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Students Metacognitive Knowledge in Numeracy Literacy on Flat Surface Shapes Material

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Abstract: Students Metacognitive Knowledge in Numeracy Literacy on Flat Surface Shapes Material. **Objectives:** This research aims to describe the metacognitive knowledge of class VIII students in solving numeracy literacy problems on flat-sided geometric material. **Methods:** This type of research is qualitative research with 3 students as subjects selected based on test results (each representing high, medium and low abilities), as well as the teacher's consideration that the students are able to communicate well. The data analysis technique used consists of data reduction, data presentation, and drawing conclusions. **Findings:** The research results show that subjects with high metacognitive knowledge fulfill all indicators of strategy knowledge, knowledge of cognitive tasks and self-knowledge well. Subjects with moderate metacognitive knowledge only met each of the two indicators of strategy knowledge, knowledge of cognitive tasks; as well as self-knowledge. Subjects with low metacognitive knowledge did not meet the indicators of strategy knowledge, 2 indicators of knowledge about cognitive tasks, and 2 indicators of self-knowledge. Another finding is that metacognitive knowledge must be supported by meaningful repetition in terms of clearly identifying problem information and knowing how to solve it. The use of image representation in spatial building materials is necessary in solving problems. Awareness that an error has occurred in the solution must be followed by knowledge of how to correct the error. **Conclusion:** Metacognitive knowledge is very necessary for students to solve numeracy literacy questions. This knowledge must be followed by good and correct representational skills and procedural knowledge.

Keywords: flat-side shape; numeracy literacy, metacognitive knowledge.

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INTRODUCTION

Mathematics is a scientific discipline that has an important role in everyday life. Mathematics plays an important role in shaping the way a person solves various life problems. Today, as in the past, many students struggling with mathematics experience obstacles in learning mathematics (Anthony & Walshaw, 2009). The demands on students' abilities to master mathematics include the ability to handle numbers, mathematical symbols, and calculation operation skills. A central aspect of mathematics studied in school is comprehension how mathematics is applied in real world situations and how mathematical analysis can be performed used to answer questions about real things (Davis, 2024)

Mathematics has a parallel role in numeracy and language literacy (Sikko, 2023). Literacy is the ability to read and write which is characterized by understanding simple statements in everyday life (Murray, 2021). Numeracy is students' knowledge, behavior, attitudes and skills in using

various mathematical methods to solve everyday problems (Khalid et al., 2019). The concept of numeracy has expanded as well as the ability to communicate, interpret, employ and evaluate mathematical information in situations related to social life and the world of education (Nortvedt & Wiese, 2020 and & Gal et al., 2020). Literacy–numeracy linkages and interdependencies point to possible sources of vulnerability in adult numeracy education. Findings from OECD (2019a) and OECD (2019b) show a strong association between performance in reading/ literacy and mathematics/numeracy.

Numeracy literacy is a person's ability to identify and understand the role of mathematics in the world; to make decisions for good reasons; to use and involve mathematics in everyday life (OECD, 2003). In the framework of PISA 2021, the definition changes slightly (Sikko, 2023). OECD (2021) explains that mathematical literacy is an individual's ability to think mathematically; formulate, use, and interpret mathematics to solve problems in a variety of real-world contexts. It includes concepts, procedures, facts and tools to describe, explain, and predict phenomena. It helps individuals to recognize the role of mathematics in the world and to make the judgments and decisions required of constructive, engaged, and reflective 21st-century citizens.

Solving even basic mathematical problems at a complex level can be found if every student can master numeracy literacy skills. Numeracy has come into focus in recent years (Gaunt, 2024) with several reports such as CESE (2016) and Tout (2020) emphasising the importance of numeracy for all individuals. However, in reality, students' numeracy literacy is still relatively low. Grawe (2024) wrote that there was an international crisis in numeracy education. Studies by Halloran et al., (2021) and Lewis & Kuhfeld, 2021) show declining average performance and widening weakening performance on numeracy literacy in the United States. The latest Programme for International Student Assessment (PISA) results for 2022 show that (predictably) the impact of pandemic restrictions is not limited to one country. The average PISA mathematics score between 2018 and 2022, across countries belonging to the Organization for Economic Co-operation and Development (OECD) fell by 15 points, which is a learning loss equivalent to three-quarters of a year of education (OECD, 2023). In Indonesia, study Zainiyah & Marsigit (2018) that students' numeracy literacy skills are still low, including prospective mathematics teacher students also have low-average literacy skills (Laamena & Laurens, 2021). This should be a serious concern for education observers, especially mathematics.

Based on the results of the researcher's interviews with mathematics teachers, information was obtained that students were not used to working on numeracy literacy questions. Students only work on questions that refer to the worksheet in students' books and are not yet accustomed to working on questions in a real context. Lack of familiarization with literacy-based questions from teachers is why students cannot solve numeracy literacy questions. Accorrding to (Sikko, 2023), numeracy literacy includes several subcategories, like quantity, change, and relationships, and uncertainty. The four categories Space and Shape (subcategory of Spatial literacy), Quantity (subcategory of both numeracy and quantitative literacy), Change and Relationships (subcategory of quantitative literacy), and Uncertainty (subcategory of quantitative literacy) are exactly what OECD has chosen, because they "reflect both the mathematical phenomena that underlie broad classes of problems, the general structure of mathematics, and the major strands of typical school curricula" (OECD, 2021). The flat surface shapes material is part of the Space and Shape. In Indonesia, this material is studied in class VII of junior high school, in the even

semester. Meanwhile, students' basic knowledge and understanding of flat-sided geometric materials is still relatively low. This has an impact on students' ability to reason and visualize the information contained in numeracy literacy questions.

Solving numeracy literacy questions requires reasoning and problem-solving abilities. According to Laamena & Laurens, (2021), problem-solving strategies are of course based on awareness in thinking, namely awareness of what is known and how to apply it. Awareness of the thought processes that have occurred is called metacognition. Metacognition has important significance for learning and instruction in educational researchand practice (Jiang, Y., Ma & Gao, 2016). In educational contexts, metacognition is continually used to explain the process by which students/teachers learn to understand their thinking, with the notion that if they can regulate their thinking effectively, they will be better learners (Perfect & Schwartz, 2002). According to Flavell (1979), metacognition consists of two components; metacognitive knowledge (What one knows about cognition) and metacognitive experiences or regulation (How one controls cognition)

Metacognitive Knowledge refers to the learner's accumulated knowledge of this type. Pedagogy research shows that improving learners' metacognitive knowledge can improve their capabilities, for example on math. According to Anderson & Krathwohl (2001) metacognitive knowledge is knowledge about cognition in general, such as self-awareness and knowledge about one's cognition. According to Garofalo & Lester (1985), metacognitive knowledge describes a person's knowledge and control over their mental processes, including knowledge about themselves, their tasks, and the strategies used. Metacognitive Knowledge is the awareness of one's own cognition and particular cognitive processes. It is strategic or reflective knowledge about how to go about solving problems, cognitive tasks, to include contextual and conditional knowledge and knowledge of self (Anderson & Krathwohl, 2001). Thus metacognitive knowledge is students' awareness of their cognitive processes which includes the components of strategy knowledge, knowledge of cognitive tasks, and self-knowledge. is the awareness of one's own cognition and particular cognitive

Anderson & Krathwohl (2001) suggested 3 indicators of metacognitive knowledge including: (1) strategic knowledge, namely knowledge of general strategies for learning, thinking, and solving problems as well as monitoring and controlling cognitive activities. (2) knowledge about cognitive tasks, namely knowledge about the characteristics of the difficulty level of the problem, how, when, and why strategies are used appropriately. (3) self-knowledge, namely awareness and belief in students' strengths or weaknesses about cognitive and learning activities. To analyze students' metacognitive knowledge, researchers used indicators of strategy knowledge, knowledge of cognitive tasks, and self-knowledge, which are presented in Table 1.

Table 1. Metacognitive knowledge indicators

Indicators	Description
Strategy Knowledge	Students repeat information to remember.
	Students transform understanding in the form of images, writing, graphics, or other forms.
	Students monitor and control cognitive activities.

Knowledge about Cognitive Tasks	Students reveal the steps in the process.
	Students know when to use strategies appropriately.
	Students reveal the reasons for choosing strategies and work steps.
Self-Knowledge	Students express confidence in their abilities.
	Students express awareness of whether there are difficulties encountered or not.

Metacognitive knowledge refers to general knowledge about how a person learns and processes information, such as knowledge about one's learning process, (Flavell, 1979). By utilizing metacognitive knowledge, students are expected to be able to solve mathematical problems in the right way.

About numeracy literacy, research Alzahrani (2017) shows that academic success is related to metacognition, literacy and numeracy, along with appropriate learning methods. Students who have good metacognitive knowledge can use known information correctly to formulate solving strategies and know when and why these strategies are used to solve problems. Apart from that, students' metacognitive knowledge will also influence students' fluency in solving numeracy literacy problems. The results of (Chytró et al., 2020) research show that students with good metacognitive skills will have good problem-solving abilities. metacognitive knowledge is a prerequisite for solving mathematical problems, that is, sensitivity to basic aspects such as causality, patterns, existence and uniqueness of solutions, geometric imagination, functional thinking, and the perception of infinity are covered generally by the term mathematical intelligence. Metacognition is one of the factors often associated with the academic performance of students. The present study revealed that there is a significant positive relationship between metacognitive skills and mathematics performance (Dorji & Subba, 2023).

Based on the description that has been presented, this research aims to describe metacognitive knowledge based on the ability of class VIII students in numeracy literacy on flat-sided geometric material.

METHOD

The participants in this research were 28 students of class VIII Madrasah Tsanawiya (MTs) in Ambon City. Then 3 research subjects were selected, each representing students with high, medium and low literacy abilities. Teacher considerations are also used as a basis for selecting subjects, namely students who are able to communicate. The research design used is a mixed method, namely a combination of quantitative and qualitative research. Quantitative research is used only to group students' metacognitive knowledge and qualitative research is the main focus for describing metacognitive knowledge.

The research instruments used were test and non-test instruments. The test instrument is in the form of a test essay consisting of 3 questions. The questions are presented in the form of mathematical literacy with questions number 1 and 2 relating to the volume of a cube but with cognitive aspects C3 and C4 and question number 3 relating to the surface area of a cube. Before use, the three questions were validated by 2 lecturers and 1 teacher. Validation is carried out on the construction and objectives of the questions to answer indicators of metacognitive knowledge and the language side of the questions that are easy for students to understand. The interview guide as a non-test instrument is also validated by the lecturer to see the suitability of the interview objectives with the questions to be asked.

Data analysis uses quantitative analysis and qualitative analysis. Quantitative analysis was carried out on students' work results using Benchmark Assessment by grouping students' metacognitive knowledge into high, medium and low categories. Qualitative analysis was carried out on the interview results using Milles & Huberman, (1994) which consisted of data reduction, data presentation and drawing conclusions. At the data reduction stage, irrelevant subject statements are ignored. The data used is only data that is relevant to indicators of metacognitive knowledge. The reduced data is presented based on the metacognitive knowledge that emerged from the three subjects. Conclusions are drawn based on what is found.

To ensure the quality of qualitative data, researchers used method and source triangulation techniques. Researchers compared the results of students' work and interviews with teacher information, then compared the results of interviews with recordings of students working to see what metacognition occurred. While the students were working, the researcher made in-depth observations using video so that the recorded results were then analyzed.

■ RESULT AND DISCUSSION

Students' Metacognitive Knowledge for High, Medium, and Low Categories

Analysis of work results and interviews with subjects shows that metacognitive knowledge emerges when students solve flat-sided geometric problems presented in the form of numeracy literacy. The subject's metacognitive knowledge is presented in Table 2

Table 2. Students' metacognitive knowledge

Metacognitive Knowledge Indicators	S1 Subject (Higher Category)	S2 Subject (Medium Category)	S2 Subject (Low Category)
Strategy Knowledge	Repeat information to remember to understand all the questions	Repeat information to remember to understand all the questions	Repeat information to remember to understand all the questions
	Transforming problems into images	-	-
	Monitor and control cognitive activities	Monitor and control cognitive activities	-
Knowledge about Cognitive Tasks	Reveal the processing steps for all questions	Reveal the processing steps for all questions	Reveal the processing steps for all questions, However, the steps taken were not appropriate
	Knowing when to use strategy appropriately	Knowing when to use strategy appropriately	Knowing when to use strategy appropriately
	Reveal the reasons for choosing strategies and work steps. However, the next steps and the final result of the solution are not quite right	Reveal the reasons for choosing strategies and work steps. However, the next steps and the final result of the solution are not quite right	Reveal the reasons for choosing strategies and work steps. However, the next steps and the final result of the solution are not quite

	right		solution are not quite right.
Self-Knowledge	Confident in some parts, but less confident in one's abilities in other parts	Lack of confidence in one's abilities.	Lack of confidence in one's abilities.
	Realizing that there are difficulties in some parts	Realizing that you are experiencing difficulties	Realizing that you are experiencing difficulties

It can be seen that students are able to generate metacognitive knowledge. To investigate and analyze the metacognition that emerged in the construction of answers, further analysis was carried out on the results of interviews and student work. If indicators of metacognitive knowledge emerge, then interview questions are asked to validate them. The 3 subjects selected are students who show metacognitive knowledge but are at different levels, namely high, medium, and low ability. The following describes students ' metacognitive knowledge based on test results and interview excerpts.

Strategic Knowledge In Numeracy Literacy

The knowledge strategy indicators are: Students repeat information to remember, Students transform understanding in the form of images, writing, graphics, or other forms, and Students monitor and control cognitive activities. The results of the interviews revealed that the three students (S1, S2, and S3) showed indicators of repeating information to remember by reading information repeatedly to remember the questions given. However, there are significant differences between the three which cause different levels of metacognitive knowledge abilities. S1 and S2 read more meaningfully, the repetition process provides a deeper understanding of the question information and what is being asked; while the S3 repeating process does not provide a true understanding of the problem to be solved. S3 believes that he understands the questions, but cannot identify what is known and asked. S3 wrote incorrectly what was asked.

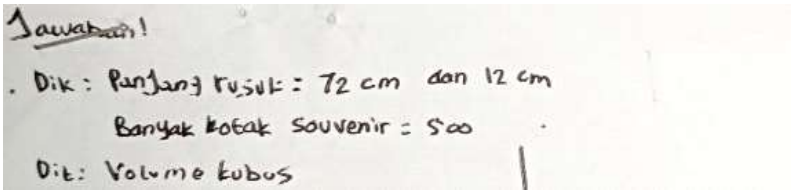


Figure 1. S3's work

Reading repeated questions as strategic knowledge does not have a positive impact on students in solving numeracy literacy problems if the reading process is not accompanied by correct understanding. Repeated reading is a strategy used by S1 so that he can remember all the information about the questions clearly. This is reinforced by the opinion of Anderson & Krathwohl (2001) that reading repeatedly is one way to remember information. Reading the problem repeatedly helps students to identify all the information contained in the problem. Repeated reading activities are reading comprehension, which means reading cognitively

(reading to understand), (Dalman, 2014). Reading comprehension means reading with full appreciation to absorb what students should be able to do, (Fahrozy, 2023). Correct understanding will avoid misunderstandings about the information of questions and the goals to be achieved.

For indicators of transforming understanding in the form of images, writing, graphics, or other forms, only the RPB subject transforms understanding in the form of images. S1 draws a large cube (in the question information it is cardboard) and a small cube (souvenir) complete with its dimensions, while S2 and S3 do not do this. Figure 2 is the transformation carried out by S1

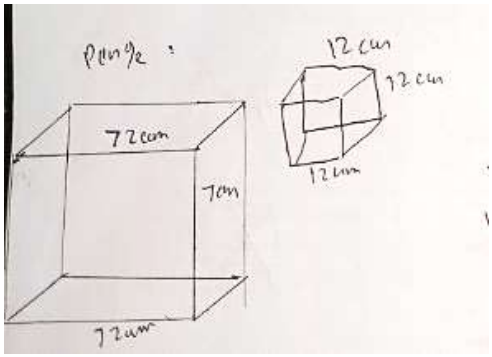


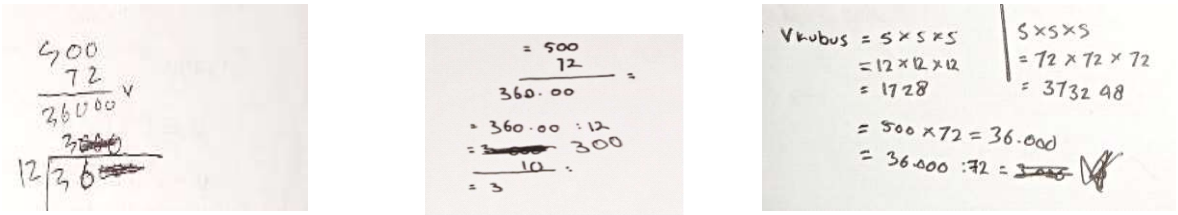
Figure 2. Transforms understanding by S1

The results of the interview revealed that the reason S1 drew the cube was so that it would be 'complete and more understandable'. (Laamena & Laurens, (2021) view the use of this image as 'graphical backing' which only serves to strengthen one's argument in solving a problem. Duval (2006) believes that in solving geometric problems as part of geometry, a combination of two representations is needed, namely verbal and visual. It is further said that the ability to change one representation to another is very important in achieving learning progress.. The imperfection of this solution is also caused by S2 and S3 not changing the problem in image form so there is no representation of the problem in the thought process.

To understand the problem, students need to visualize the problem which in (Ubah & Bansilal (2019)' view is called visualization. Visualization is the process of changing the words on a problem into visual images. Drawing is also a strategy that allows students not only to imagine the solution through their thoughts but also express it directly. Post & Prediger (2024) added that this strategy can help students reveal the information contained in the problem so that the relationship between the components of the problem can be seen more clearly. According to Laamena, (2019), S1 students are the type of students with a visual learning style so they feel the need to change the question information into images. Laamena further explained that students need to restructure problems into simple ones so that they are easy to solve.

This finding is strengthened by McDowell & Jacobs (2017) who said that, the many studies have shown that tasks presented with visual models tend to be solved more successfully than those in text-only format. This visual representation is important, especially in solving problems related to geometry. Tiwari et al., (2021) confirmed that visual representations represent a combination of concrete and abstract elements of the mathematical structure of the problem. Therefore, they can bridge the gap between the concrete and abstract side of the problem and can facilitate both the mathematization and the concretization of the problem Tupamahu et al., (2023) said that making pictures and graphs is one of the representations that help students to solve problems that must be solved

The final indicator of Strategic Knowledge is monitoring and controlling cognitive activities carried out by the three subjects is shown by scribbling on their work but not following up with correct corrections.



(a) (c)

Figure 3. Monitoring and controlling cognitive activities: a. Subjek S1 b. Subjek S2 c. Subjek S3

The results of interviews to ascertain the meaning of the subjects' scribbles revealed that there were different reasons for the three subjects' scribbles. To check the cognitive control carried out by students, the teacher asked the same questions to the three subjects, and all three admitted to checking, as in the following interview excerpt:

R : "After getting the results, do you check your work again??"
S1 : "Yes"
R : "In which part?"
S1 : In division and multiplication, and everything"

The streak occurred after S1 evaluated its work by checking every stage and calculation that had been carried out. The graffiti shows monitoring of the cognitive work that has been carried out. S1 realized the calculation error was made and then corrected it. Awareness arises as a result of metacognition that occurs in S1's mind. Siddiqui et al., (2020)'s research results show that the connections between metacognitive awareness and educational achievement as it could be utilized to help to prepare projects to show learners metacognitive strategies and procedures that help increase their educational accomplishment. These activities are viewed as meta-level and linked to objects (such as cognition) through monitoring and control functions. Wilson & Clarke (2004) calls it individual awareness of thought processes, and individual evaluation of these thought processes; awareness individuals have of their own thinking; their evaluation of that thinking; and their regulation of that thinking.

S3 controls cognitive activities by re-examining the work that has been done and there are changes after being checked, but there is no positive impact. Awareness of the mistakes that have been made does not provide improvements to the work process so that changes to the answers that should have been made do not occur. Cognitive control only occurs in the calculation process, not in solving strategies. This shows that awareness of mistakes, if not followed by knowledge to correct mistakes, will cause 'stuck'.

The important of knowledge about Cognitive Tasks

There are 3 indicators of Knowledge about Cognitive Tasks, namely Students reveal the steps in the process, students know when to use strategies appropriately, and Students reveal the reasons for choosing strategies and work steps.

During the interview, the three subjects were able to explain the work steps taken along with the reasons. In the initial stage, the three subjects calculated the volume of the large and small cubes, using appropriate formulas. However, at the next stage, there are differences in strategies to determine the number of boxes needed. S1 multiplies 500 by 72 then divides by 12 and produces 3; S2 multiplies 500 by 500 by 12 then

divides by 72; S3 multiplies 500 by 72 then divides again by 72 (meaningless).

The stages of problem-solving as declarative knowledge, namely the ability to describe thinking strategies, while procedural knowledge includes knowledge of how to use the chosen strategy, and conditional knowledge is knowledge about the right time to use it. Metacognitive abilities require procedural knowledge and conditional knowledge (Janiola & Baguin, 2023). Procedural knowledge relates to how to determine and carry out steps in a process, while conditional knowledge is knowledge about when to use a procedure, skill, or strategy and not use it, why the procedure can be used and under what conditions, and why one procedure is better than another. Laamena & Laurens, (2021) group the three subjects into the functional literacy group, namely students who try to use formulas to solve problems but then experience difficulties in the solving process.

S2 raises knowledge of cognitive tasks, namely using the cube volume formula correctly, explaining the steps to solve it and the reasons, but it is not correct. S2's mistake was multiplying the number of souvenir orders by the length of the cardboard rib, even though it should have been by the volume of the souvenir cardboard rib. Knowledge of cognitive tasks just knowing the formula is not enough, knowledge is also needed about the appropriate strategy, when to use it, and the reasons for using it. Abilities involve various techniques and strategies that are important in solving problems. Students need to synthesize knowledge, skills, and understanding, to be able to solve the problems they face well. Children's ability to synthesize knowledge, skills, and understanding is at stake in their success in solving problems (Reys, 1998). It needs to be realized that a child's ability to synthesize is based on his reasoning skills.

The knowledge of cognitive tasks demonstrated by S3 is imperfect. The selection of the formula and the reasons for using the formula are correct but the solution strategy is not correct. S3 multiplies 500 by 72 and then divides again by 72, which represents a meaningless solution. When S3 revealed the work steps, there was no awareness of the wrong process, because the explanation was without careful investigation but gave the impression of re-reading answers that had already been written. This shows that knowledge of a procedure does not always guarantee that someone understands the concepts underlying the material, this depends on the metacognitive knowledge they have (Laamena & Laurens, 2021).

Self-Knowledge in Solving Numeracy Litaracy

There are two indicators for Self-Knowledge in metacognitive knowledge, namely: Students express confidence in their abilities and Students express awareness of whether there are difficulties encountered or not. The following are excerpts from interviews to reveal the Self-Knowledge of the three subjects

R : "Are you having any difficulties?"
S1 : "Yes In the section on multiplying 500 by 72. and dividing."
R : "Are you sure about the answer??"
S1 : "I'm not sure"

Based on interview excerpts, it can be seen that the S1 subject involves self-knowledge by realizing the difficulties experienced when doing multiplication and division and is less confident about the results that have been obtained. Uncontrolled metacognitive knowledge can lead to errors (Laamena & Laurens, 2021). This is in line with the opinion of Desoete & De Craene (2019) and Veenman & van Cleef (2019) that metacognitive knowledge about how we learn can be wrong or right and knowledge about ourselves. we (self-knowledge) will most likely change. This change will occur when there are

cognitive monitoring activities that increase awareness.

R : "Are you having difficulties??"
S2 : "Yes In the division section. The problem is that this number is too many."
R : "Are you sure about the answer??"
S2 : "Not sure about the answer"

S2's self-knowledge arises from realizing his difficulties in carrying out division calculations and lack of confidence in the answers obtained. S2's lack of confidence in his answer shows that he realizes that his difficulties make the solution process wrong but he does not know how to solve it. Kipnis & Hofstein, (2008) call it cognitive regulation which refers to a set of activities that help students control their learning. S2 shows monitoring cognitive regulation which is characterized by awareness of his work but he does not carry out evaluations so his work cannot be improved.

The S3subject also raises metacognitive knowledge about self-knowledge in question number 1, which is shown in the following interview excerpt.

R : "Are you sure the answers and steps are correct??"
S3 : "A little confident with the results."
R : "Are you having difficulties??"
S3 : "The difficulty is $72 \times 72 \times 72$*. Due to the large number of numbers, it can be confusing."*

Based on interview excerpts, it can be seen that the S3 subject involves self-knowledge by realizing that he has difficulty in carrying out multiplication calculations and is less confident about the answers obtained. Again, S3's lack of confidence is only in operations involving large numbers, not in the process and solution strategy, so it has no implications for the correct answer. Güner & Erbay (2021) proposed three components as markers for problem solvers to review the problem-solving process they have carried out if they encounter one of three things, namely Not moving forward, Finding mistakes, and obtaining an answer that doesn't make sense. If there is no visible progress, students should return to analyzing the problem to assess whether the strategy used is appropriate and continues to be maintained, whether there is still useful information that has not been used, or whether to change strategies altogether.

■ CONCLUSION

The results show that for students to correctly complete numeracy literacy, all components of metacognitive knowledge are needed, not just some. Knowledge of strategies for repeating information is not enough if the repetition process is not accompanied by meaningful understanding. Repetition helps students to identify all the information in the problem presented and what needs to be done. This has implications for what strategy should be used. If the subject fails to determine a solution strategy, he will fail to solve the problem. Pictures or diagrams can make it easier for students to understand and become a strategy for completing numeracy literacy. Monitoring and control of cognitive activities will only occur if students have correct knowledge about the material to be completed. The choice of formula must be accompanied by the right strategy and when to use it. Wrong strategies can be replaced when monitoring and controlling cognitive activities occur, but this requires correct student knowledge about the material of the problem to be solved. Students tend to be unsure of the answer but do not know how to change the answer or improve it because they do not have metacognitive knowledge of cognitive tasks.

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