Students’ metacognition process in solving contextual problems based on gender

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Abstract. The purpose of this study is to describe the student’s metacognition process in solving contextual problems based on gender. The subjects in this study consisted of one male student and one female student. The research location is in SMPN 23 Surakarta. The results of this study showed that at the planning stages, male student has been able to identify what is known and what is being asked and being able to choose and believing the strategy. In the monitoring stage, male student didn’t monitor the constructions or calculations and didn’t believe the truth. In evaluating stage, male student didn’t recheck the suitability of the results, didn’t recheck to the work steps and the calculation, didn’t believe the truth of the result. In the planning stage, female student has been able to identify what was known and what was asked, but didn’t believe the strategy chosen. In the monitoring stage, female student didn’t monitor the step of completion and sustainability strategy that has been planned and didn’t believe the truth. At the evaluating stage, female student didn’t check the compatibility of the answers and didn’t recheck every work and didn’t believe in the correctness.

1. Introduction

4.0 industrial era, as recently, brings many changes and benefits for human life. Lots of easiness resulted from the era development that permeates all aspects of life. But it cannot be denied, new problems are also emerging. Many definitions of what a problem is. Problem can be defined as a difficulty which should be overcome or a newly encountered and complicated issue requiring mental focusing which an individual cannot predict how to find a solution about it at first [1]. Silver said that a problem is a situation in which a goal is to be achieved but the direct route to attain the goal is blocked [2]. Polya defines the problem solving as finding a way around a difficulty or an obstacle a solution that is unknown [3]. It needs an action to resolve the problems. This action requires a problem-solving skills that must be developed since early-age through school education. It is expected to develop and shape students into individuals who are capable of facing any problems in the future.

One subject matter that can be used to practice problem-solving skills is mathematics. According Cockroft, mathematics should be taught to the students because of is always used in all facets of life, all areas of life require the appropriate mathematical skills, is a powerful means of communication, concise, and clear, can be used to present information in a variety of ways, and give satisfaction to attempt to solve a challenging problem [4]. Considering the importance of problem-solving ability, the students should try to master it. But the fact shows that there are students who have not been able to master. Based on interviews with teachers where researchers conducted the study, most students are...
still have difficulties in solving mathematical problem-solving. There are students who just stopped in the middle of working on the problem, even some can not work at all. These difficulties one can be caused by metacognition students who have not good yet. Schoenfeld said that metacognition as capabilities that allow troubleshooters to breakdown the problem into sub-problems, solve sub-problems and eventually resolve the original problem [5]. Student problem-solving difficulties do not always stem from a lack of mathematical knowledge, but rather from ineffective activation of their knowledge, since they lack the metacognitive skills needed to control, monitor, and reflect on the solution processes[6]. Based on that, in other words, the lack of metacognitive skills can also affect problem solving abilities.

Metacognition is a skill that is needed to be mastered by students in the modern era and competitive as it is today. Developing metacognition is necessary for academic achievement [7]. Metacognition can reinforce the ability of students to become better problem solvers, because metacognitive strategies support the efforts during problem solving [8]. Metacognitive experience directly affected mathematical problem-solving performance [9]. Flavell defines metacognition as one's knowledge of their cognition and control and monitor one’s own cognition [10]. Metacognition itself has several components and experts have diverse definitions of the components. Demircioğlu said that metacognition can be broken down into two parts, namely "knowledge of cognition" and "organization of cognition". Knowledge of cognition is knowing your cognitive processes and others, the structure of cognition, function, what we / they know and what we / they do not know, etc. Organization of cognition is the ability to use metacognitive knowledge to achieve the goal of cognitive [11]. Taccaisu mention metacognition is part of the planning, monitoring, and evaluating the learning process as well as awareness and control of the learning process [12].

Problem solving and metacognition are interrelated. Metacognition has positive influence to the mathematical problem solving [13]. The use metacognition strategies will affect the students’ performance in the problem solving process. Students can use procedure reflection to plan and monitor the procedure and assessment to plan how to find a solution [14]. Vrugt & Oort said that students who often use metacognition strategies perform better and vice versa [15]. The metacognition processes involved in solving problem are planning, monitoring, and evaluating [16]. Planning refers to selection of strategies and allocation of resources; monitoring describes the ability to track one’s comprehension and/or accuracy of performance as the task is carried out; evaluating refers to the ability to critically assess the outcomes and processes of one’s learning or problem-solving [17]. Based on this, metacognition when solving problems can be analyzed through its components, namely planning, monitoring, and evaluating.

There are many types of problems solving of mathematical problems, one of which is a contextual problem. Contextual problem is a problem that corresponds to the situation experienced by students, correspond to their real life and close to the student [18]. Contextual math problem is a mathematical problem related to objects, events, facts or concepts that are well known to someone so that he can generate the knowledge about the issue in its own working methods. The use of the test questions to students based on the context need to be reproduced. Contextual problem solving trains students to always involve their metacognitive abilities starting from the beginning to the end of problem solving as a formulation of answers and evaluating to ensure the achievement of objectives related to the contextual situation of the problem being solved [19]. Gender differences in problem solving are also noteworthy. Gender is an attribute associated with a person's sex, including roles, behaviors, preferences that describe masculinity or femininity in a particular cultural context [20]. In this research, gender is defined as person sex only, male and female. Results of the previous study revealed that in solving problems of female students performed better than male [21]. In other side, Gong, He & Evans said that males and females might demonstrate the same cognitive performance but mentally they were actually gone through different information processing paths[22]. In some previous research, it was seen that a significant difference between metacognitive competencies and the gender was emerged [23]. But there are studies [24] say that there is no significant difference in the metacognitive awareness based on their gender. This difference is certainly influenced by other
variables or the sample used or other factors. This research will try to use gender as a review variable in describing the process of metacognition.

Based on the description above, the purpose of this study are: (1) describe the metacognition process of male students in overcoming contextual problem; (2) describe the metacognition process of female students in overcoming contextual problem.

2. Research Methods
This study is a qualitative research. This research intends to describe the students' metacognition in solving contextual problems. The subject selection is done by purposive sampling technique. Researchers chose the subject based on the consideration of the teacher in class VIII, in which the selected subjects were those who have a good communication skills and able to express their opinions clearly. Subjects consisted of two eighth grade students, one male and one female, of the academic year 2019/2020. The research located in SMP Negeri 23 Surakarta, Central Java.

Data collection techniques in this study using test and interview. The test instrument used is a problem or question of contextual problems solving. The use of the test is intended to obtain data on the student’s work in solving contextual problem-solving. In addition, data collection is assisted with interview to dig deeper into students' metacognition in solving contextual mathematics problem-solving. The questions of the interview in this study are based on the metacognition indicators (planning, monitoring, and evaluating). The data analysis techniques used is a model of Miles and Huberman. Step-by-step analysis of Miles and Huberman model data are data reduction, data display and conclusion drawing / verification.

3. Results and Discussion
3.1. Metacognition Process of Male Student

Here is presented the figures of male student’s work for number 1.

![Figure 1](image1.png)

**Figure 1.** The work of S1 for number 1

![Figure 2](image2.png)

**Figure 2.** The work of S1 for number 2

At the planning stage, it can be seen at figure 1 and figure 2, that the S1 has been able to write what is known and what is asked appropriately, S1 also try to work with initially looking for the length of the rhombus side. To dig deeper into the process of metacognition, the researchers conducted interviews to S1. When asked about what is known and what is asked, the students were able to explain it well. S1 is also able to explain and justify the selected strategy that is used, although there
are still an inappropriate one. Based on the interview and test results, the planning stage S1 has been able to identify what is known and what is asked and able to choose a strategy that will be used, and sure about the correctness of the chosen strategy.

In the monitoring stage, it appears that S1 using Pythagorean formula to find the length of the diagonal of a rhombus or in terms of a representation of parts of the pond. However, it can be seen that there had been an error in its calculations. S1 wrong in entering figures into the formula. It is in accordance with previous studies which states that when calculating students are less careful [25] and make an inaccurate calculation [26]. Supposedly 25 is the length of c (the hypotenuse). Being asked whether the student monitored every step he did, S1 say no. S1 only perform calculations without checking whether the numbers entered into the formula are correct. Based on the interview, for question number 1 in figure 1, S1 has not been convinced that the calculations are correct. However, S1 has not been able to reveal what should be the means used to solve the problem number 1.

For question number 2 in figure 2, strategies that students use in the initial stages is correct, but there is a mistake when calculate the profit from the sale of chicken noodle each month. S1 calculates or looks for the monthly profit amount by dividing 1,500,000 by 4. Even though the monthly profit should be obtained by multiplying 1,500,000 by 4. Based on the interviews, it is known that the S1 was again not checking or monitoring the progress of each step. Students also feel that the concepts he uses when calculating are correct. From that fact, it shows that there is still a misconception in students when calculating profits each month. Consequently S1 did not realize that there are errors in the calculating process. This is in accordance with previous studies [27] which revealed that the willingness to overcome individual barriers during problem solving left them searching for alternative solutions, but new problems and misconceptions kept rising from their attempts. Unconsciousness that there is a misconception from the calculation done will make the next work even wrong. Monitoring needs to be done so that we are aware of errors at an early stage so that it does not make the results of our work go wrong too. From the results of the tests and interviews, at the monitoring stage, S1 did not monitor each step of the work or the calculation done, so they were not sure whether the process and the calculation is correct or incorrect.

At the evaluating stage for the number 1, S1 did not recheck the steps of the problem solving from the beginning to the end and did not check the compatibility of the answers to the question. So, S1 did not realize the mistake in concluding the final results he got. It appear in Figure 1, that S1 uses the result of the formula of Pythagoras as the length of the path. Whereas it should be the result of the calculation is the diagonal length of the rhombus fish pond. When asked about the answer, S1 said that they still in doubt whether the answers are correct because S1 is not believing the truth of the calculation process. However S1 believes that the strategy used is correct. While the results of the work in question number 2 (figure 2), S1 also did not reexamine the steps of the problem solving. Although, tragically, the solution finding was appropriate but S1 is not aware that there is an error in the counting process. Thus, at the stage of evaluating, S1 did not recheck the compatibility of the final result to the question, did not recheck the steps of work steps and the calculation process done, and was not sure with the final results obtained. From this we can know that when the evaluation is not carried out we consequently do not know whether there is an error in the results of the work, both in planning and implementing and drawing conclusions. It could be what we thought was right at first, but the strategy we used or the calculations we did were not completely correct or there were errors. Evaluation enables students to evaluate their performance on the task, students can compare their performances with each other and they can use the result of comparison to locate the error in the solution process [28]. So, evaluation is needed to determine whether what we have done in accordance with the goals we want to achieve or is already the right solution for the problem itself. Evaluation will also be a way to measure the effectiveness of the problem solving strategies used and as a benchmark to improve our performance in solving other problems.
3.2. Metacognition Process of Female Student

At the planning stage, based on the image of student work in figure 1 and figure 2, either number 1 or number 2 has been able to write what is known and what is being asked correctly. At the time of the interview S2 had been able to explain well. However, when asked about the strategies used when solving number 1, S2 do not know what strategy and what formula was needed to resolve the problems. These results are in accordance with previous studies [29] which reveals that when solving problems there are students who do not even know the algorithm and steps to resolve the problem. As for question number 2, S2 is able to figure out the strategy that should be used and be able to explain when interviewed by researcher. So, at the planning stage, S2 has been able to identify what is known and what is being asked, but did not believe the strategy that she chose.

In the monitoring stage, based on interviews, S2 did not monitored at each step of the process, both the number 1 and number 2. It has an impact on the process of counting the error number 2. It is seen that S2 has not changed the amount of profit earn into the daily unit. S2 uses monthly profit to deduct the total income of the chicken noodle seller per day. This indicates that the inaccuracy caused by not doing monitoring the implementation of the strategy at each step of work. Consequently S2 did not realize that there was a miscalculation that has occurred. Thus, at the stage of monitoring, as well as S1, S2 also did not monitor every step of the completion and continuity of the planned strategy and did not believe in its truthfulness. In the evaluation stage, S2 did not check or inspection correspondence between answers to questions. S2 also did not recheck each of work done. In other words, student did not evaluate his own work. This is consistent with previous research [30] which said that students do not evaluate their thought processes and do not recheck the solutions obtained.

It appears that the process of metacognition in female students is not much different from male students. Both male and female student did not recheck the work steps and also did not evaluate. In this study, male student seemed more willing to take action than female student. This is consistent with research [31] that says that at the same levels of observed abilities, girls' mathematics abilities beliefs under challenges are markedly lower than those of boys. Apart from metacognition, this might be influenced by other factors that need to be studied further in future research.
4. Conclusion
Based on the results, several conclusions can be drawn about students' metacognition when solving a math contextual problem as follows. In the planning stages, the male student has been able to identify what is known and what is being asked and being able to choose a strategy that will be used and believing the truth of the chosen strategy. In the monitoring stage, did not conduct monitoring of every step of construction or calculation and did not believe the truth. In the evaluating stage, the male students did not recheck the suitability between the final results with the question, did not recheck to the work steps and the calculation process done, of workmanship and the counting process is done, did not believe the truth of the final result obtained. Metacognition of female students in the planning stage has been able to identify what was known and what was asked but did not believe the strategy chosen. In the monitoring stage, female students did not conduct monitoring at every step of the completion and sustainability strategy that has been planned and did not believe the truth. Then, at the evaluating stage, the female student did not check or inspection the compatibility of the answers to questions and did not recheck every work done and did not believe in the correctness of their work.

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