Investigation of Metacognition Level of Secondary School Students in Solving Islamic-based Numerical Literacy

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ABSTRACT
The integrated mathematical problem was the application of mathematics to solve problems from various disciplines. This study aimed to determine students' metacognition level in solving integrated mathematics problems. In addition, it can also improve students' numerical literacy. This research was qualitative research with data collection instruments, a one-question problem-solving test, and interviews. Research subjects for interviews were students with the highest score based on the test results. The results showed that students with mathematical abilities in high category at semi-reflective use and level of reflective use. That happened because subjects used Islamic-integrated knowledge to create problem-solving strategies in their metacognitive activities. Therefore, if students knew Islamic material, they could reach a good metacognition level in solving Islamic-integrated mathematics problems.

Keywords: *Metacognition level, Secondary school students, Integrated mathematics problems, Problem-solving strategies.*

1. INTRODUCTION

As a part of complex problems, integrated mathematics problems can be used to solve problems from various disciplines. Integrated mathematics problems involve other disciplines in the process of solving them. The integration can be in the form of integration of mathematics with diverse fields [1–4], integration of mathematics with the culture [5–9], and integration of mathematics with religion [10–12]. Thus, students need to have the ability to solve these integrated problems to face the challenges of the globalization era, which demands complex problem-solving skills [13]. One of the factors that influence success in solving mathematical problems is metacognition [14,15]. Aljaberi declares that there is a significant correlation between metacognitive thinking factors and problem-solving ability [16]. The correlations are procedural knowledge, evaluation, error choosing, and managing knowledge. Metacognitive reflection builds awareness of tasks and strategies, mainly through planning and monitoring, to collect the metacognitive skills needed for problem-solving [17]. Thus, students need to have good metacognitive abilities for the success of solving complex mathematical problems.

Studies on students' metacognition level in solving mathematical problems had been done by many researchers, as reported in previous publications [18–23]. However, such works were generally related to the metacognition level of mathematical ability in high school students [18,21] and secondary school students [20,22–24]. Mahromah's and Siagian et al.'s research showed that the metacognition level of secondary school students with mathematical abilities in the high category reached the highest level of strategic use [20,22]. Previous research stated that the first intermediate students with high mathematical abilities reached the level of reflective use [23].

Furthermore, such previous works examined the metacognition level in solving mathematical problems [18,20–22] and mathematical literacy [23]. Therefore the application of the metacognition level in solving integrated mathematics problems for secondary school students is rarely reported. Additionally, the metacognition level of secondary school students had not yet reached the highest level [20,22]. Thus, it is crucial to conduct research related to the metacognition level of secondary students in solving integrated mathematics problems. It is certainly interesting because integrated

mathematics problems involve concepts from other disciplines in the problem-solving process.

As a country with the largest Muslim population in the world, Indonesia has its uniqueness in learning. Uniquely, this education is divided into general-based education and Islamic-based education. General-based education at the secondary school level is divided into secondary school and Islamic secondary school. The Islamic-based education at the secondary school level is Madrasah *Tsanawiyah*. Mathematics is also present in solving problems, especially those related to Islamic integrated mathematics problems. As a Muslim majority population, cases related to Islamic issues often arise, as an example in the distribution of inheritance [25]. Previous studies were generally still in the form of general mathematical problems. Therefore, investigation of the metacognition level of secondary school students in solving Islamic-integrated mathematics problems is essential to research.

2. METHODS

This research used an exploratory and descriptive study to investigate the students' metacognition level in solving integrated mathematics problems. Qualitative data analysis in this study used the model proposed by Miles and Huberman, namely data reduction, data presentation, and conclusion [26]. Qualitative data was gained from students' work on a one-question problem-solving test and interview results. The research data in the form of the results of the problem-solving test work and the interviews were summarized and focused on essential things related to the metacognition level. Furthermore, data reduction was carried out based on the results of interviews conducted after the test.

The test was given to 24 students, from secondary school students, Islamic secondary students, and Madrasah *Tsanawiyah* students. The 24 students had different categories of mathematical ability based on the teacher's recommendations: 6 students with low ability level, 12 students with middle ability level, and 6 students with high ability level. Before being given a problem-solving test, the 24 students conducted a competency test. They did a test to categorize the mathematical abilities of the 24 prospective subjects. The problem-solving test was directed to 24 students who had used the triangle-based learning module on metacognition and integration [11]. The selected subjects were the students with the highest score. The results of the subjects' interviews were converted into transcripts. This research used time triangulation, which set many interviews several times to get valid data. Finally, data reduction was converted to narrative text to produce coherent and evident data. The detail of metacognition level indicators in solving mathematical problems can be found in Table 1 [27].

Table 1. Coding of students' metacognition level indicators in solving mathematical problems

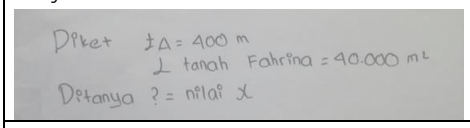
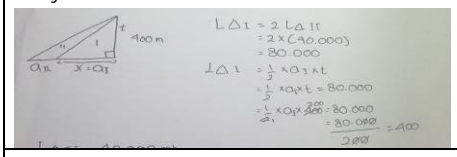
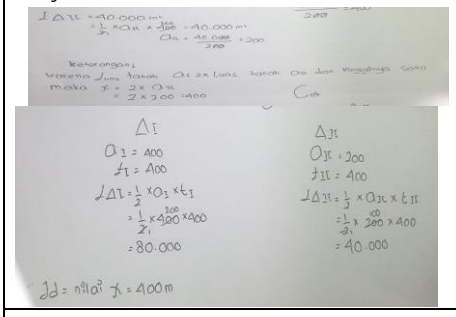
Level	Indicators	Coding
Semi Reflective Use	1. Rethinking past knowledge that can be used.	SR1
	2. Check and thought again of his work.	SR2
	3. Doing reflection does think during the process of solving, but is limited to certain parts.	SR3
	4. Tend to prove the final result.	SR4
	5. Convinced of the correctness of the answer after checking.	SR5
Reflective Use	1. Understanding and mastering mathematical concepts became the basis of the problem by realizing that the concepts learned are helpful to solve the problem.	R1
	2. Planing and solving strategies by identifying the problem.	R2
	3. Rethink the plans that have been made and use different strategies to improve the precision of thought.	R3
	4. Always check every step and revise directly if finding an error.	R4
	5. Think again about the methods that have been used and the results obtained.	R5
	6. Think of another way to solve the problem.	R6
	7. Rethink about the effective-ness of the strategies that have been used.	R7

3. RESULTS AND DISCUSSION

The instrument used to determine students' metacognition level was a one-question problem-solving test and interview guidelines. Before being used, experts have validated the problem-solving test instrument and interview guide. The subjects did the problem-solving test after they used the module for independent study [11]. Based on the results of the problem-solving test, two subjects got the highest score. Both of them have

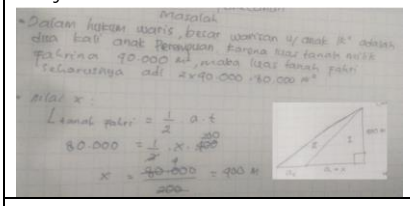
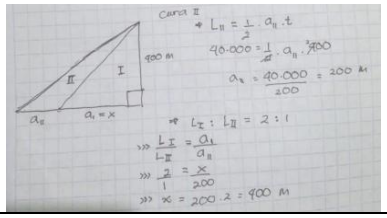
mathematical abilities in the high category. After the test, the researchers used semi-structured interviews to explore some pieces of the information which was not obtained from problem-solving problems. Based on data reduction and triangulation, the results of interview 1 were valid. The following is the process of the subject's

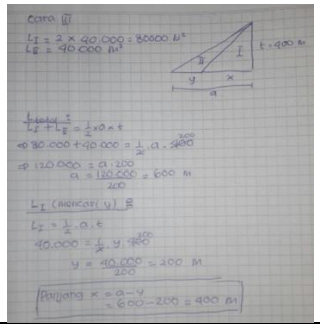
Table 2. Analysis of interview results and works of subject SY in solving integrated mathematics problems

Interview Results and Works of Subject SY	Category of Metacognition Level Indicator
State the problem and information contained in the question completely and correctly. (8) *The information known is the height of the triangle, that is 400 m, the land area of Farina is 40,000 square meters. Asked, the value of x in the triangle* (9) *The problem is having to find the value of x in the triangle. x = base of Fahri's triangle*. Subject's work 	R1 and SR1
Using inheritance law as a strategy to solve problems (10) *The share of the boy (Fahri) is twice that of the girl's (Fahrina), so Fahri's land area is equal to two times of Fahrina's.* Subject's work 	R2 and SR1
Checking the results of his work, and correcting when something goes wrong (11) *There was something wrong with my work, so I corrected it.*	SR2
Doesn't always check back on his work (12) *Yes, sometimes I check my work again* Subject's work 	SR3
Conduct inspections on processes and final results (13) *I saw the final result, ma'am, if the final result is the same, it means that my calculations are correct. I also checked this one (pointing to the calculation process), I'm afraid there's a miscalculation.*	SR4
Convinced with the answers obtained because they have used various methods (14) *Sure, because I have checked in various ways.*	SR5
Determine the most effective way (15) *The method in which the base of one is equal to twice the base of two because all you have to do is multiply.*	R7

metacognition in solving integrated mathematics problems.

Table 3. Analysis of interview results and works of subject ST in solving integrated mathematics problems

Interview Results and Works of Subject SY	Category of Metacognition Level Indicator
State what to ask and what is known in the question completely and correctly (1) *This is ma'am (while pointing to the question text), the length of the side of the land that is not yet known in Fahri's part is the base of one triangle* (2) *It is known that two heirs are Fahri and Fahrina, Fahrina's land area is 40000 square meters, and one side of Fahri's land is the height of the triangle equal to 400 meters.*	R1 and SR1
Using inheritance law as a strategy in solving problems (3) *Using inheritance law information, the amount of inheritance for boys is twice that for girls. Because Fahrina's land area is 40000 square meters, Fahri's land area should be 80000 square meters.* (4) *It's in the module.* Subject's work 	R2 and SR1
Checking the calculations and methods used and using more than one method (5) *If the area of Fahri's triangle 1 is calculated, that is, the area of I is equal to half times four hundred is equal to eighty thousand, now eighty thousand is equal to twice the area of Fahrina's triangle 2, it means that method 1 is correct, as is method 2. The large of area 1 = ½ × 400 × 400 = 80000 = 2 × area of triangle 2(Fahrina)..., means method 1 is correct as well as method 2.* Subject's work (6) 	R3
Always check (7) *So during my work, there are no errors because I always check.*	R4 dan SR2

Thinking about the various ways and the results obtained (8) *Before doing that, I thought about how this is going to be, how about that. Then, for scribbling, thank God, two ways to produce the same value continue to try with the previous method.*	R5
Thinking of an alternative way (9) *Yes, I just found it, ma'am. This is ma'am (showing another answer/way) …* Subject's work 	R6
Determine the most effective way (10) *Way one*	R7

3.1. Subject SY

Based on data analysis in Table 2, the subject SY fulfilled the indicators R1, R2, and R7. Subject SY also fulfilled the SR1, SR2, SR3, SR4, and SR5 indicators. Thus, subject SY is categorized as being at the level of semi-reflective use in solving Islamic integrated mathematics problems.

3.2. Subject ST

Based on data analysis in Table 3, subject ST fulfilled the indicators R1, R2, R3, R4, R5, R6, and R7. Additionally, subject ST also fulfilled the SR1 and SR2 indicators. Thus, subject ST in solving Islamic integrated mathematics problems, categorized as being at the level of reflective use.

Based on the analysis results as shown in Table 2 and Table 3, subject ST and the subject SY were aware of the problem and some information. This result indicates that the two subjects had carried out awareness on metacognition activities [28–30]. The analysis results of subject ST and SY also showed planning activities such as using integrated knowledge, namely inheritance law. Subject ST and SY also carried out monitoring, such as when they stated that they checked the results of their calculations at each completion step. Additionally, subject ST and SY also carried out evaluation activities such as comparing the final results obtained and selecting the most effective method from the methods used. Their actions consisting of three metacognitive skills: planning, monitoring, and evaluation, can help students control their thinking or learning processes [31,32].

The metacognition level of subject ST and SY shows a reflection activity in solving problems. So, two subjects laid the level of reflective use. This is related to the grading of Swartz and Perkins' ranking [24]. The existence of imperfections in reflection activities carried out by subject SY in solving integrated mathematics problems indicates her level of semi-reflective use [27]. Reflection activities carried out by subject SY in this study also differ from previous studies' results. Subject SY reflects during and after solving problems. The previous research stated that students reflect when solving problems at the level of semi-reflective use [21]. Students tend to reflect on the completion steps they have taken. Meanwhile, according to Laurens, at the semi-reflective use level, students tend to check the truth of the final results [27].

Additionally, there is a different indicator from previous research [18,20–24,27]. It appears in the results of the investigations in Table 2 (3) and Table 3 (3)-(4). Students use the law of inheritance to determine the size of the triangular sides of the inherited land. The student stated that the amount of land inherited by sons is twice as large as that of daughters. Students obtain information about the law of inheritance from the modules they read. It indicates that students use integrated knowledge to create strategies in solving Islamic-integrated

mathematics problems. This indicator is important because using the right strategy will determine success in solving problems [33]. Furthermore, integrated mathematics problems can instill the seeds of faith, purity, and noble character and provide new challenges for students. This argument is encouraged by Cozza & Oreshkina, which state that challenging assignments are one of the conditions that make students more reflective and more metacognitive [34]. In addition, non-routine questions are the main thing to solve various problems in the real world [34,35,36].

Another finding in this study is that the metacognition level of the subject in solving Islamic-integrated mathematics problems reached the level of reflective use. This finding aligns with previous research [23,24]. In contrast, this result is different from previous research that secondary school students only reach the level of strategic use in solving problems [20,22].

4. CONCLUSION

Based on the results and discussion, students' metacognition level in solving Islamic-integrated mathematics problems reaches the level of semi-reflective use and reflective use. Students achieve this level with mathematical abilities in the high category. The characteristics of the students' metacognition are: 1) affirming what to ask and what is known in the question completely and correctly 2) using inheritance law as a strategy in solving problems 3) checking the calculations and methods used and using more than one method 4) re-checking the results of the work 5) thinking about various ways and the results obtained 6) thinking of another way to solve the problem, and 7) determining the most effective way to solve the problem. There is a difference in checking between subjects at semi-reflective use and a subjects at reflective use. A subject at the level of semi-reflective use checks during and after solving the problem. While a subject at the level of reflective use checks before, during, and after solving the problem.

AUTHORS' CONTRIBUTIONS

All authors conceived and designed this study. All authors contributed to the process of revising the manuscript, and in the end, all authors have approved the final version of this manuscript.

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