Metacognitive ability of male students: difference impulsive-reflective cognitive style

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Abstract. This study revealed the metacognitive activity of male students in impulsive cognitive and reflective cognitive style in solving mathematical problems, especially in the material of plane. One student of impulsive cognitive style and one student of reflective cognitive style were selected to be the subjects of the study. Data were collected by giving written test of problem solving and interview. Data analysis was done through data reduction, data presentation, data interpretation and conclusion. The results showed that male student of reflective cognitive style was meticulous and careful in solving the problem so as to obtain correct answers, while the impulsive cognitive style student had the characteristics of using a short time in solving the problem, but less careful so that the answers tended to be wrong.

1. Introduction

Problem-solving skill can be obtained by providing opportunities for students to apply metacognitive strategies: when solving the given problem [1]. Besides having to beliefs in problem solving, students must also have the metacognitive skill to be successful in solving the problem [2-3]. Students need to manage their minds well by applying their knowledge, controlling and reflecting process of their own thinking results because what is thought can help solve the problem [4-5]. Awareness of this thought process is called metacognitive. Students who are skilled in metacognitive can know and be aware of their own strengths and weaknesses. They who are skilled in metacognitive will be able to measure themselves so that when they are conscious of their abilities they will do strategically better than those who are indifferent to the workings of their own mental systems. Metacognitive concerned with optimizing the students' skills in problem solving [6], the activities to regulate and monitor human learning [7]. In principle, the efforts involving metacognitive in various learning activities are expected to provide benefits to improve the quality of learning that is implemented. Related to learning mathematics, metacognitive has a role to help students solve the existing problems. How the students controls what they have done, the problems that they have done, and how well they use the observation result to solve the problem. It means that students’ metacognitive can be a benchmark of students' ability in solving math problems. This is very important because there is a significant relationship between metacognitive and academic skills [8], where in the different academic abilities either ability of high, medium or low is influenced by metacognitive activities undertaken.

Metacognitive activities in solving mathematical problems consist of (1) planning, (2) monitoring, and (3) reflection [9]. The implementation of these three metacognitive activities is largely determined by the students' awareness of the knowledge they possess in relation to the problem solved and how to manage the awareness in solving the problem. Students' ability to solve mathematical problems is also
influenced by cognitive styles, such as reflective and impulsive cognitive styles. Student who have characteristics using a long time to answer the problem, but carefully or thoroughly so that the answers given tend to be correct, are called a person with reflective cognitive style, while student who have characteristics using a short time to solve problems, but less carefully so that answers tend to be wrong, are called a person with impulsive cognitive style [10]. Two important aspects are taken in measuring reflective and impulsive cognitive styles: the amount of time required and the accuracy of the answers. The time aspect is divided into two namely the short and the long, and the accuracy of the answers are differentiated to be accurate and inaccurate. Thus, the students can be grouped into four: groups of students who use short time in answering and the answers given are accurate, group of students using short time in answering but inaccurate (impulsive), a group of students who use a long time in answering but the answer provided is accurate (reflective), and a group of students who use a long time in answering and the answer given is not accurate [11].

Gender differences also allow their influence in the achievement of learning outcomes [12-14]. Male and female have different preferences in the use of problem-solving strategies [14]. Further Geary, Saults and Liu [12] believe that the influence of gender factors in mathematics is due to the biological differences in the brains of boys and girls, where girls are generally superior in the field of language and writing, while boys are superior in mathematics because of better spatial abilities. Based on the description, the aim of this study was to know the profile of metacognitive activity of male students in solving mathematical problems in terms of cognitive style.

2. Methods

The subjects of the study were chosen purposively from the fourth semester students of Mathematics Education, Universitas PGRI Semarang academic year 2016/2017 that had mastered the rectangular plane. The students were given five description tests within 30 minutes. Students are categorized reflective if $t > 15.5$ minutes and $f < 3$ questions and were categorized impulsive if $t \leq 15.5$ minutes and $f \geq 3$ questions. The selection of research subjects was based on test results, then students who were able to communicate their ideas both orally and in writing were selected. The research subjects is presented in Table 1.

| No | Name               | Code | Gender | Cognitive style |
|----|--------------------|------|--------|-----------------|
| 1  | Ahmad Haris        | S-AH | Male   | Reflective      |
| 2  | Muhammad Nur Arifin| S-MN | Male   | Impulsive       |

After the subjects of research were chosen, a written test to obtain data of metacognitive ability of students in solving mathematical problems was then performed. This written test was conducted at different time and place on each subject. The interview was conducted to verify the data of problem solving test result and got clearer information about the students metacognitive in solving the plane problem that could not be expressed in writing. Data analysis in this research included: reducing, presenting in the form of descriptive, and concluding metacognitive students in solving plane problem. Implementation of the written test and interview was documented by handy came camera. It was intended that all matters relating to research could be recorded properly. To maintain credibility and dependability, the researcher performed audit technique, did focus group discussion, and performed time triangulation namely comparing research data from the first instrument and research data from second instrument; the data collection was carried out at different times [15].

3. Result and Discussion

3.1. Analysis of male students’ metacognitive abilities with reflective cognitive styles
Subject S-AH is capable to prepare the action plan done by trying to realize the process of thinking when identifying information in the problem, so that the subject able to interpret the problem well. It can be seen with the existence of the known things and things that were asked from the problem written correctly, and the writing of the completion plan that was seen from the mathematical model created by the students namely rhombus. The subject write down what was known namely the distance of city A to city B, in the middle of city A and B there was city O, distance CD, AB \perp CD and the route taken. The answers of the subjects are presented in Figure 1 and Figure 2.

**Figure 1.** Answers S-AH about planning

Subject S-AH is capable to implement the plan of Pythagoras and rhombus including checking every step of the solution, whether the steps were correct or it could be proven that the step was correct. It can be seen through the writing of the strategies used in solving the problem and compare the results of his work with the information known and checking each step. The subject’s answer of finding the distance of city A to city C using Pythagoras formula and calculating the distance traveled is 48 km.

**Figure 2.** Answers S-AH about monitoring

The subject give an explanation of the strategy used in solving the problem. The subject is able to provide arguments that supported his thought, and he shows that each step was correct and examine the calculation correctly. The interview result is as follows:

Q-10  Is every step that you have done systematically and appropriately?
S-AH  Yes, it is
Q-11  How do you show that every step you take is right?
S-AH  Knowing what distance, AB and CD are perpendicular and in the middle of it there is city O. After that drawn straight line A to C and D continue B to C and D forming rhombus. The rhombus has same sides. To be able to find the side of the sloping side, use Pythagoras formula. Answering the problem should be one by one from A to O, C to O, O to D, B to O and the last from O to A, then sum it all up.

Subject S-AH did not experience an error in the evaluation stage. It was seen on the answer that subject S-AH wrote "so the distance traveled is 48 km." It refers to the objectives to be achieved appropriately, evaluate the result of implementing a strategy based on efficient criteria and effectiveness. The subject's answer can be seen in the picture.
Based on data analysis of the first instrument and second instrument, subject S-AH can perform metacognitive activity well without any error. Data on the conclusion of male students’ metacognitive ability with reflective cognitive style in solving plane problems can be seen in Table 2.

### Table 2. Metacognitive ability of male students with reflective cognitive style

| Metacognitive Activities | Metacognitive Ability |
|-------------------------|-----------------------|
| Planning                | Realizing what is known, asked, define purpose, obtain something useful from data, determine the relationship between data and question, get plan, get problem solving plan and can connect with a concept. |
|                         | Realizing the completion chosen is correct, performing a steady step, being able to remember important information, setting the results, controlling the possibility of error in step, checking the accuracy of the calculation step by step and analysis of the conformity of results and the achievement of goals. |
| Monitoring              | Re-examining the work, recognizing the shortcomings that have been done, checking the correctness of the results, and believing himself that the evaluation is correct. |
| Evaluation              |                       |

3.2. Analysis of male students’ metacognitive abilities with impulsive cognitive style

Subject S-MN did not experience an error in planning stage. It was seen on the answer that subject S-MN is capable to prepare the action plan by trying to realize the process of thinking when identifying information in the problem, so that the subject was able to interpret the problem well. It can be seen with the writing of the known things and the things that were asked from the problem written correctly, and the writing of the completion plan was seen from the mathematical model created by the students namely rhombus. It was known that distance A to B was 16 km, AB \( \perp \) CD, O was in the middle AB, and distance C to D was 12 km, the matter asked was \( S_{\text{tot}} \) (total distance), that shown in Figure 3 and Figure 4.

![Figure 3. Answers S-MN about planning](image)

Subject S-MN has an error in monitoring stage. It can be seen in the answer the subject S-MN. He is able to carry out the plan including checking every step of the solution, but the subject did realize that there was a miscalculation. This can be seen from the writing of the strategies used in solving the problem and compare the results of his work with the information known and checking of each step. In checking the steps, the subject did not realize there was a calculation error, that is the length OD was 12 when the correct was 6. It caused the wrong answer at the final answer. Subject write 54 km when the correct was 48 km.
Figure 4. Answers S-MN about monitoring

Subject S-MN write "so the distance traveled is 54 km". It refers to the objective to be achieved inappropriately, did not re-check the correctness of the work, did not recognize errors and did not make correction on the mistakes. The subject give an explanation of the activity in reviewing the answers he wrote and the subject believes the results obtained are correct when there is a mistake in his job. The result of the interview is as follows.

Q-18 How do you relate between the concepts used in solving the problem?
S-MN Length of AD, AC, CB, DB is the same, two sides of the perpendicular are the same namely 6 km and 8 km. There are 4 right triangles using Pythagoras.

Q-19 Pay attention on the answer you have written, is there something that does not fit?
S-MN Let me check again. They fit all?
Q-20 Are you sure? Don’t you want to check again? Are you sure with all your heart?
S-MN I am sure. They are right.
Q-21 How is the conclusion of the solution of the story problem?
S-MN So the distance traveled by traders is 54 km
Q-22 Are you sure?
S-MN Sure, steady.

Based on the data analysis of the first instrument and the second instrument, the student' metacognitive ability with reflective cognitive style in solving plane problems can be seen in Table 3.

| Metacognitive Activity | Conclusion of Metacognitive Ability |
|------------------------|-------------------------------------|
| Planning               | Realizing of what is known, asked, define purpose, obtain something useful from data, determine the relationship between data with question, get plan, get problem solving plan and can connect with a concept. Lack of ability to use notation. |
| Monitoring             | Recognizing the chosen solution is correct, setting the outcome, checking the accuracy of the calculation step by step and analyzing the conformity of results with the achievement of the goal but not yet able to control the possibility of error. |
| Evaluation             | Re-checking the work, checking the correctness of the results, and believing that the evaluation is correct even though there is still a mistake. It does not recognize any calculation errors and does not make mistakes. |

It is clearly described in Table 4 that male students with reflective cognitive styles are consistently able to answer all the problems given with the correct final result because students could develop their metacognitive process well in accordance with the given problem. This is inversely proportional to the male student with impulsive cognitive abilities that have consistently not been able to answer all the problems given with the correct final result because they were unaware of errors and did not correct mistakes. Reflective students are more likely to perform tasks: (a) recalling structured information, (b)
reading by understanding and interpreting texts, and (c) solving problems and making decisions. The results were in accordance with the opinions of some researchers [5] who argued that a person's success in solving problems was also influenced by his metacognitive activity. Different results are shown by male students with impulsive cognitive abilities indicating that students in this category have problems in developing their metacognitive activity while solving problems so that some metacognitive capability indicators are expected to emerge not yet achieved well.

The results of this study reinforced the view [10] that cognitive-style students are reflective, meticulous and careful in solving problems so as to obtain correct answers, whereas cognitively impulsive-style students possessed the characteristics of using a short time to solve problems, but less carefully so that the answers tended wrong. The next responsibility is that educators should be able to facilitate students to learn math problems that not only emphasize on procedural ability so that students with reflective and impulsive cognitive abilities can practice to develop metacognitive ability in mathematical problem solving. Shanon [16] explained that at first the students had no idea of how they learned and what learning styles they had, shown in Table 4. However, after being introduced to learning using metacognitive strategies, they are interested in trying to do survey on their own learning styles by thinking about the outcomes of their thought process.

| Metacognitive Activities | Impulsive                                                                 | Reflective                                                                 | Difference                      |
|--------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------|
| Planning                 | Realizing of what is known, questioned, defining purpose, obtaining something useful from data, determining the relationship between data with question, getting plan, getting problem solving plan and can connect with a concept. | Realizing of what is known, asked, defining purpose, obtaining something useful from data, determining the relationship between data with question, getting plan, getting problem solving plan and can connect with a concept. | No difference                   |
| Monitoring               | Recognizing that the chosen solution is correct, setting the outcome, checking the accuracy of the calculation step by step and analyzing the conformity of results with the achievement of the goal but not yet able to control the possibility of error. | Realizing that the chosen solution is correct, performing a steady step, being able to remember important information, setting results, controlling the possibility of error in step, checking the accuracy of the calculation step by step and analysis of the conformity of results with the achievement of goals. | Impulsive male are unaware of mistakes. |
| Evaluation               | Re-checking the work, checking the correctness of the results, and believing that the evaluation is correct even though there is still a mistake. It does not recognize any calculation errors and does not make correction on mistakes. | Re-examine the work, recognize the shortcomings that have been done, check the truth of the results, and believe themselves that the evaluation is correct. | Impulsive male are unaware of mistakes and do not make correction on mistakes. |
4. Conclusion

Based on the discussion of the research results, it can be concluded as follows: (1) the metacognitive ability of male students with reflective cognitive style in solving the problem of plane was able to realize the thinking process well in planning, monitoring and evaluating. This leads to subjects with reflective cognitive abilities that were consistently capable of answering all the problems that are given with the correct final result even for a long time. (2) The metacognitive ability of male students with impulsive cognitive style in solving the problem of plane was not able to realize the process of thinking well. It caused that students with consistent impulsive cognitive ability with a short time have not been able to answer all the problems given has right final result.

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