on the 5th floor.

P1 : Are there any other ways?

M-2: No.

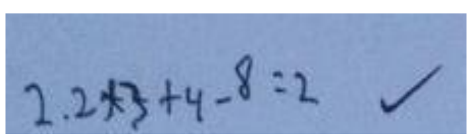

Figure 4. M-2 Answer number 2

Based on the answer in Figure 4, the strategy used by Subject M-2 is $2 \times 3 + 4 - 8 = 2$, this fulfills the requirements of the problem by using four different numbers (2, 3, 4, and 8) and three operators ($+, -, \times$). The result of the calculation is correct, which is 2, so the indicator of solving the problem correctly is met. However, the answer only shows one strategy without exploring alternative ways, so the indicator of using more than one strategy/way has not been met. The strategy chosen is quite effective and efficient because it is simple and easy to understand, but without a comparison with other strategies, it is difficult to conclude that this is the most optimal strategy, so this indicator is only partially met. This is corroborated by the interview results below.

P_2: How did you solve the problem? Did you try more than one way to get the result?

M-2: I immediately tried to use the numbers given, namely 2, 3, 4, and 8, then set the operator to $2x3 + 4 - 8 = 2$.

P_2: Do you think there is another way to get the result of 2 with the same numbers and rules?

M-2: There might be, but I didn't think to try other methods because the one I was using was working.

Figure 5, shows the answer of subject F-1 using a simple arithmetic method, the method used is quite creative and produces the correct answer, but the subject is only able to provide one way. Thus, the answer given has not been able to show flexibility perfectly. The interview results below reinforce the test answers given by the subject.

P_1: Can you explain how you solved this problem?

F-1 : I chose the numbers and operators that were easiest to remember, and then tried them until the results matched the question.

P_1: Did you try any other ways to solve this problem?

F-1 : No.

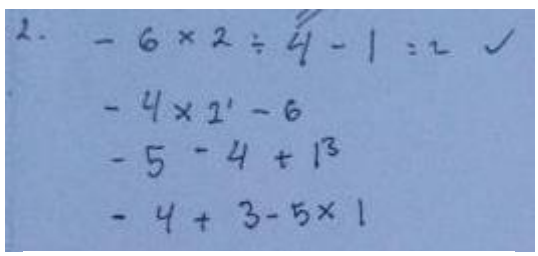

Figure 6. F-1 Answer number 2

Based on Figure 6, subject F-1 used four different strategies in solving the given problem. All strategies produced the number 2 with the correct calculation, so the indicator "solving the problem correctly" was met. The diversity of strategies used also shows the exploration of alternative ways, fulfilling the indicator "using more than one strategy/way". Of the four solutions, the first strategy $6 \times 2 \div 4 - 1 = 2$ is the most effective and efficient because it uses minimal steps and basic operators, so this indicator is also met. Thus, the answer fulfills all three flexibility indicators. This is also strengthened by the following interview results.

P_2: Can you explain how you solved this problem to get the result 2?

F-1 : I tried various combinations, ranging from basic operations such as addition and subtraction to combinations with multiplication and division. One of the methods I used was $6 \times 2 \div 4 - 1 = 2$.

P_2: What is the reason for this?

F-1 : Since there are fewer steps and the operators used are simple, it is faster to calculate. Also, this method is less complicated and gives the correct result immediately. Although I tried several other ways, I think this first way is the most efficient way to solve the problem.

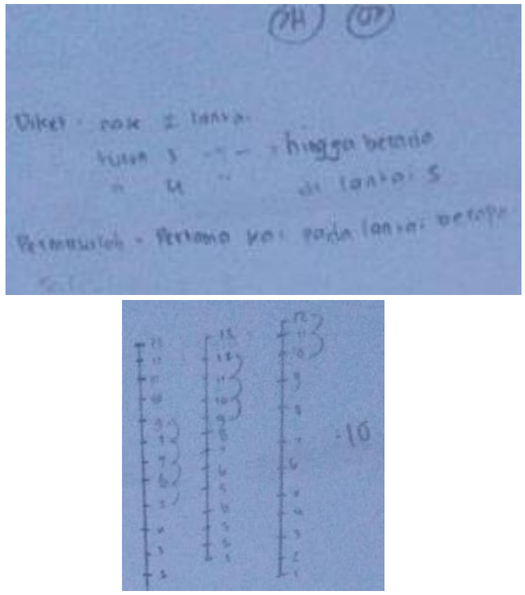

Figure 7. F-2 Answer number 1

The answer in Figure 7 shows that subject F-2 is able to meet the flexibility indicator because it uses more than one strategy, namely visualization of the number line to make it easier to understand the movement up and down the elevator, as well as explicit mathematical calculations to get the final solution, which shows a combination of visual and numerical strategies. The problem solving was done correctly, where the calculation showed that Abi's initial floor in the elevator was the 10th floor, corresponding to the final condition on the 5th floor after going up 2 floors, down 3 floors, and down again 4 floors. The strategy used is also effective and efficient, because the visualization of the number line helps explain the steps of the elevator movement in stages, ensures the calculation is not wrong, and provides certainty of results, so that the answer meets all indicators of flexibility. This is also reinforced by the interview results below.

P_1: Can you explain how you solved the problem related to the movement of Abi's elevator to find its initial floor?

F-2 : I used two methods, first by making a number line to illustrate the movement of the elevator up and down. After that, I also did the mathematical calculations directly to make sure the results were correct. This way, it was easier for me to understand the steps and check if the end result was correct.

P_1: Do you think this strategy is appropriate? If so, why?

F-2 : I found it very effective, as the visualization helped me understand the gradual movement of the elevator, while the calculation ensured that the result was correct. This combination made me more confident in my answer, and I eventually found that the starting floor was the 10th floor, according to the given end condition.

P_1: Are there any other ways?

F-2 : Yes, in addition to using ordinary calculations, I also use a number generator.

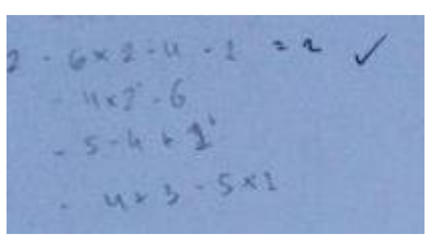

Figure 8. F-2 Answer number 2

Based on Figure 8, the answer of subject F-2 shows that it is able to fulfill flexibility as a whole, because it uses several different strategies to solve the problem, by trying various combinations of numbers, operators, and calculation sequences. One of the strategies gave the correct result, namely, $6 \times 2 \div 4 - 1 = 2$ which is marked with a check mark, thus fulfilling the accuracy indicator. This strategy also fulfills efficiency because it uses different numbers (6, 2, 4, 1) and three operators as required by the problem, and the steps are simple and lead directly to the required result. Thus, the correct answer shows the ability of flexibility, accuracy, and efficiency in solving problems according to the given indicators. Reinforced by the interview results below.

P_2: Can you explain how you solved the problem?

F-2 : I tried several combinations of numbers and operators first, such as addition, subtraction and division, until I found the right result. Finally, I chose $6 \times 2 \div 4 - 1 = 2$, because the result was correct and fulfilled all the requirements of the question.

P_2: Why did you choose that method? Do you consider it the most efficient or appropriate?

F-2 : Yes, because I used different numbers such as 6, 2, 4 and 1, and only three operators. The process is also simple, producing the correct answer immediately without any redundant steps. So, in my opinion, this is the most appropriate way.

Based on the results of the study which showed that only some subjects were able to fulfill the indicators of mathematical thinking anomalies thoroughly, it is important to illustrate that continuity of mathematical thinking is a crucial ability in solving mathematical problems. Based on data analysis, it was found that female subjects, namely Subjects F-1 and F-2 who showed a high level of thinking argumentation, used more than one strategy in solving the problem, reflecting the diversity of ways of solving, the accuracy of the answers, and the effectiveness of the strategies used. This is in line with research Firdaus et al. (2019) which shows that mathematical thinking includes the use of various strategies to solve mathematical problems. Critical thinking skills are a very important part of learning mathematics, especially in dealing with problems with high difficulty levels (Siswono, 2016).

In contrast, Male subjects like M-1 and M-2 who tend to use a single strategy show that their thinking is still limited. Research by Prajitno and Toifur was not found in the references provided, so it cannot be used to support this claim. However, research (Tambunan, 2019) revealed that students with good thinking skills are better able to solve problems based on Higher Order Thinking Skills (HOTS) because they can consider various alternative solutions and choose the most efficient strategy. This finding is reinforced by Nisa Rambe & Sinaga Asmin (2019), which shows a direct relationship between the ability to explore various approaches and the success of solving mathematical problems. Thus, the difference in mathematical thinking ability between subjects reflects the variation in exploratory strategies for solving the problems encountered.

According to Krutetski in (Nuryadi et al., 2022) states that women are superior in accuracy, thoroughness, accuracy, and sexiness of thinking in mathematics learning. While the findings of Anggraeni & Herdiman (2018), male students have better problem solving skills compared to female students, male subjects are also more thorough and complete in writing problem solving steps compared to female students. However, women's abilities are better at the plan implementation stage, although there are several stages where there are still errors. In contrast to research conducted by Lestari et al. (2021), female students are more rigid in counting. However, this study also underlines that male students are better at understanding problems.

According to Pasiak in (Kondo et al., 2018), differences in mindset between men and women are influenced by brain structure and hormonal influences. This difference has an impact on the way and style they do things. Maccoby and Jacklin (Kondo et al., 2018) revealed that in general, girls are superior in language and writing skills, while boys tend to be better at math.

Based on the description above, it shows that women think more flexibly than men. The variation in mathematical thinking ability between subjects reflects differences in the exploration and application of problem-solving strategies. This emphasizes that the ability of mathematical thinking flexibility should continue to be developed to increase students' success in solving various types of problems.

Conclusion

This study shows that students' mathematical thinking flexibility in solving HOTS problems on number operation material still varies based on gender. Subjects F-1 and F-2 showed high mathematical thinking ability by fulfilling all flexibility indicators, namely using more than one strategy, solving problems correctly, and choosing effective and efficient strategies. In contrast, subjects M-1 and M-2 tended to use a single strategy, which showed limited flexibility in thinking. The exploration factor and diversity of strategies are the main determinants of the level of flexibility in mathematical thinking, where subjects with higher flexibility are able to explore various approaches and optimal strategies. This finding highlights the importance of developing flexibility in mathematical thinking as a crucial skill in learning mathematics, especially in dealing with problems that require higher order thinking skills.

It is expected that mathematics teachers focus more on developing students' mathematical thinking flexibility, especially in solving HOTS (Higher Order Thinking Skills) problems. Teachers are advised to design learning strategies that encourage the exploration of various problem-solving approaches, for example through group discussions, visual media, and problems with varying levels of difficulty. In addition, teachers need to motivate students to try different ways of solving and appreciate their creativity, without focusing too much on the right or wrong answer. Further research is expected to examine other factors, such as learning style, motivation, or self-confidence, and involve a wider range of subjects for more generalized results.

References

Abdullah, A. H., Abidin, N. L. Z., & Ali, M. (2015). Analysis of Students' Errors in Solving Higher Order Thinking Skills (HOTS) Problems for the Topic of Fraction. *Asian Social Science*, *11*(21). https://doi.org/10.5539/ass.v11n21p133.

Akgül, S., & Kahveci, N. G. (2016). A Study on the Development of a Mathematics Creativity Scale. *Eurasian Journal of Educational Research*, *16*(62). https://doi.org/10.14689/ejer.2016.62.5.

Abdullah, A. H., Abidin, N. L. Z., & Ali, M. (2015). Analysis of Students' Errors in Solving Higher Order Thinking Skills (HOTS) Problems for the Topic of Fraction. *Asian Social Science*, *11*(21). https://doi.org/10.5539/ass.v11n21p133.

Akgül, S., & Kahveci, N. G. (2016). A Study on the Development of a Mathematics Creativity Scale. *Eurasian Journal of Educational Research*, *16*(62). https://doi.org/10.14689/ejer.2016.62.5.

Amina, S., Listiawati, E., & Affaf, M. (2020). Kemampuan Berpikir Kreatif Siswa dalam Memecahkan Masalah HOTS Ditinjau dari Gaya Kognitif. *ANARGYA: Jurnal Ilmiah Pendidikan Matematika*, *3*(2), 120–126. https://doi.org/10.24176/anargya.v3i2.5230.

Anggraeni, R., & Herdiman, I. (2018). Kemampuan pemecahan masalah matematik siswa SMP pada materi lingkaran berbentuk soal kontekstual ditinjau dari gender. *Numeracy*, *5*(1), 19–28.

Artikasari, E. A., & Saefudin, A. A. (2017). MENUMBUH KEMBANGKAN KEMAMPUAN BERPIKIR KREATIF MATEMATIS DENGAN PENDEKATAN CONTEXTUAL TEACHING AND LEARNING. *JURNAL MATH EDUCATOR NUSANTARA*, *3*(2). https://doi.org/10.29407/jmen.v3i2.800.

de Vink, I. C., Willemsen, R. H., Lazonder, Ard. W., & Kroesbergen, E. H. (2022). Creativity in mathematics performance: The role of divergent and convergent thinking. *British Journal of Educational Psychology*, *92*(2), 484–501. https://doi.org/10.1111/bjep.12459.

Firdaus, A., Nisa, L. C., & Nadhifah, N. (2019). Kemampuan Berpikir Kritis Siswa pada Materi Barisan dan Deret Berdasarkan Gaya Berpikir. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *10*(1), 68–77. https://doi.org/10.15294/kreano.v10i1.17822.

Goleman, D. (1995). *Emotional Intelligence, New York, NY, England*. Bantam Books, Inc.

Kondo, S. A. S., Side, S., & Minggi, I. (2018). *Analisis Kemampuan Penalaran Matematis dalam Pemecahan Masalah Aljabar Ditinjau dari Perbedaan Gender pada SMP Negeri 8 Makassar*. UNIVERSITAS NEGERI MAKASSAR.

Lestari, W., Kusmayadi, T. A., Nurhasanah, F., & Keguruan, F. (2021). Kemampuan pemecahan masalah matematika ditinjau dari perbedaan gender. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(2), 1141.

Melawati, Y., Rochmiyati, R., & Nurhanurawati, N. (2022). A needs analysis of HOTS-based assessment instruments for elementary school mathematics learning. *Asian Journal of Educational Technology*, *1*(2), 90–95. https://doi.org/10.53402/ajet.v1i2.41.

Nisa Rambe, K., & Sinaga Asmin, B. (2019). Analysis of metacognitive skills in solving mathematical problems reviewed from students' learning style. *American Journal of Educational Research*, *7*(11), 780–793.

Nuryadi, N., Sukestiyarno, Y. L., Suyitno, H., & Kharisudin, I. (2022). Analisis Kemampuan Berpikir Kritis Ditinjau Dari Gender Dan Self-Efficacy Matematika Siswa Dalam Mengerjakan Soal Framework PISA. *Prosiding Seminar Nasional Pascasarjana*, *5*(1), 846–855.

Purwasih, R., Maya, R., Zanthy, L., & Minarti, E. (2019). Analysis Of Mathematical And Disposition Creative Thinking Ability Of Students Through Learning Alternative Solution Worksheet. *Proceedings of the International Conference of Science and Technology for the Internet of Things*. https://doi.org/10.4108/eai.19-10-2018.2281363.

Ratnaningsih, N. (2017). THE ANALYSIS OF MATHEMATICAL CREATIVE THINKING SKILLS AND SELF-EFFICACY OG HIGH STUDENTS BUILT THROUGH IMPLEMENTATION OF PROBLEM BASED LEARNING AND DISCOVERY LEARNING. *JPMI (Jurnal Pendidikan Matematika Indonesia)*, *2*(2), 42. https://doi.org/10.26737/jpmi.v2i2.219.

Rizalno, S. M., & Purwanto, S. E. (2022). Mathematical creative thinking ability: The impact of adversity quotient on triangle and quadrilateral shapes material. *Desimal: Jurnal Matematika*, *5*(2), 143–154. https://doi.org/10.24042/djm.v5i2.12642.

Siswono, T. Y. E. (2016). Berpikir kritis dan berpikir kreatif sebagai fokus pembelajaran matematika. *Seminar Nasional Matematika Dan Pendidikan Matematika (Senatik 1)*, 11–26.

Supriadi, S. (2019). Didactic Design of Sundanese Ethnomathematics Learning for Primary School Students. *International Journal of Learning, Teaching and Educational Research*, *18*(11), 154–175. https://doi.org/10.26803/ijlter.18.11.9.

Tambunan, H. (2019). The Effectiveness of the Problem Solving Strategy and the Scientific Approach to Students' Mathematical Capabilities in High Order Thinking Skills. *International Electronic Journal of Mathematics Education*, *14*(2), 293–302.

Widana, I. W. (2018). Higher Order Thinking Skills Assessment towards Critical Thinking on Mathematics Lesson. *International Journal of Social Sciences and Humanities (IJSSH)*. https://doi.org/10.29332/ijssh.v2n1.74.