EduMa: Mathematics Education Learning And Teaching
July 2024, Vol 13 No 1 Page 63 – 76
https://syekhnurjati.ac.id/jurnal/index.php/eduma/eduma/article/view/xxxx
p-ISSN: 2086-3918, e-ISSN: 2502-5209
Published by Tadris Matematika IAIN Syekh Nurjati cirebon

EduMa
MATHEMATICS EDUCATION LEARNING AND TEACHING

Analyzing Students' Cognitive Process of Mathematical Problem Solving for Mathematical Literacy

Setiyani[1*], Nurul Ikhsan Karimah[2], Trusti Hapsari[3], Sri Sumarwati[4], Turini Erawati[5], Try Suprayo

1 Pendidikan Matematika, Fakultas Pendidikan dan Sains, Universitas Swadaya Gunung Jati
2 Pendidikan Matematika, Fakultas Pendidikan dan Sains, Universitas Swadaya Gunung Jati
3 Pendidikan Matematika, Fakultas Pendidikan dan Sains, Universitas Swadaya Gunung Jati
4 Faculty of Technical and Vocational Education University Tun Hussein Onn Malaysia
5. Pendidikan Bahasa Inggris, Fakultas Pendidikan dan Sains, Universitas Swadaya Gunung Jati
6. MTs. Husnul Khotimah 2 Kuningan

[*]Corresponding author: Setiyani, Cirebon, Jawa Barat, 45131, Indonesia. Country. e-mail addresses : setiyani@ugj.ac.id

article info

How to cite this article:

Setiyani et. al., (2024). Analyzing Students' Cognitive Process of Mathematical Problem Solving for Mathematical Literacy. *Eduma : Mathematics Education Learning And Teaching*, 13(1), 63 - 76.

doi: 10.24235/eduma.v13i1.16272

Article history:

Received: 12 24, 2023

Accepted: 07 26, 2024

Published: 07, 2024

abstract

Math education aims to develop thinking skills and promote problem-solving using math. Unfortunately, students often find it dull, leading them to rely on memorization instead of grasping concepts. Mathematical literacy involves using math in everyday situations, requiring reasoning and concept application. This study used a descriptive qualitative method to explore how eighth-grade students approach math literacy problems from a cognitive perspective. The instruments used in this research include tests, interviews, observations, and documentation. Subjects were chosen by giving numeracy problems to 25 AKM program participants, and then three subjects were selected for in-depth interviews based on cognitive level. Data analysis involved data reduction, examining results and semi-structured interview responses for verbal expressions of thinking processes related to math literacy at different cognitive levels. Based on the results of this research, subjects with high abilities demonstrated a deep understanding of the problems, organized information very well, used prior knowledge and experience to make attempts, and engaged in reflection and evaluation of the answers obtained. In summary, students with varying cognitive levels showed good math literacy skills, as evidenced by all three subjects successfully meeting the descriptors of the thinking process when solving math literacy problems."

Keywords:
Mathematical thinking process; matematics literacy problems; Cognitive levels.

INTRODUCTION

The aim of mathematics education is to cultivate mathematical thinking processes and utilize them in problem-solving, supporting advancements in science, technology, and economic life (Maslihah et al., 2020). Developing mathematical thinking and reasoning skills in students is essential for their success in life. This not only enhances their mathematical abilities but also fosters a connection between theory and practice, improving their problem-solving skills (Hasanah et al., 2019). These skills have positive impacts on daily life and future career choices.

Experts believe that learning mathematics should go beyond memorizing formulas and concepts without real-world application (Owusu, 2023). However, the math education system in the research setting tends to be dull for students, leading them to rely on memorization methods rather than truly understanding and solving problems using related concepts. Yet, efforts to apply mathematical thinking processes are evident in the research setting by equipping students with practical math skills and providing intellectual adventures achievable through mathematics. While only a small percentage of students may reach the highest levels in mathematics, it's crucial to offer many students the chance to experience the joy of discovering mathematics.

Mathematical thinking involves using math to solve real-world problems, and it's a crucial skill in today's era. Mathematical and logical thinking are closely related, teaching students to practice a mathematical approach enhances their logical thinking abilities, aiding them across various subjects and making them better problem solvers (Oljayevna & Shavkatovna, 2020). Mathematical thinking requires using math to solve real-world problems, encouraging unconventional thinking—a valuable skill in today's world. Mathematics is not just about formulas; it's a perspective on the world around us. Mathematics, as a subject, not only offers elegant solutions but also opens endless opportunities for posing new questions. Mathematical thinking involves mapping everyday situations and problems into relevant mathematical models, requiring diverse perspectives to understand nuances in problem spaces (Candrama et al., 2023). Mathematical thinking goes beyond finding example solutions; it involves extracting the essence of the problem and deep understanding.

The mathematical thinking process is a challenging and gradual endeavor for many, demanding hard work and sometimes collaboration (Fouze & Amit, 2017). Its goal is to comprehend problems, view them from various perspectives, and find creative and persistent solutions, even if errors occur. In mathematics, exploration, questioning, systematic work, visualization, conjecture, explanation, generalization, justification, and proof are at the core of mathematical thinking (Lerman, 2020). Learning is greatly enhanced when there is a strong sense of curiosity, resilience, and collaborative intelligence. Mathematical thinking is a dynamic process allowing individuals to expand understanding and increase the complexity of ideas when solving problems through the phases of entry, attack, and review (Stacey et al., 1982). The entry phase involves discovering meaning and purpose in a problem. The attack phase is about logically and comprehensibly finding solutions, and the review phase involves solving problems using ideas gained from experience. Cognitive styles, according to (Liu & Ginther, 1999), refer to individual characteristics and consistencies in sensing, remembering, organizing, processing, thinking, and problem-solving.

The ability to apply mathematics in various life situations, involving mathematical reasoning, concept utilization, procedures, and facts to describe, explain, and estimate phenomena or events, is known as mathematical literacy (Ferdianto et al., 2022). The cognitive levels of mathematical literacy are divided into three levels: (1) Understanding (Knowing), assessing basic knowledge and understanding of students about processes, facts, procedures, and concepts; (2) Applying, assessing the mathematical ability to apply knowledge and understanding of relations, facts, procedures, concepts, and methods in real-life or everyday contexts to solve problems or answer questions; (3) Reasoning, assessing students' reasoning abilities in analyzing information and data, expanding their understanding, and making conclusions involving more complex contextual situations (Anggraini & Setianingsih, 2022).

Mastering mathematical literacy helps individuals understand the role and value of mathematics in life, enabling them to make informed decisions as educated individuals. With mathematical literacy, one can mathematically solve various context-related life problems, aligning with mathematical principles. In the modern era, mathematics is not just seen as calculations but also as mathematical literacy involving mathematical reasoning and problem-solving (Wulandari et al., 2023). Mathematical literacy is a skill that needs to be developed as many life activities involve mathematics and require literacy skills to solve them, as stated by (Miftah et al., 2021) emphasizing that mathematical literacy helps individuals understand the role and usefulness of mathematics in life.

However, based on observations at a junior high school in Cirebon Regency, students tend to experience difficulties in solving word problems that require the application of mathematical concepts in everyday situations. This indicates that their ability to connect mathematics with real-life contexts is still low. Additionally, many students do not fully master basic mathematical concepts such as fractions, percentages, and proportions, which are crucial foundations for understanding more complex mathematical material. This is suspected to be due to the inadequate absorption of material during elementary school as a result of the COVID-19 pandemic.

The low level of mathematical literacy has often been the basis for several subsequent studies. (Sukmawati et al., 2020; Tabun et al., 2020) applied a problem-based learning model to improve mathematical literacy skills. The same treatment was also applied by combining it with the scaffolding strategy (Fani et al., 2023). An analysis of mathematical literacy for high school students has been conducted by (Hayati & Kamid, 2019; Sari & Wijaya, 2017). From the various studies conducted, none have analyzed the mathematical thinking process of junior high school students in solving mathematical literacy problems.

This research was conducted to illustrate the mathematical thinking process of eighth-grade students in solving mathematical literacy problems from a cognitive level perspective. The exploration of students' mathematical thinking processes followed the stages introduced by (Stacey et al., 1982), consisting of three phases: (1) Entry, (2) Attack, and (3) Review. This research is deemed necessary due to the need for students to develop their abilities in solving mathematical literacy problems, given the low scores of Indonesia in the PISA and TIMSS assessments. By understanding the stages of students' thinking processes in solving math literacy problems, improvements in the learning process that support students' thinking processes are anticipated.

METHODS

This study uses a descriptive qualitative method to describe the mathematical thinking process of 8th-grade students in solving mathematical literacy problems from a cognitive level perspective. The research was conducted at MTs. Husnul Khotimah 2 Pancalang. The selection of research subjects was done by providing numeracy literacy problems to 25 students selected to participate in the AKM program. Subsequently, 3 subjects were chosen based on cognitive levels for in-depth interviews.

In the initial stage, 25 students were tasked with solving numeracy literacy problems that had undergone several stages of validation and practicality, thereby eliciting thinking processes. Later, the selection of 3 subjects was carried out to facilitate in-depth interviews, ensuring the results align with the research objectives.

The selection of these 3 subjects was based on several factors, considering specific aspects (Sugiyono, 2016), aligned with the research objectives (Ahyar et al., 2020), such as cognitive level, data saturation, students' problem-solving abilities, fluency in oral communication, considerations from the mathematics teacher (Arikunto, 2010), and the initial mathematics proficiency level of subjects, categorized as low, medium, and high (Azwar, 2012). However, in this study, subjects were selected based on their high mathematical thinking abilities for comparability. The following are the criteria for the levels of mathematical ability:

Table 1
Level of mathematical ability

Levels	Scale
Low	$x < 54,46$
Middle	$54,46 \leq x < 90,21$
High	$x \geq 90,21$

After collecting data on mathematical literacy issues, further data collection was conducted through the subjects' work results, as well as recommendations from the mathematics teacher based on cognitive levels, including understanding, application, and reasoning. This also considered the results of the AKM trial conducted by the research institution. The third set of data was obtained through interviews with the subjects to gather deeper information about the mathematical thinking process. Data collection took place at different times from start to finish, and the data were compared.

The data analysis technique in this study includes: Data reduction, involving the results of work and semi-structured interview expressions representing verbal processes of mathematical thinking in solving mathematical literacy problems from a cognitive level perspective. The results of the mathematical thinking process in solving mathematical literacy problems were then categorized based on the stages of students' thinking processes and their cognitive levels, considering the results of students' written responses. Secondly, Data presentation, where data were analyzed and described as a reference for drawing conclusions about the conducted research. Then the thrid one, Drawing verification/conclusions. The data analysis process can be seen in Figure 1 below.

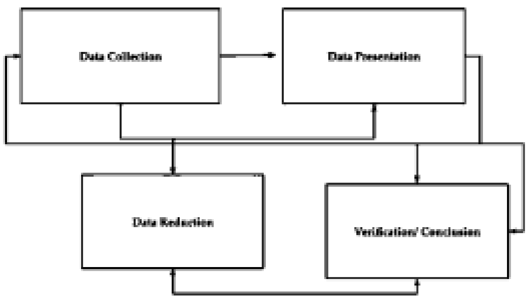

Figure 1.
Data Analysis Process

In this study, the mathematical thinking process was adapted from the opinions of (Stacey et al., 1982), with some descriptors taken from (Burton, 1984; Stacey, 2006). The following are the stages of the mathematical thinking process with the descriptors possessed.

Table 2
Mathematical thinking process

Mathematical Thinking Process	Stages	Rubric	Descriptor
Specializing	Entry	I know	• Understand the problem well. • Finds what is known and what is asked.
		I want	• Want to categorize and sort information. • Want to solve the problem in the problem.
		Introduce	• Create a symbolic math mode of the problem. • Organize what is known from the problem.
	Attack	Try	• Submit a conjectured solution for troubleshooting. • Modify wrong guesses to be correct.
		Maybe	• Try the guesses that have been made whether they can solve the problem or not.
		Why	• Have logical reasons for accepting or rejecting allegations. • Convince others that each step of the solution was done correctly orally or in writing through a systematic solution.
Generalizing	Review	Check	• Check the accuracy of calculations. • Check the accuracy of the reasoning for the complaint step. • Check the appropriateness of the settlement step to the question.
		Reflect	• Reflecting on the idea of solving, which parts were difficult, and what can be learned from the solving that has been done. • Reflecting on provisional conjectures.
		Extend	• Create a generalized form of the result so that it can be used in a broader context. • Find another way to solve it. • Attempt to solve similar problems with changes to the facts and things asked.

RESULT AND DISCUSSION

RESULT

The research was conducted in October 2023 at MTs. Husnul Khotimah 2 Kuningan. This presentation and analysis of the data present the results of the high-category subjects' work (P-1, P-2, and P-3), and interviews were conducted to observe the mathematical thinking process based on its stages in solving mathematical literacy problems with questions that have undergone validation and practicality testing, thus revealing the potential effects of this research if viewed from the cognitive level determined. The results of P1's work in solving mathematical literacy problems at the comprehension level can be seen in Figure 2

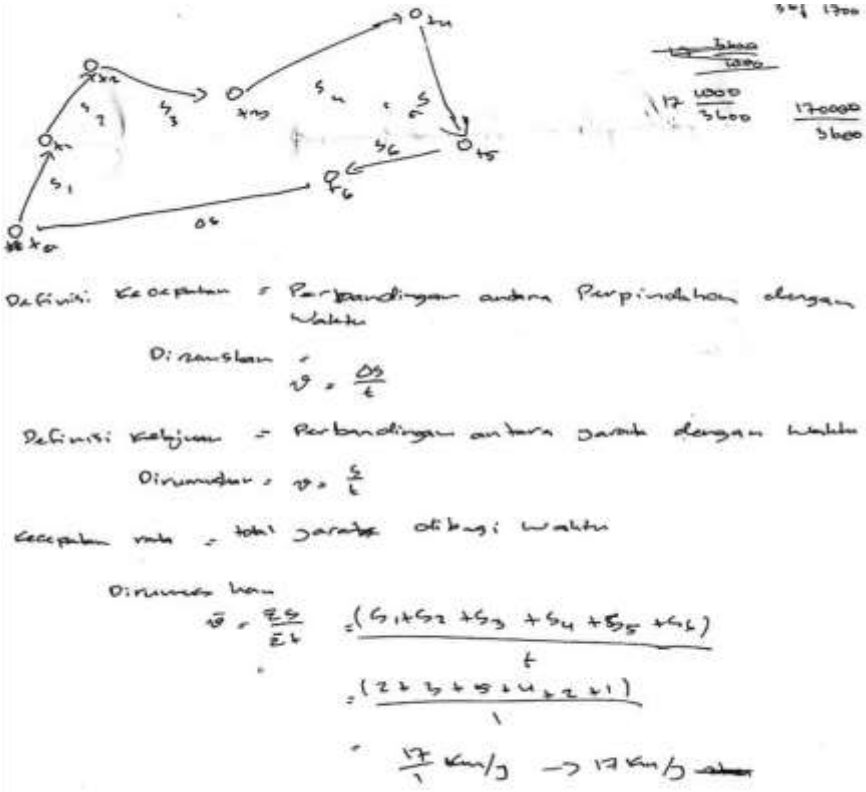

Figure 2.
Student Answers at the Comprehension Level

Based on Figure 2, P-1 completed all stages of the mathematical thinking process comprehensively. In the Entry stage, P-1 provided a representation of the route described in the problem by drawing its model. Although P-1 did not explicitly state what was known and what was asked in the problem, they demonstrated an understanding of the problem by creating a drawing. In the attack stage, P-1 wrote down the definitions of speed and velocity and the formula for average speed to ensure the correctness of their problem-solving process. P-1 experienced some hesitation in the calculations, but during the review stage, they checked the accuracy of their steps, resulting in a correct answer. To support the student's work, the researcher also conducted an interview with P-1. Here is an excerpt from the interview with P-1 aimed at exploring their mathematical thinking process while solving the mathematical literacy problem.

Researcher : Do you think there is a difference between speed and velocity?
P-1 : Of course, sir. Speed compares the displacement and time.
Researcher : So, what is the difference with velocity?
P-1 : Velocity compares the distance with time.
Researcher : Then, to solve this problem, did you use speed or velocity?
P-1 : Velocity, sir.
Researcher : How did you do it?
P-1 : By finding the average velocity, which is done by summing the

displacement and then dividing it by the total time taken.

Researcher : Did you convert from km/h to m/s? How did you do it?

P-1 : Yes, sir. First, we convert km to m and hours to seconds, so we get 1700 multiplied by 3600/1000.

Researcher : Are you sure the answer you got is correct?

P-1 : Yes, sir.

Researcher : Try checking again, converting from km to m and hours to seconds.

P-1 : Oh, it should be 1000/3600, right?

Based on P1's work on the first mathematical literacy problem, P1 was able to solve the problem well by understanding the question's intent and effectively utilizing the provided information. By indicating the available information and then simplifying the problem by linking it to their existing knowledge, P1 demonstrated a form of specializing thinking, leading to a correct answer. The correct result indicates that P1 engaged in an attacking process, with several instances of checking and reflecting as a form of review of the obtained answer. This led to a conclusion as part of the extend phase of the review process. The fulfillment of all stages of the thinking process from entry, attack, to review demonstrates P1's good mathematical ability. Next, the results of P2's work on mathematical literacy problems at the application level can be seen in the following image.

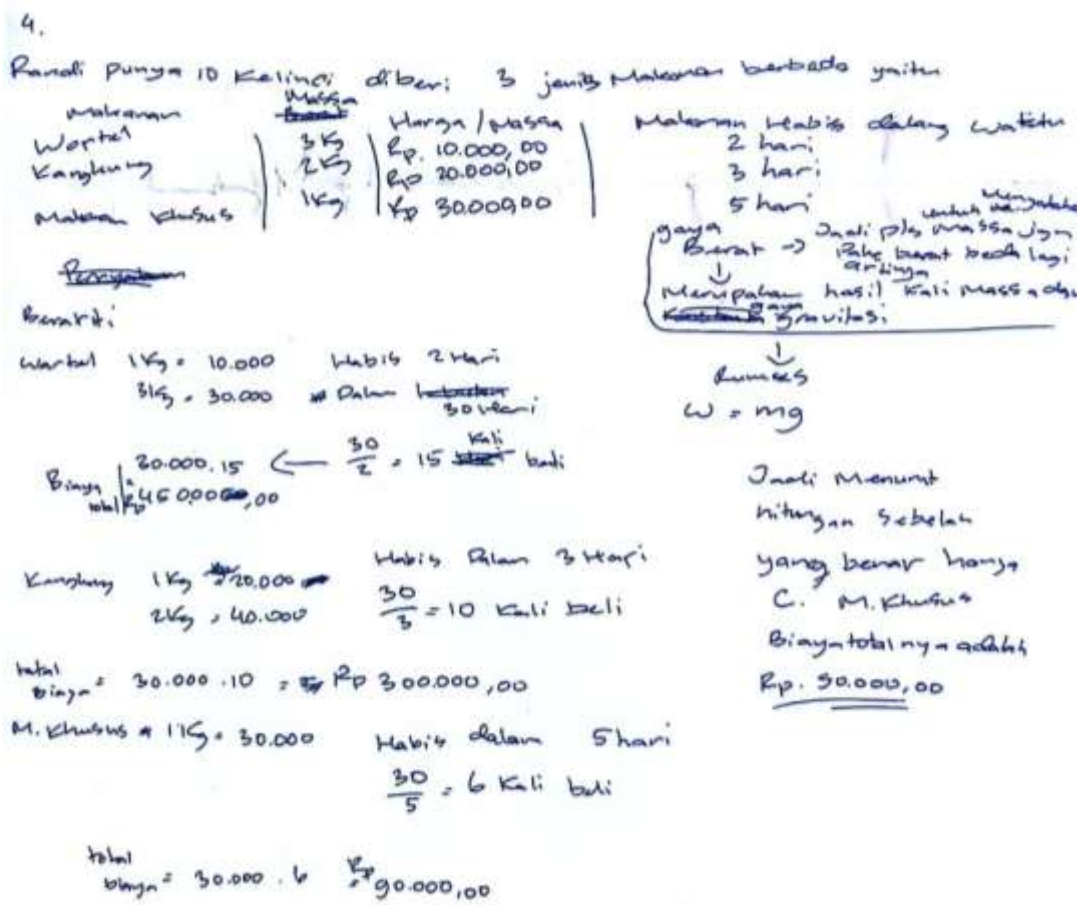

Figure 3.
Student Answers at the Application Level

Based on Figure 3, in the Entry stage, P-2 understood the problem by writing down what was known and asked. In the attack stage, P-2 calculated the costs required to purchase carrots, water spinach, and special food. P-2 also critiqued the problem for using the term "weight" instead of "mass," noting that these terms have different meanings. In the review stage, P-2 checked their work and wrote a conclusion. To support the student's work, the researcher also conducted an interview with P-2. Here is an excerpt from the interview aimed at exploring P-2's mathematical thinking process while solving the mathematical literacy problem.

Researcher : Based on the problem you faced, do you understand it?
P-2 : Yes, sir.
Researcher : What is the first thing you do before starting to solve the problem?
P-2 : I wrote down the information from the problem and then tried to calculate the cost for each type of food.
Researcher : Explain from the beginning.
P-2 : First, I calculated the price of carrots per kg, which is 10,000, and it will be used up in 2 days. So for 3 kg, the price is 30,000. Therefore, in 30 days, carrots can be bought 15 times.
Researcher : How did you get that?
P-2 : It's simple, sir. Just divide 30 days by 2 days, which gives 15. Then, 15 purchases of carrots multiplied by the price for 3 kg results in 450,000.
Researcher : What about the water spinach?
P-2 : It's the same, sir. The price of 1 kg of water spinach is 20,000, so for 2 kg, it costs 40,000. Since 2 kg of water spinach is used up in 3 days, it can be bought 10 times in 30 days.
Researcher : How much is the total cost for 30 days then?
P-2 : Just multiply 30,000 by 10 purchases, resulting in 300,000.
Researcher : Check again if there is any mistake.
P-2 : There is none, sir.
Researcher : Okay, if you think so. How about the special food?
P-2 : It's similar, sir. Special food is used up in 5 days, 1 kg each time. So in 30 days, it can be bought 6 times. Since the price per kg is 30,000, multiplying it by 6 results in 90,000.
Researcher : Is that correct?
P-2 : Yes, sir. The calculation is correct.
Researcher : Check again just in case there is an error in the calculation.
P-2 : Okay, sir. It's correct.

Based on the work and the interview, P2 completed all stages of the mathematical thinking process thoroughly. However, there was a mistake in entering the numbers when determining the total cost of water spinach and special food. P2 demonstrated a review process by checking and reflecting on their calculations, then made a general conclusion by showing the obtained results. Next, the results of P3's work on the mathematical literacy problem at the reasoning level can be seen in the following image.

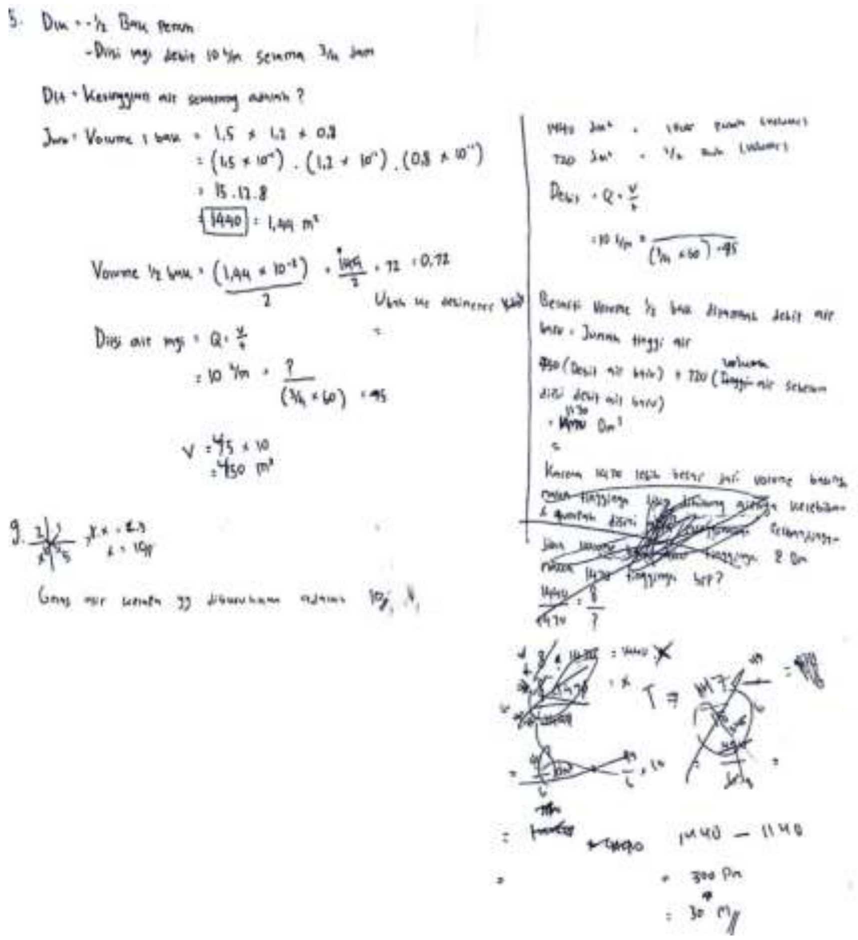

Figure 4.

Student Answers at the Reasoning Level

Based on Figure 3, at the Entry stage, P-3 can understand the problem by writing down what is known and what is being asked. At the attack stage, P-3 calculates the total volume of the tank, half the tank, and calculates the water flow rate. At the review stage, P-3 rechecks his work and makes several changes because he realizes he made mistakes, such as replacing the comparison strategy with a subtraction operation. To support the student's work results, the researcher also conducted an interview with P-3. Here is an excerpt from the interview with subject P-3, which aims to explore his mathematical thinking process while solving mathematical literacy problems.

Researcher : What is asked in the problem?

P-3 : To find the water level in the tank, right?

Researcher : What did you do first?

P-3 : I wrote down the information given in the problem, then started the calculations, like finding the volume of one tank, which gave the volume of half a tank.

Researcher : What did you do next?

P-3 : I calculated the additional water volume using the flow rate formula.

Researcher : And then?

P-3 : After getting the volume of half a tank, I added the additional water volume, resulting in 1170.

Researcher : What happened next?

P-3 : Since 1470 is greater than the tank's volume, the water inside will overflow.
Researcher : Are you confident in the process you followed?
P-3 : Yes, sir.
Researcher : Let me ask, where did you get 1470 from?
P-3 : Oh, I made a mistake, sir.
Researcher : Right, so now what?
P-3 : Just subtract the volume of one tank, which is 1440 - 1170, resulting in 300 dm = 30m.
Researcher : Double-check to make sure there are no mistakes.
P-3 : It's correct, sir.

Based on the work and interview results, P-3 completed all stages of the mathematical thinking process but made several mistakes, indicating thinking processes at the attack stage, particularly the "why" part. As a form of checking and reflecting, P-3 realized the mistakes made and then corrected them with another strategy. The error occurred when P-3 wrote the wrong number in the final answer, which should have been 1440 – 1170.

DISCUSSION

Based on the results of the work and in-depth interviews with the 3 subjects, it shows the mathematical thinking process that occurs when subjects are faced with mathematical literacy problems. The completion results demonstrate a good outcome regarding the occurring mathematical thinking process; it is evident that all three subjects fulfill every stage of the mathematical thinking process. The following is an explanation of the mathematical thinking process that occurs in each subject.

Subject P1

Subject P1 engages in an interesting thought process by collecting information and simplifying the problem through redrawing it in a simpler form. P1 then approaches the problem by connecting it with their prior knowledge. After the process of attacking the problem by demonstrating the operations with simple integers, P1 arrives at the answer. Despite not avoiding calculation errors as part of the checking and reflecting on the answer, in the final stage, P1 concludes the obtained answer. This indicates that P1 is capable of fulfilling the mathematical thinking process in solving mathematical literacy problems. This research result aligns with the findings that state high-ability students are accustomed to checking their work (Muhtadin, 2020).

Subject P2

Subject P2 also engages in good thinking processes. It is evident that P2 goes through all stages of the thinking process, starting from entry, which involves gathering information, organizing it, performing operations, and experimenting as a form of attacking in thinking. Then, finally, P2 undergoes a good review process by trying and convincing themselves about the obtained answers. P2 exhibits good mathematical thinking processes, as seen in systematic and organized work, but there are errors in entering numbers. As a result, the final outcome obtained is incorrect. Errors in copying numbers from the problem to the worksheet or from one calculation step to the next can also lead to inaccurate results. Incomplete problem-solving steps, such as errors in calculation, prevent students from reaching the algorithmic thinking stage (Supiarmo et al., 2021). This is in line with (Azzahra & Pujiastuti, 2020; Booth et al., 2013) which state that in solving problems, calculations are often not performed correctly, thus the correct solution is not found. In this study, these errors occur because students are not careful and rush in their work.

Subject P3

Furthermore, subject P3 also fulfills all stages of the thinking process starting from the entry of understanding the problem, demonstrating a good process. Then, calculations are performed which are not easy, resulting in several errors being made. P3 also fulfills all stages of the thinking process from understanding the problem to showing good ability in exploring solutions. Students with high abilities systematically analyze the problems they face, identify various possible solution options (Ayuningtyas, 2013), and have good resilience (Rahmatiya & Miatun, 2020). However, in the calculation process, there are several unexpected challenges, leading the subject to make mistakes due to carelessness. This study is limited to providing an overview of the mathematical thinking process in students with high categories in solving mathematical problems. Further research can combine with scaffolding strategies when students make mistakes and design learning tools to accommodate the improvement of students' mathematical literacy skills.

CONCLUSION AND IMPLICATION

Conclusion

Based on the results and discussions presented, it can be concluded that the mathematical literacy skills of students with different cognitive levels are proficient. This is evidenced by the fact that all three subjects were able to fulfill all descriptors of the mathematical thinking process when solving mathematical literacy problems. At the cognitive understanding level, the subjects could determine and explain information or material related to numeracy literacy questions clearly and accurately. Similarly, at the applied cognitive level, the subjects could provide correct solutions to mathematical literacy problems. Furthermore, at the reasoning level, they could analyze and solve problems with appropriate reasoning. Therefore, the researcher suggests continuous development of students' thinking abilities in solving mathematical problems, both in mathematical literacy and other mathematical problem-solving contexts.

ACKNOWLEDGMENTS

Researcher would like to express gratitude to: Universitas Swadaya Gunung Jati for the grant (Riset Kompetitif Universitas) Nomor SKEP/139/UNIV/VI/2023.

REFERENCES

Ahyar, H., Andriani, H., & Sukmana, D. J. (2020). Buku Metode Penelitian Kualitatif & Kuantitatif (Issue March). CV. Pustaka Ilmu.

Anggraini, K. E., & Setianingsih, R. (2022). Analisis kemampuan numerasi siswa sma dalam menyelesaikan soal asesmen kompetensi minimum (AKM). *MATHEdunesa*, 11(3), 837–849. https://doi.org/10.26740/mathedunesa.v11n3.p837-849

Arikunto, S. (2010). *Prosedur penelitian suatu pendekatan praktek*. Pustaka Pelajar.

Ayuningtyas, N. (2013). Proses penyelesaian soal higher order thinking materi aljabar siswa SMP ditinjau berdasarkan kemampuan matematika siswa. *Mathedunesa*, 2(2). https://doi.org/10.26740/mathedunesa.v2n2.p%25p

Azwar, S. (2012). *Penyusunan skala psikologi (2nd).* Yogyakarta: Pustaka Pelajar.

Azzahra, R. H., & Pujiastuti, H. (2020). Analisis kemampuan pemecahan masalah siswa pada materi sistem persamaan linear tiga variabel. Transformasi: *Jurnal Pendidikan Matematika Dan Matematika*, 4(1), 153–162. https://doi.org/10.36526/tr.v4i1.876

Booth, J. L., Lange, K. E., Koedinger, K. R., & Newton, K. J. (2013). Using example problems to improve student learning in algebra: Differentiating between correct and incorrect examples. *Learning and Instruction*, 25, 24–34. https://psycnet.apa.org/doi/10.1016/j.learninstruc.2012.11.002

Burton, L. (1984). Mathematical thinking: The struggle for meaning. *Journal for Research in Mathematics Education,* 15(1), 35–49. https://doi.org/10.2307/748986

Candrama, M. M. T., Darmawan, P., & Basri, H. (2023). Berpikir Siswa SMA dalam Memecahkan Masalah AKM Numerasi Bangun Ruang Sisi Lengkung Berdasarkan Teori Dual-Process. *Jurnal Riset Pendidikan Dan Inovasi Pembelajaran Matematika (JRPIPM),* 7(1), 1–25. https://doi.org/10.26740/jrpipm.v7n1.p1-25

Fani, F. L., Mariani, S., & Agoestanto, A. (2023). Problem Based Learning (PBL) with Scaffolding Approach to Improve Students' Mathematical Literacy. *EduMa: Mathematics Education Learning and Teaching,* 12(2), 235–247. http://dx.doi.org/10.24235/eduma.v12i2.14117

Ferdianto, F., Sukestiyarno, Y. L., & Widowati, I. J. (2022). Mathematical Thinking Process On Numeracy Literacy Problems For Middle School Students. *Journal of Positive School Psychology,* 6(8), 6909–6923. Retrieved from https://journalppw.com/index.php/jpsp/article/view/11007

Fouze, A. Q., & Amit, M. (2017). Development of mathematical thinking through integration of ethnomathematic folklore game in math instruction. *Eurasia Journal of Mathematics, Science and Technology Education,* 14(2), 617–630. https://10.12973/ejmste/80626

Hasanah, S. I., Tafrilyanto, C. F., & Aini, Y. (2019). Mathematical Reasoning: The characteristics of students' mathematical abilities in problem solving. *Journal of Physics: Conference Series,* 1188(1), 12057. https://ui.adsabs.harvard.edu/link_gateway/2019JPhCS1188a2057I/doi:10.1088/1742-6596/1188/1/012057

Hayati, T. R., & Kamid, K. (2019). Analysis of mathematical literacy processes in high school students. *International Journal of Trends in Mathematics Education Research*, 2(3), 116–119. https://doi.org/10.33122/ijtmer.v2i3.70

Lerman, S. (2020). *Encyclopedia of mathematics education*. Springer.

Liu, Y., & Ginther, D. (1999). Cognitive styles and distance education. Online Journal of Distance Learning Administration, 2(3), 1–17.

Maslihah, S., Waluya, S. B., & Suyitno, A. (2020). The role of mathematical literacy to improve high order thinking skills. *Journal of Physics: Conference Series*, 1539(1), 12085. https://ui.adsabs.harvard.edu/link_gateway/2020JPhCS1539a2085M/doi:10.1088/1742-6596/1539/1/012085

Miftah, R., Herman, T., & Kurniawat, L. (2021). *Students'thinking Process In Solving Mathematical Literacy Problem Based On Cognitive Style*.

Muhtadin, A. (2020). Defragmenting Struktur Berpikir Melalui Refleksi untuk Memperbaiki Kesalahan Siswa Menyelesaikan Soal Cerita. *Primatika: Jurnal Pendidikan Matematika, 9*(1), 25–34. https://doi.org/10.30872/primatika.v9i1.248

Oljayevna, O., & Shavkatovna, S. (2020). The Development of Logical Thinking of Primary School Students in Mathematics. *European Journal of Research and Reflection in Educational Sciences,* 8(2), 235–239.

Owusu, A. (2023). Problem Based Learning: Errors Minimization, Conceptual and Procedural Understanding in Trigonometry. *African Journal of Educational Studies in Mathematics and Sciences,* 19(1), 1–18. Retrieved from https://journals.uew.edu.gh/index.php/ajesms/article/view/199

Rahmatiya, R., & Miatun, A. (2020). Analisis kemampuan pemecahan masalah matematis ditinjau dari resiliensi matematis siswa SMP. *Teorema: Teori Dan Riset Matematika*, 5(2), 187–202. http://dx.doi.org/10.25157/teorema.v5i2.3619

Sari, R. H. N., & Wijaya, A. (2017). Mathematical literacy of senior high school students in Yogyakarta. *Jurnal Riset Pendidikan Matematika*, 4(1), 100–107. http://dx.doi.org/10.21831/jrpm.v4i1.10649

Stacey, K. (2006). What is mathematical thinking and why is it important. Progress Report of the APEC Project: *Collaborative Studies on Innovations for Teaching and Learning Mathematics in Different Cultures* (II)—Lesson Study Focusing on Mathematical Thinking.

Stacey, K., Burton, L., & Mason, J. (1982). *Thinking mathematically*. Addison-Wesley.

Sugiyono. (2016). *Metode Penelitian Kuantitatif Kualitatif dan R&D*. Bandung: Alfabeta.

Sukmawati, S., Saumi, T. F., & Nasrullah, A. (2020). Camtasia-assisted computer statistics application practicum learning video in online classes to improve students' mathematical understanding. *Journal of Physics: Conference Series*, 1657(1), 12016. http://dx.doi.org/10.1088/1742-6596/1657/1/012016

Supiarmo, M. G., Mardhiyatirrahmah, L., & Turmudi, T. (2021). Pemberian scaffolding untuk memperbaiki proses berpikir komputasional siswa dalam memecahkan masalah matematika. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(1), 368–382. https://doi.org/10.31004/cendekia.v5i1.516

Tabun, H. M., Taneo, P. N. L., & Daniel, F. (2020). The Ability of Student Math Literation on Problem Based Learning Model. *EduMa: Mathematics Education Learning and Teaching,* 9(1), 43–48. http://dx.doi.org/10.24235/eduma.v9i1.6036

Wulandari, S., Sari, C. K., Nurcahyo, A., & Setyaningsih, R. (2023). Literasi Matematika Siswa dalam Memecahkan Masalah Hots. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, 6(3), 1033–1044. https://doi.org/10.22460/jpmi.v6i3.17581