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Students' mathematical literacy in terms of metacognitive awareness

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Abstract

Research on mathematical literacy has been done, but mathematical literacy in metacognitive awareness has not been done much. This study aimed to analyze mathematical literacy in terms of students' metacognitive awareness. This research is qualitative. The instruments used are literacy tests and Metacognitive Awareness Inventory questionnaires. The research subjects consisted of 3 students with high metacognitive awareness and three students with moderate metacognitive awareness. Data evaluation employed a dynamic framework: gathering information, minimizing data, displaying data, and making conclusions. Students with high metacognitive awareness could complete all literacy indicators, namely, evaluating mathematical results in the context of the given problem, paying attention to important information again, and checking the calculations made. The pattern of metacognitive awareness of students with high metacognitive awareness is monitoring their declarative knowledge to identify problems and evaluate solutions. Meanwhile, students with moderate metacognitive awareness solve problems up to the level of using math to make a problem-solving plan. The pattern of metacognitive awareness of students with moderate metacognitive awareness is that they do not monitor the problem-solving steps. Continuous development is needed to determine the level of development of mathematical literacy by paying attention to students' metacognitive awareness. Through this research, further research on metacognitive awareness will be developed.

Keywords:
Metacognitive awareness, Mathematical literacy

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1. INTRODUCTION

Mathematical literacy is the ability to formulate, use and interpret mathematics various contexts, including mathematical reasoning, using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena in order to assist individuals in making constructive and reflective decisions (Yang & Lin, 2015). Mathematical literacy as the ability of people to create, apply, and understand mathematics in different situations (Dewantara et al., 2023; Kusmaryono et al., 2024; OECD, 2013; Sistyawati et al., 2023; Wijaya et al., 2024). In line with PISA, the Indonesian Center for Assessment and Learning (PUSMENJAR, 2020) equates numeracy with mathematical literacy and describes it as the capability to reason using mathematical knowledge, ideas, methods, and instruments to address daily issues in different situations important to people as members of Indonesia and the global community. Mathematical literacy is included in the general literacy dimension (Tutkun et al., 2014). In short, mathematical literacy refers to an individual's capability to use mathematics in daily situations (Ojose, 2011). The concept of mathematical literacy is more inclined to the notion of applying mathematics in everyday life rather than remembering mathematical formulas (Asmara et al., 2024; Ayuningtyas et al., 2024; Fauzan et al., 2024; Harisman et al., 2023; Mevarech & Fan, 2018). This means that mathematics teachers must have good mathematical literacy skills.

Kolar and Hodnik (2021) identified two foundations of mathematical literacy, namely: 1) mathematical thinking involves grasping and applying mathematical ideas, methods, strategies, and communication as the foundation of mathematical literacy; and 2) problem solving in various contexts (personal, social, professional, scientific) that enable mathematical methods. Problems related to mathematical literacy in general can be seen from PISA test results. Sari and Wijaya (2017) state the mathematical literacy of upper secondary level students is classified in a very low category, with details for the comprehension indicator classified as low, while for indicators of making mathematical models, using concepts-facts-objects, interpreting and evaluating are in the very low category. In addition to the secondary level, level mathematical literacy is still a problem at the adult. In a study conducted by Ehmke comparing the mathematical literacy of adults and students aged for PISA, it was found that the average mathematical literacy competence of adults was the same as that of 15-year-old children (Ehmke et al., 2005). Several studies related to mathematical literacy, including Bolstad's research on the operationalization of mathematical literacy of teachers in Norway, showed that teachers still have difficulties in implementing learning to develop mathematical literacy (Bolstad, 2020). The findings show that teachers' views on mathematical literacy can be divided into seven categories: knowledge and skills in math, practical math, solving problems, mathematical reasoning, critical thinking, natural ability in math, understanding concepts, and the desire to learn math (Genc & Erbas, 2019).

Machaba (2017) said that the elements of mathematical literacy consist of 1) math understanding through math material, (2) math understanding through everyday scenarios, (3) math understanding through problem-solving skills tied to unfamiliar ideas, (4) math understanding through math dialogue in making choices, and (5) math understanding through content and abilities combined with problem solving. Furthermore, according to Ojose (2011), the indicators to measure mathematical literacy are (1) Process literacy involves the ability to comprehend and utilize information presented in ongoing text, (2) Document literacy pertains to the abilities and understanding required to locate and employ information found in different document types, (3) Quantitative literacy denotes the capabilities and knowledge necessary to perform mathematical calculations (arithmetic) on numbers displayed in printed formats.

The indicators that need to be investigation in this study are that students can (1) Create and state actual issues or be capable of noting the details within the issue, specifically being able to identify elements of the problem connected to familiar problems or mathematical ideas, truths, or methods and can break down scenarios or issues so they can be examined mathematically; (2) Utilize math to create plans for solving problems, specifically by gathering and implementing tactics to achieve mathematical answers and using mathematical principles, regulations, methods, and frameworks when seeking solutions; (3) Interpreting the solution in implementing the problem solving plan, i.e. being able to interpret mathematical results into the context of the problem; and (4) Evaluating the solution in checking back on what has been done, i.e. being able to evaluate mathematical results in the context of the given problem, paying attention to important information again, checking all calculations that have been done, checking whether the solution given is logical, looking for other solutions and re-reading the question carefully so that it is sure the question has been answered accordingly.

Pre servic teachers who will later teach mathematics, especially in the upper grades, must get enough opportunities to develop their mathematical literacy. Teaching techniques for problem-solving is a teacher’s role to offer challenges or inspire students so that they can comprehend the issue, develop an interest in finding a solution, utilize their knowledge to create strategies for resolving the problem, apply the strategies, and evaluate if the solution is accurate. Students who have poor mathematical literacy will result in poor consistency and discipline in carrying out activities in their daily lives (Yavuz et al., 2013). Additionally, a teacher must possess strong math skills (Yavuz et al., 2013). Teachers must have good mathematical literacy; this also applies to student teachers.

Furthermore, there are three important things that become the core of mathematical literacy assessment, namely: the skill to create, use, and understand mathematics in different situations; logical thinking in mathematics and the application of mathematical ideas, methods, information, and instruments to illustrate, clarify, and forecast events; along with the advantages of being mathematically literate in daily living.

Thinking skills are an important skill to be developed at every level of education as mandated by UNESCO through its four pillars of education (Scott, 2015) namely learning to know, learning to do, learning to be and learning to live together. This is because these thinking skills are expected to be a provision to answer the challenges and various problems that arise in the increasingly complex 21st century, especially to become successful workers and be able to compete with other workers (Zhao et al., 2014). One of the 21st century thinking skills in question is metacognitive skills (Ramlah et al., 2024; Scott, 2015). Metacognition is related to a person's awareness of their thinking process when working on or solving a problem (Çini et al., 2023; Güner & Erbay, 2021; Kaberman & Dori, 2009; Rivas et al., 2022). Two aspects of metacognition awareness support students to succeed in learning, namely cognitive knowledge (declarative knowledge, procedural knowledge, conditional knowledge) and cognitive regulation (planning, information management strategies, monitoring, search strategies, evaluation) (Schraw & Dennison, 1994).

Metacognitive knowledge is an understanding of thinking processes, including effective study techniques and how to apply them at the right times, then metacognitive regulation involves managing one's thought processes and learning activities, which includes planning, checking comprehension, and assessing progress (Danial, 2010). Metacognitive skills include skills in planning, implementing, monitoring, and evaluating the individual's own learning process (Veenman et al., 2014). Meanwhile, according to Desmita (2006), metacognition is a person's ability to understand how to think or understand the process of cognition that he does by involving the components of planning (functional planning), control (self-monitoring), and evaluation (selfevaluation) in solving the problems he faces. Metacognitive awareness facilitates the improvement of one's critical thinking skills (Çakici, 2018). When practicing critical thinking, learners must develop specific metacognitive abilities, including overseeing their thinking methods, assessing their advancement toward important objectives, confirming correctness, and determining how to allocate their time and cognitive resources (Haller et al., 1988). According to this description, it is essential for everyone, including both teachers and student teachers, to possess metacognitive skills (Jiang et al., 2016). Moreover, teachers who possess strong metacognitive skills can only cultivate students with effective metacognitive abilities (Demirel et al., 2015). Metacognitive strategies are provided to guide students to work together, then students can apply metacognitive strategies by themselves, and they need external support in the form of scaffolding to do, so there is a broad theoretical and empirical consensus stating that the effect of metacognition on learning outcomes is closely related to scaffolding (Maass et al., 2019).

The relationship between mathematical literacy and metacognitive awareness provides a deeper understanding of how students not only master mathematical knowledge, but also how they realize and control their thinking processes in solving mathematical problems. The urgency of this study focuses on how metacognitive awareness can enrich and improve students' mathematical literacy, and how it can be translated into more effective educational practices. Based on the background description above, the purpose of this study is how is mathematical literacy reviewed from students' metacognitive awareness?

2. METHOD

This research method is qualitative, employing a case study design. The instruments used to collect data in this study are mathematical literacy test instruments in the form of description questions and MAI (Metacognitive Awareness Inventory) questionnaires to measure students' metacognitive awareness.

Mathematical literacy test questions include indicators of creating and stating real problems or being able to record details in problems, using mathematics to create problem-solving plans, interpreting solutions in implementing problem-solving plans and evaluating solutions by re-examining what has been done. Mathematical literacy test consists of two question items where the questions are developed according to mathematical literacy indicators. Furthermore, the instrument was tested for its internal validity by involving two mathematics education experts. The instrument validity data was then used to analyze the reliability level of the two experts using the Cohen's Kappa Inter-Rater formula (Hsu &

Field, 2003). Based on the results of the analysis, it was found that the two experts had an agreement level of 0.819 so that it was classified as having a high level of reliability. Furthermore, the results of the internal validity were then analyzed using the Aiken coefficient value formula to see the level of validity of the content of each question item (Aiken, 1985). The results of the analysis showed that each question item had a high level of validity, namely 0.875. Then the instrument was tested on 5 students to see whether the questions were easy to understand and did not cause ambiguity for students. The results of the trial showed that the instrument was declared valid.

While the Metacognitive Awareness Inventory (MAI) questionnaire was adopted from Schraw and Dennison (1994). MAI covers all aspects of metacognition which consists of 2 major parts, namely knowledge about cognition (consisting of declarative knowledge, procedural knowledge, conditional knowledge) and control or regulation of cognition (consisting of planning, information management management, monitoring understanding, correction strategies and evaluation).

The subjects in this study were 49 students who took Analytical Geometry courses from one of the mathematics education students in Karawang, Indonesia. The researcher chose this subject because some students have difficulty with problems related to reasoning, representation, and communicating mathematically with the material.

Furthermore, data analysis aims to analyze and map mathematical literacy in terms of students' metacognitive awareness by using an interactive model which includes data collection, data reduction, data presentation, and conclusion drawing (Miles, 1994). Qualitative data accuracy through triangulation. Triangulation occurs in the midst of data gathering that includes examinations, observations, and comprehensive interviews to gather insights (Sukestiyarno, 2020). Data analysis with an inductive approach where conclusions are obtained from in-depth investigation to produce the best picture. Qualitative data analysis is guided by an interactive model (see Figure 1) with the following explanation.

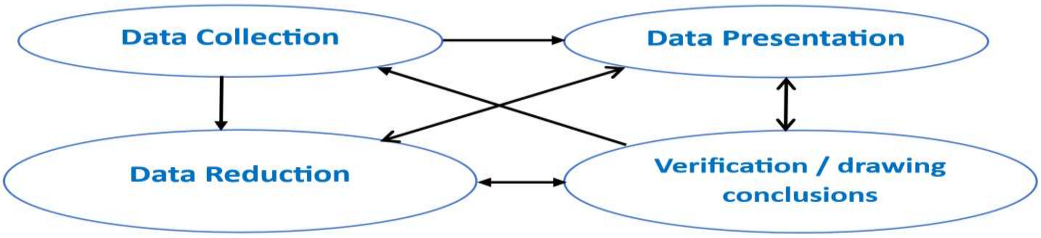

Figure 1. Qualitative data analysis with interactive model

Data reduction is verifying student work by excluding data that does not support research. Activities carried out at the data reduction stage include sharpening, selecting, focusing, abstracting, and transforming the results of the mathematical literacy test obtained in the field into data that is really needed in describing mathematical literacy in terms of student metacognitive awareness on analytic geometry material. The data set after being reduced is organized and categorized. Data display is clarifying and identifying data that is organized and categorized so that it allows conclusions to be drawn. This data presentation is then verified by in-depth interviews. Conclusion drawing/verification is drawing conclusions or verification. The results obtained are in the form of categorization of mathematical literacy and metacognitive awareness of students. The results of the questionnaire score were analyzed descriptively and matched with the metacognitive awareness category (Isnawan, 2015) in Table 1.

Table 1. Metacognitive awareness categories

No	Score Range	Category
1	36 ≤x ≤ 51	High
2	18 ≤x ≤ 35	Medium
3	0 ≤x ≤ 17	Low

3. RESULTS AND DISCUSSION

3.1. Results

The results of the MAI instrument on 49 mathematics education study program students are 18 students in the high category, 31 students in the medium category and there are no students in the low category. From each category, three research subjects were presented, namely 3 students with high metacognitive awareness (S1, S2 and S3) and 3 students with moderate metacognitive awareness (S4, S5 and S6).

3.1.1. Mathematical Literacy of Students with High Metacognitive Awareness

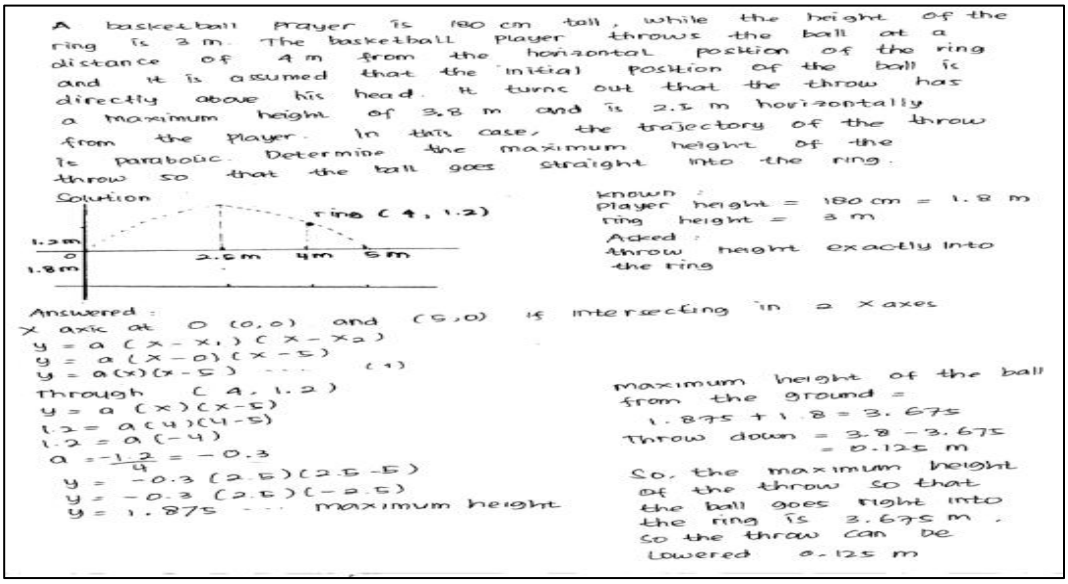

Figure 2. Answer sheet for undergraduate students with high metacognitive awareness test

Based on Figure 2 at the stage of formulating the situation, undergraduate students with high metacognitive awareness are able to simplify the problem by creating illustrations in the form of pictures. Students are able to write the parabola formula in the chosen mathematical model to solve the problem. The following are the results of interviews with undergraduate students with high metacognitive awareness:

P : What information did you get from the given problem?
S1 : The player is 1.8 m tall and the ring is 3 m high.
P : How did you solve the given problem?

S1 : Because the basketball player threw the ball at a distance of 4 m from the horizontal position of the ring and it is assumed that the initial position of the ball is directly above his head, there is a point (4, 1.2) that passes through the parabola path

P : Why use these steps?

S1 : Because to get the parabola formula 1, you can't do it directly, ma'am, so you have to use the properties of the parabola, ma'am.

Based on Figure 2, students are able to meet the indicators at the stage of applying mathematical concepts and procedures. This can be seen from the student's answer where he has been able to design a strategy and apply the right parabola concept and is able to do the calculations correctly to solve the problem. The following is an excerpt from an interview with a student.

Q : What is the next step you take after formulating the problem into a mathematical model?

S1 : Solve the parabola equation and find the maximum height of the throw.

At the stage of interpreting the results, students write conclusions from the results obtained on the answer sheet. However, when the interview was conducted, students were able to provide conclusions and evaluate the answers given whether they were correct or not and were able to provide reasons. The following is an excerpt from the interview with a student.

Q : Are you sure about the answer you have obtained? Why?

S1 : Sure, ma'am. Because the formula used and the solution are correct.

Q : Is there another way to solve the problem above?

S1 : No, ma'am.

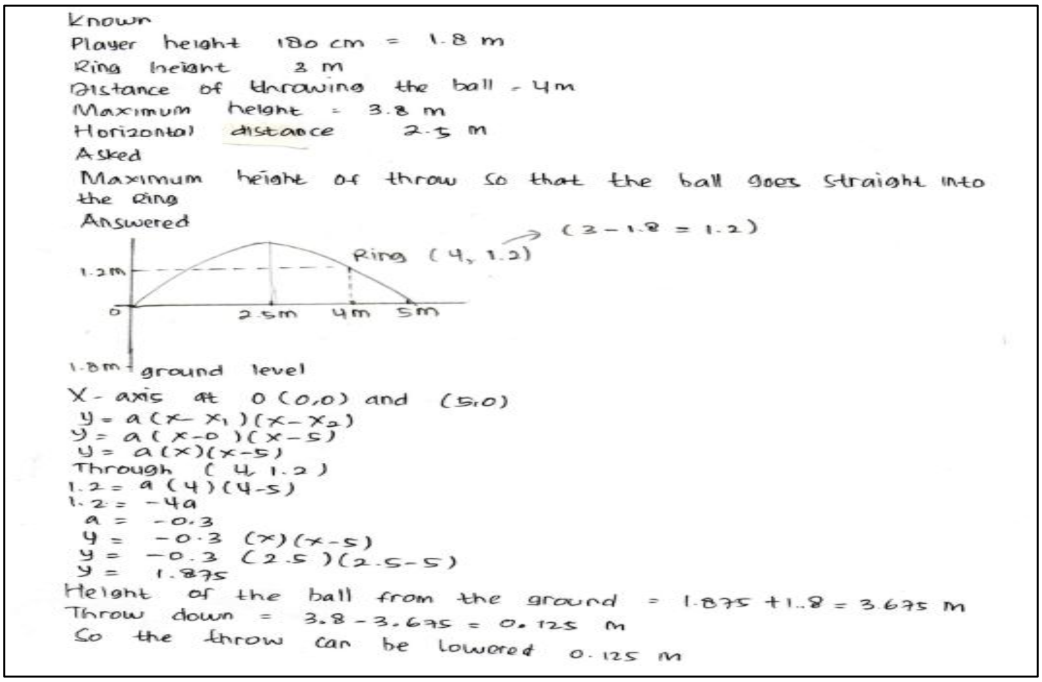

Figure 3. Answer sheet for master's students' test with high metacognitive awareness

Based on Figure 3 at the stage of formulating the situation, Master's students with high metacognitive awareness are able to create illustrations in the form of parabolic trajectory images. Students are able to develop strategies by creating parabolic equations and substituting known points. Furthermore, students are able to solve the problem. The following are the results of interviews with undergraduate students who have high metacognitive awareness:

P : What information did you get from the given problem?
S2 : Parabola passes through points (0,0) and (0,5)
P : How did you solve the given problem?
S2 : Compose a parabolic equation then substitute the known points and its extreme points.
P : Why use these steps?
S2 : Because to get the next parabola formula, the maximum height.

Based on Figure 3, students are able to meet the indicators at the stage of applying mathematical concepts and procedures. This can be seen from the student's answers where he has been able to design strategies and apply concepts and is able to do calculations correctly to solve the problem. The following is an excerpt from an interview with a student.

Q : What is the next step you take after formulating the problem into a mathematical model?
S2 : Finding the maximum height of the ball from the ground.

In the stage of interpreting the results, students write conclusions from the results obtained on the answer sheet. During the interview, students are able to provide conclusions and evaluate the answers given whether they are correct or not and are able to provide reasons. The following is an excerpt from the results of interviews with students.

Q : Are you sure about the answers you have obtained? Why?
S2 : Sure. Because the formula used and the solution are correct.
Q : Is there another way to solve the problem above?
S2 : Maybe there is.

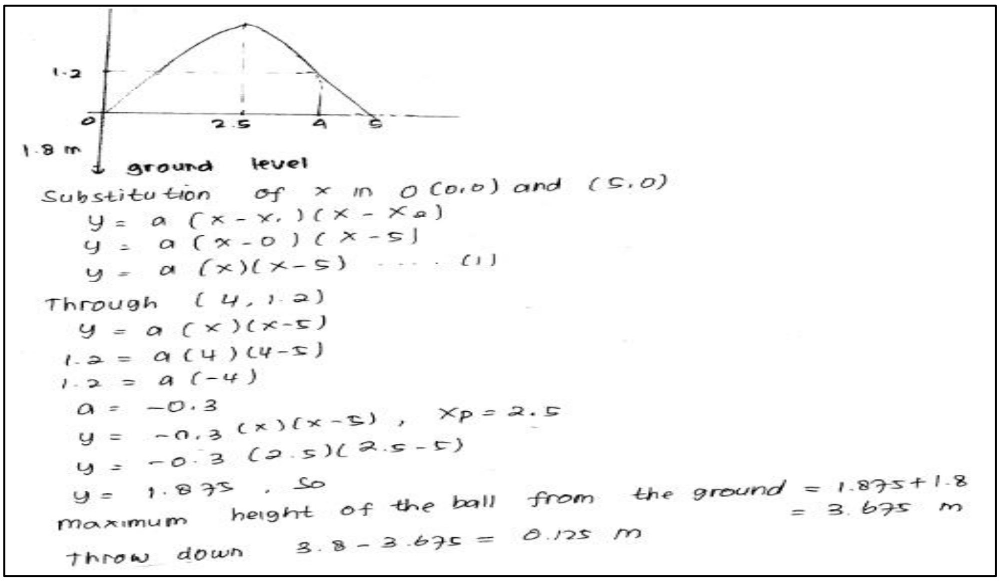

Figure 4. Answer sheet for doctoral students with high metacognitive awareness

Based on Figure 4 at the stage of formulating the situation, doctoral students with high metacognitive awareness are able to simplify the problem by creating an illustration in the form of a parabola image. Students are able to write the parabola formula in the mathematical model chosen to solve the problem. The following are the results of interviews with undergraduate students with high metacognitive awareness:

P : What information did you get from the given problem?
S3 : As in the picture ma'am.
P : How did you solve the given problem?
S3 : Compiling a parabola equation
P : Why did you use that step?
S3 : Because it is related to a parabola, to find the maximum height of the ball.

Based on Figure 4, students are able to meet the indicators at the stage of applying mathematical concepts and procedures. This can be seen from the student's answer where he has been able to design a strategy and apply the right parabola concept and is able to do the calculations correctly to solve the problem. The following is an excerpt from an interview with a student.

P : What is the next step you take after formulating the problem into a mathematical model?
S3 : Finding the maximum height of the ball.

At the stage of interpreting the results, students write conclusions from the results obtained on the answer sheet. During the interview, students are able to provide conclusions and evaluate the answers given whether they are correct or not and are able to provide reasons. The following is an excerpt from the results of interviews with students.

P : Are you sure about the answers you have obtained? Why?
S3 : Sure, ma'am. In order to enter the ring exactly, the maximum height is 3.675 meters, so if in the question it is 3.8 meters, then the correct one is 3.675 meters.
P : Is there another way to solve the problem above?
S3 : Maybe there is, ma'am.

Based on the test results and interviews, students with high metacognitive awareness were able to complete all indicators of mathematical literacy up to the indicator of evaluating solutions in rechecking what had been done, namely being able to evaluate mathematical results in the context of the given problem, re-considering important information, checking all calculations that had been done, checking whether the solution given was logical, looking for other solutions and re-reading the question carefully so that they were sure the question had been answered appropriately. The steps for solving the problem were also made sequentially and in order. Students were able to consider strategies in solving the problem. So it's not just using existing strategies for sure. Understanding of the context of the problem is also quite good. In addition to these results, students can also understand the theory well, so that sometimes they will miss some steps in solving to set a strategy for solving the next step. However, it is clear that students can understand the steps of the solution well. The next thing is also seen in decision making. Students can make good conclusions. Based on the results of the analysis of student answers and interviews in solving problems with high metacognitive awareness, they are able to interpret solutions in implementing problem-solving plans and evaluate solutions in rechecking what has been done. According to Pantiwati, students who have metacognitive knowledge can work better than those who do not understand, so that metacognitive awareness can help students to plan, design, and monitor their learning (Pantiwati, 2013).

The metacognitive awareness pattern of students with high metacognitive awareness is writing a plan to solve the problem, writing several concepts used in solving the problem, writing a mathematical model of the concept used and writing the reasons for using the concept. In terms of information management strategies, students actually have the awareness and enthusiasm to seek and obtain information to build their abilities and knowledge. In monitoring their understanding, students have good awareness in considering several alternative solutions before answering and stopping regularly to check their understanding. Students can engage all elements of metacognitive knowledge and regulation. At first, students observe their declarative knowledge to find issues. Finally, they assess when reviewing the solutions that have been established. This aligns with what Pate and Miller proposed (Pate & Miller, 2011). The pattern of metacognitive awareness of these students can be seen in Figure 5.

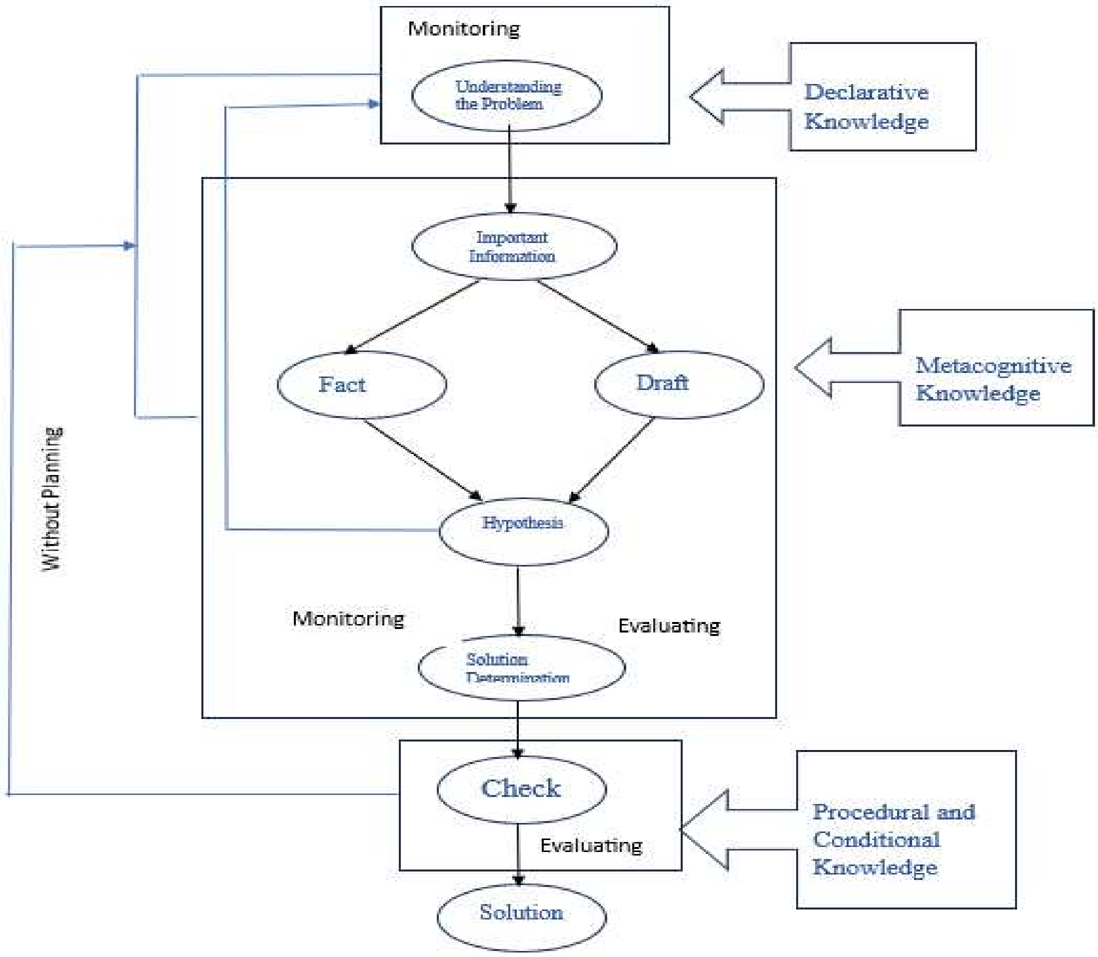

Figure 5. Metacognitive awareness patterns in students with high metacognitive awareness

3.1.2. Mathematical Literacy of Students with Medium Metacognitive Awareness

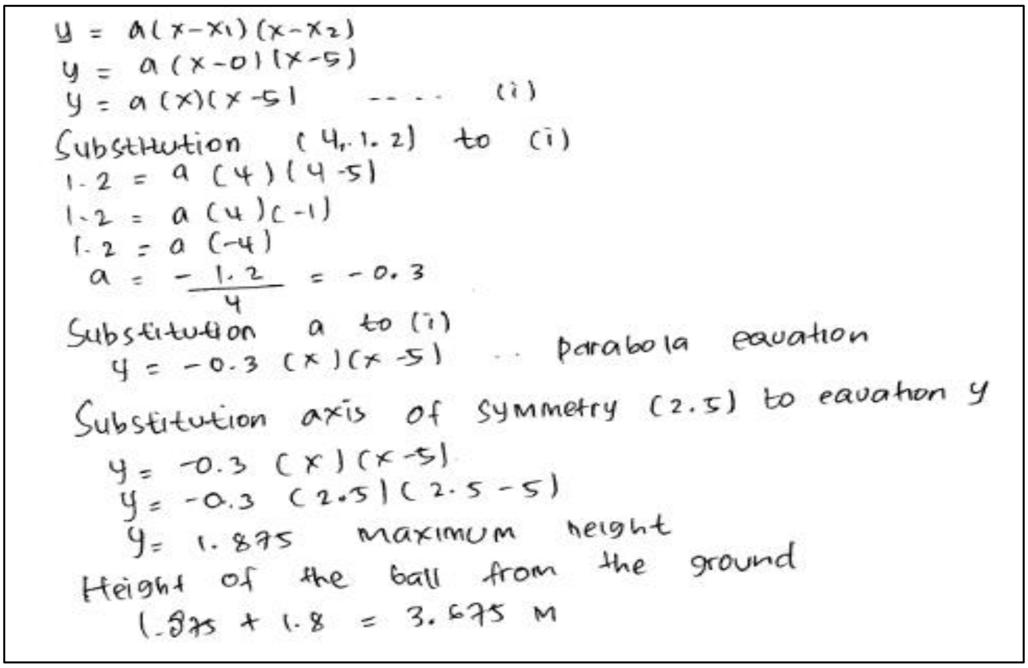
y = a(x−x1)(x−x2)
y = a(x−0)(x−5)
y = a(x)(x−5) ..... (i)
Substitution (4, 1.2) to (i)
1.2 = a(4)(4−5)
1.2 = a(4)(−1)
1.2 = a(−4)
a = −1.2/4 = −0.3
Substitution a to (i)
y = −0.3 (x)(x−5) .. parabola equation
Substitution axis of symmetry (2.5) to equation y
y = −0.3 (x)(x−5)
y = −0.3 (2.5)(2.5−5)
y = 1.875 maximum height
Height of the ball from the ground
1.875 + 1.8 = 3.675 m

Figure 6. Answer sheet for S4 student test with moderate metacognitive awareness

Based on Figure 6, at the stage of formulating the problem situation, students with moderate metacognitive awareness have not yet compiled illustrations to simplify the problem in the form of images. Students can understand the questions well even though they do not write down what is known and asked in the question. The following are the results of interviews with undergraduate students:

P : What information can you get from the given problem?
S4 : Asked to find the maximum height of the ball, ma'am.
P : Can you formulate into a mathematical model how to calculate it?
S4 : Yes, ma'am, using the concept of a parabola.

At the stage of applying the concept, students have been able to design a strategy to solve the problem, but in evaluating the problem it is still incomplete where students do not explain the maximum height for the ball to enter the ring. The following are the results of interviews with students.

P : What strategy do you use to solve the problem?
S4 : Using the parabola formula, ma'am.
P : Is the answer you got correct? Why?
S4 : Yes, ma'am, because there are no errors in the calculation.
P : Okay, is there another way to solve the given problem?
S4 : No ma'am.

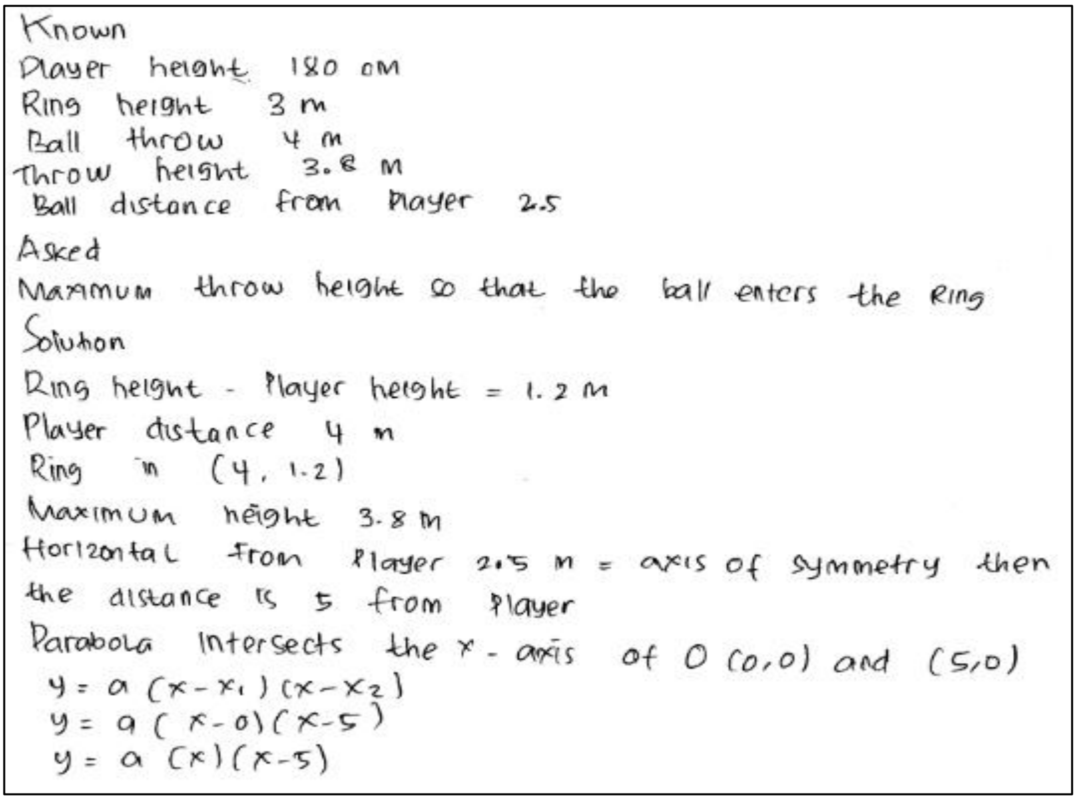
Known
Player height 180 cm
Ring height 3 m
Ball throw 4 m
Throw height 3.8 m
Ball distance from Player 2.5
Asked
Maximum throw height so that the ball enters the Ring
Solution
Ring height - Player height = 1.2 m
Player distance 4 m
Ring in (4, 1.2)
Maximum height 3.8 m
Horizontal from Player 2.5 m = axis of symmetry then the distance is 5 from Player
Parabola intersects the x - axis of O (0,0) and (5,0)
y = a (x - x₁) (x - x₂)
y = a (x - 0)(x - 5)
y = a (x)(x - 5)

Figure 7. Answer sheet for student test S5 with moderate metacognitive awareness

Based on Figure 7, at the stage of formulating the problem situation, students with moderate metacognitive awareness have not yet compiled illustrations to simplify the problem in the form of images. Students can understand the questions well and write down what is known and asked in the questions. The following are the results of interviews with undergraduate students:

P : What information can you obtain from the given problem?
S5 : Finding the maximum height.
P : Can you formulate into a mathematical model how to calculate it?
S5 : Yes, ma'am, using the parabola formula.

At the stage of applying the concept, students have not been able to design a strategy to solve the problem but in applying the concept of a parabola. Students have not been able to reach the stage of interpreting the results. The following are excerpts from interviews with students.

P : What strategy do you use to solve the problem?
S5 : Axis of symmetry.
P : Is the answer you got correct? Why?
S5 : Not yet ma'am, because it's not finished.

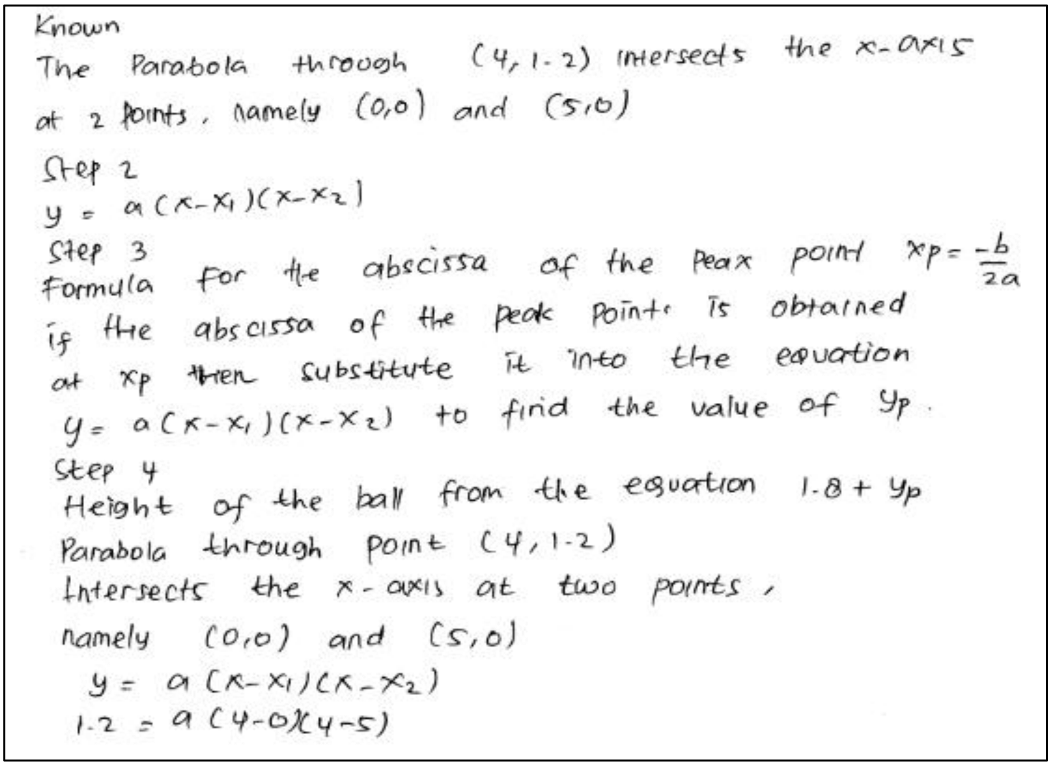
Known
The Parabola through (4, 1.2) intersects the x-axis at 2 points, namely (0,0) and (5,0)
Step 2
$y = a(x-x_1)(x-x_2)$
Step 3
Formula for the abscissa of the peak point $x_p = \frac{-b}{2a}$
if the abscissa of the peak point is obtained at x_p then substitute it into the equation
$y = a(x-x_1)(x-x_2)$ to find the value of y_p.
Step 4
Height of the ball from the equation $1.8 + y_p$
Parabola through point (4, 1.2)
Intersects the x-axis at two points,
namely (0,0) and (5,0)
$y = a(x-x_1)(x-x_2)$
$1.2 = a(4-0)(4-5)$

Figure 8. Answer sheet for S6 student test with moderate metacognitive awareness

Based on Figure 8 at the stage of formulating the situation, S6 students with moderate metacognitive awareness have not been able to simplify the problem by making an illustration in the form of a perpendicular circle. Students are able to write the parabola formula in a mathematical model but have not been able to solve the problem. The following are the results of interviews with students who have moderate metacognitive awareness:

P : What information did you get from the problem given?
S6 : Throwing a ball is included in the parabola path.
P : How did you solve the problem given?
S6 : Arranging a parabola equation through a known point
P : Why use these steps?
S6 : Because from what is known.

Based on Figure 8, students are able to meet the indicators at the stage of applying mathematical concepts and procedures even though they are not yet completely complete. This can be seen from the student's answer where he has been able to design a strategy and apply the parabola concept even though it is not yet complete. The following is an excerpt from an interview with a student.

P : What are the next steps you take after formulating the problem into a mathematical model?
S6 : Determining the value of a.

At the stage of interpreting the results, students have not written conclusions from the results obtained on the answer sheet. When the interview was conducted, students were not able to provide the next steps in their calculations. The following is an excerpt from the results of the interview with students.

P : Are you sure about the answer you have obtained? Why?
S6 : Not sure ma'am. Because I haven't finished it.

Based on the test results and interviews, students with moderate metacognitive awareness are able to solve problems up to the indicator of using mathematics to create a problem-solving plan, namely being able to compile and apply strategies to obtain mathematical solutions and apply facts, rules, algorithms and mathematical structures when finding solutions. Students first identify before determining a solution strategy. The ability to understand the context of the problem is not very good. This can be seen from the ability of students to process mathematical forms and formulas. The subject's reasoning ability has developed well, but is still wrong in making final reflections. Students do not seem to understand the context well, so that in making decisions they choose unstructured sentences. The arguments given are also not in accordance with what is intended in the problem. Meanwhile, the subject's communication skills and mathematical representation skills have not developed well. Students have not been able to write down the process even though it is still simple and not detailed. The mathematical representation of these students does not look good enough. This can be seen from how the student has not represented the mathematical form of the calculation results into a picture. The procedures used are also not well structured, because they only apply formulas. This is in line with students' metacognitive awareness in procedural knowledge, these students are only able to read certain objectives for each strategy used, but they are still slow in finding learning strategies that are used and useful. On the other hand, students are still weak in making pictures or diagrams to improve their understanding and ability to use concept maps to help their understanding. Students do not have sufficient ability to package the information obtained so that it is easy to understand and can be absorbed well. Students have not optimally processed or used critical skills to find the right strategy and improve their work performance, because they are not supported by adequate intellectual resources.

The students' ability regarding monitoring understanding shows that students have low awareness in analyzing the usefulness of strategies when they are learning. So every time they are faced with a problem, students have difficulty deciding which alternative solution is the most reliable. The students' ability regarding evaluation ability shows that students tend to have low ability in analyzing the performance and effectiveness of strategies after completing their studies. This low regulation is indicated by the students' still less than optimal awareness to ask themselves about how well they have achieved their goals (after the task is completed), and their still low awareness in making a summary of what they have learned. The arguments given in drawing conclusions are not too deep and not detailed. Based on the results of the analysis of students' answers in solving problems with moderate metacognitive awareness, they are able to use mathematics to make problem-solving plans, namely being able to compile and apply strategies to obtain mathematical solutions and apply facts, rules, algorithms and mathematical structures when finding solutions. The pattern of metacognitive awareness of students with moderate metacognitive awareness can be seen in Figure 9, where students do not monitor their metacognitive knowledge in the problem-solving steps. Students can evaluate but are unable to find and correct errors.

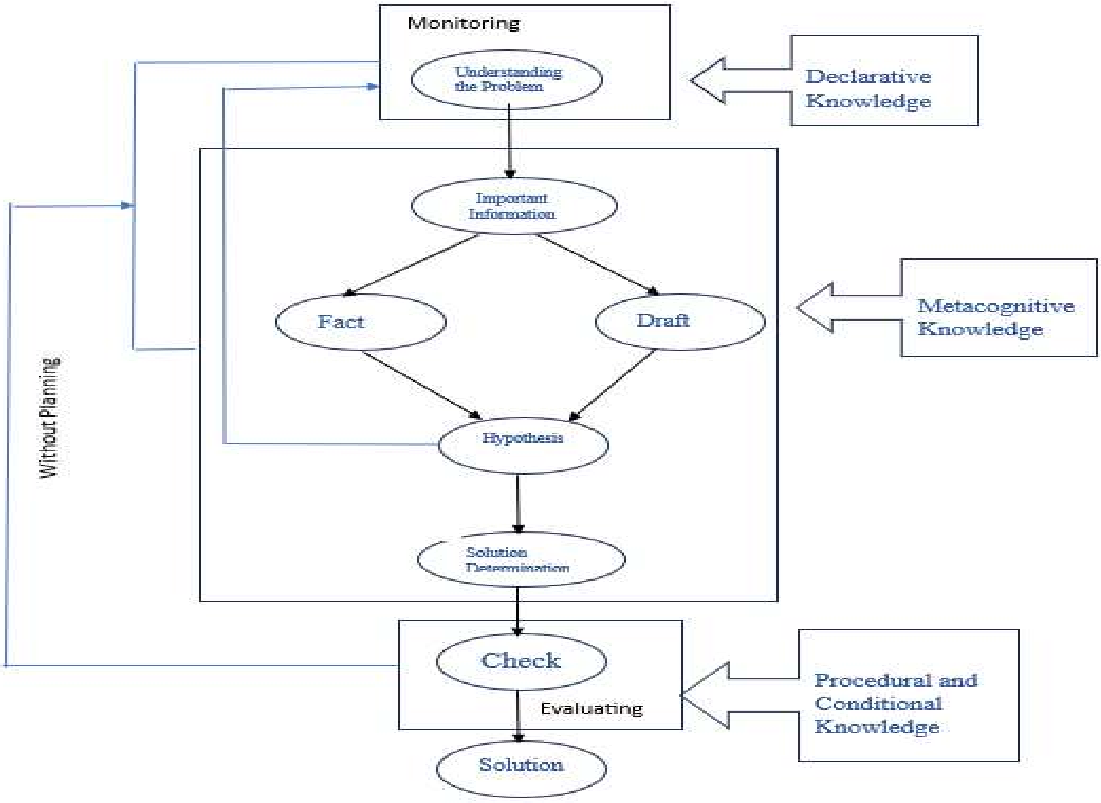

Figure 9. Metacognitive awareness patterns in students with moderate metacognitive awareness

3.2. Discussion

Metacognitive awareness can help students find and know what they know and what they will do to improve their academic achievement. The first process in mathematical literacy is understanding the given problem or issue, identifying relevant information, and formulating the steps that need to be taken to solve the problem. At this stage, metacognitive abilities will be involved in planning, such as thinking about the steps to be taken, planning the right strategy to solve the problem, and recognizing potential difficulties that may arise. Students will ask themselves, "What do I know about this problem? What do I need to find out more about?". Students choose the right mathematical strategy or method to solve the problem, such as choosing the appropriate formula or procedure. Students must actively monitor whether the strategy they choose is working well or not. They must be able to ask themselves, "Am I on the right track? Is there a more efficient approach?" At this point, metacognition plays a role in the awareness to make corrections, if necessary, for example by changing strategies if the first approach does not work.

In continuing to solve problems, individuals continue to apply mathematical concepts and procedures to find the correct solution. At this stage, metacognitive abilities will be involved in regulating and controlling the thinking process. Students monitor and evaluate each step they take, correct errors if found, and ensure that the solution given is consistent with the available information. Students can also ask themselves, "Do my steps make sense? Do I need to fix something in this process?". After reaching a solution, students must evaluate the results and re-check whether the solution found is appropriate to the context of the problem. The process of reflection or evaluation is very important in metacognition. At this stage, students will reflect and ask, "Does my solution really make sense? Is there another way to solve this problem?" They identify the steps that worked and those that did not, and think about how they can be better in solving similar problems in the future. Metacognitive abilities allow students to transfer the knowledge and strategies they learn from one context to another. Students who have good metacognitive awareness can effectively utilize previous experiences and adjust their strategies according to new problems faced.

They are able to divert the frustration that usually occurs when things are confusing or unproductive at first into learning strategies and further research (Jaleel, 2016). Nearly all elements of metacognition can be found in mathematical literacy, particularly those concerning metacognitive knowledge. The aspects of metacognitive knowledge that surface result in an understanding of the concepts they possess (Laamena & Laurens, 2021).

Some researchers believe that metacognition is important because it allows individuals to plan and allocate limited learning resources as efficiently as possible, monitor the level of knowledge and skills they have, and evaluate their learning conditions (Schraw et al., 2006). The high-level thinking skills of students who have high metacognitive awareness are significantly different from students who have low metacognitive awareness (Sastrawati et al., 2011). In line with the results of Asriningsih's research that the use of metacognitive strategies to facilitate metacognitive awareness makes students think about considering alternative problem solving to get the best solution to solving learning problems (Asriningsih et al., 2017).

In this section, it seems that students need assistance (scaffolding process) from their environment, so that they can develop the ability to understand problems or subject matter. The role of teachers is very much needed to continue to train students so that their mathematical literacy develops optimally (Supianti et al., 2022). Learning needs to be developed to improve students' ability to analyze the usefulness of strategies, so that they can choose the right strategy to use in solving problems (McGuire, 2023; Rohm et al., 2021). One treatment that can be done is to create learning that can accustom students to problem-solving activities. According to Cardelle-Elawar (1995), metacognitive training using self-generated questions supports students in managing their own learning. Metacognitive inquiries prompt students to tap into existing knowledge, assess information, redefine the problem area by combining information into a clear understanding, and track their own advancement by reviewing and fixing their errors (Cardelle-Elawar, 1995). Students need a situation where they are trained to carry out self-evaluation activities on their entire learning process. Learning also needs to be designed so that students are accustomed to carrying out confirmation activities (making affirmations about what has been learned). Strategies that can be done to overcome this problem are (1) by creating self-evaluation activities or filling out learning implementation control sheets, and (2) by implementing confirmation activities in core learning activities.

4. CONCLUSION

Based on the analysis of students' mathematical literacy skills, students with a high metacognitive awareness category in solving mathematical literacy test questions are able to complete all indicators of mathematical literacy, namely the indicator of writing and formulating real problems or being able to write down information contained in the question to the indicator of evaluating solutions in re-checking what has been done, namely being able to evaluate mathematical results in the context of the given problem, paying attention to important information, checking all calculations that have been done, checking whether the solution given is logical, looking for other solutions and re-reading the question carefully so that they are sure the question has been answered appropriately. In students with a moderate metacognitive awareness category in solving mathematical literacy test questions to the indicator of using mathematics to make problem-solving plans, namely being able to compile and apply strategies to obtain mathematical solutions and use information, guidelines, procedures, and mathematical frameworks to discover answers. Students with high metacognitive awareness actively monitor the steps they take in solving math problems. They know what they are doing and are constantly evaluating whether their chosen approach or strategy is effective. They can stop the process and evaluate whether the steps they are taking are correct and know when to change strategies if they run into difficulties. Students with high metacognitive awareness are more likely to spot and correct errors more quickly. In contrast, students with low metacognitive awareness may not pay as much attention to how they are thinking or how their problem-solving process is going. They may not realize that they have made a mistake or are using an ineffective strategy. They are also less likely to evaluate whether the steps they are taking are correct. Without effective monitoring of their thinking processes, these students are more likely to make undetected errors and continue to make them without correction. By understanding and leveraging metacognitive awareness, instructors can design more effective learning experiences that encourage students to not only master mathematical concepts but also become more aware of how they think and solve problems. Educators can leverage educational technology to support the development of students' metacognitive awareness and provide specific training to students on the importance of metacognitive awareness and how to develop these skills.

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