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METACOGNITIVE SKILLS OF SENIOR HIGH SCHOOL STUDENTS' IN SOLVING WORD PROBLEMS BASED ON THE LEVEL OF MATHEMATICAL ABILITY

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Abstract

Metacognitive skills play an important role in problem solving. One part of the problem-solving exercises is solving word problems. Students need appropriate steps and strategies to solve word problems. In many cases, each student employes different strategy in solving word problem. This is because the difference of mathematical ability. This research is a qualitative research with interview-based test method that aims to describe the metacognitive skills of high school students in solving word problems based on the level of mathematical ability. The subjects in this research consisted of three students comprising one student with high mathematical ability, one student with medium mathematical ability, and one student with low mathematical ability. Based on the results of research, the most frequent metacognitive skills in solving word problem shown by student with high mathematical ability. At each stage of solving word problems, student of high mathematical ability is able to demonstrate metacognitive skills for all three stages: planning, monitoring, and evaluating. While the student with medium mathematical ability and low mathematical ability are not able to demonstrate the evaluating of metacognitive skills at the stage of devising a plan and carrying out the plan. More over, student with low mathematical ability also not able to demonstrate the monitoring at the stage of looking back.

Keywords: Metacognitive Skills, Word Problem, Mathematical Ability

INTRODUCTION

Mathematics is a science that has important roles in various aspects of life. Many problems and our activities in daily life are solved using mathematical sciences like counting, measuring, and others. The importance of mathematics can be seen in the educational system of Indonesia in which mathematics is taught in all levels of formal education, from elementary education to higher education. There are some benefits obtained by students when they are following mathematical learning. Therefore, it is important for teachers to convey the objectives of mathematical learning at the beginning of learning so that students can understand the benefits gained and what they will learn. One of the objectives of mathematical learning according to the National Council of Teachers of Mathematics (2000) and Curriculum 2013 is learning to solve problems. Thus, problem solving becomes a demand that must be mastered by students in learning mathematics.

In problem solving, students will face problems that they never encountered before. It can train students to think and use their knowledges and skills to solve problems. The thinking process of students in solving mathematical problems is an important thing that needs to get the attention of educators, especially in terms of helping students to develop problem-solving skills. Lester (in Gartman and Freiberg, 1993) states that the primary goal of teaching problem solving in mathematics is not only to equip students with a set of skills or processes, but rather to enable students to think about what they think. The ability of one's thinking about what he thinks is often known as metacognition.

The term metacognition was first introduced by Flavell (1976),

> "Metacognition refers to one's knowledge concerning one's own cognitive processes and products or anything related to them, e.g., the learning-relevant properties of information or data".

Metacognition can help someone look at himself and ponder his thinking process so that what he did can be optimally controlled. Metacognition has a close association with one's cognition. If metacognition is understood as the knowledge of one's self-instructions to regulate the performance of a task, then cognition is their vehicle for self-instructions. For example, a teacher asks students to add up six numbers. Students will use their cognitions to add up the six numbers and they use their metacognitions to think of the addition process. McLoughlin and Hollingworth (2001) show that effective

problem solving can be obtained by allowing students to apply their metacognitive strategies when solving problems. Metacognitive strategies refer to a person's way of increasing awareness of thinking and learning process so that if the awareness manifests, then metacognitive skills will arise.

According to Flavell (1976), "Metacognitive skills refer to the procedural knowledge that is required for the actual regulation of, and control over, one's learning performances". While Chairani (2016: 89) states there are three components of metacognitive skills, namely planning, monitoring, and evaluating. Furthermore, Chairani revealed three indicators related to metacognitive skills, namely:

1. Awareness in planning at every stage of problem solving by connecting the various knowledge they have to choose a strategy that fits the purpose of cognition.
2. Awareness in monitoring at every stage of problem solving.
3. Awareness in evaluating at every stage of problem solving.

In general, metacognitive skills can be defined as a person's awareness in planning, monitoring, and evaluating of his thoughts at every stage of problem-solving. Metacognitive skills can help students to organize, monitor, and direct their learning processes individually. However, based on the results of research conducted by Garcia, et.al. (2015), the metacognitive skills are shown by students during solving mathematical problems are lacking. This is in accordance with Hartman's opinion (2001) which states that many students have academic difficulties because they focus continuously on the subject content without learning about the metacognitive skills necessary to support their efforts. The lack of metacognitive skills is reasonable because the skills are not explicitly taught and not everyone can develops them individually.

Students need to think more when solving mathematical problems so that students should first be given the exercise of word problems that require a deeper understanding of the meaning. Word problems are a mathematical question presented in the form of sentences related to daily life. Students need the ability of understanding the problem in solving word problem, starting from knowing about what is known, what is asked, what is the required information, and how to solve the problem. There are four steps to solve word problems based on Polya (1973), i.e. understanding the problem, devising a plan, carrying out the plan, and looking back. Solving word problem is a part of the practice of solving mathematical problems so that students also need appropriate steps and strategies for solving word problem. In this case, metacognitive skills are necessary.

Steps and strategies used by students in solving word problems are not same among students with one another. One possible cause is the difference of mathematical ability. Mathematical ability is the ability of students in solving mathematical problems which is shown by a mathematics score. According to research conducted by Nurman (2008), the mathematical abilities of students influence the abilities of solving mathematical problem. Based on the results of that research can be stated that each student has a different thinking process or strategy in solving problems due to differences in the level of mathematical ability possessed by students. Seeing the role of metacognitive skills of students in problem solving, the researchers interested in conducting research to describe the metacognitive skills of high school students' in solving word problems based on the level of mathematical ability. The material used in this research is linear programming related to its application in daily life because linear programming can be solved by some method and require various steps of solution so hopefully the researcher can more easy to describe metacognitive skills of student.

METHOD

This research is a qualitative research, aims to describe the metacognitive skills of students in solving word problems based on the level of mathematical ability. This research was conducted in SMA N 8 Surabaya in the even semester of academic year 2016-2017. The subjects of the study consisted of three students of XI grade, i.e. one student with high mathematical ability, one student with medium mathematical ability, and one student with low mathematical ability.

The instruments used in this research consists of the main instrument that is the researchers while the supporting instruments that are mathematical ability test, word problem test, and interview guide. The material used in this study is linear programming. The aim of the test is to know the steps of students in solving word problems, while the aim of the interview is to know the involvement of metacognitive skills of students that cannot be known through the test.

Data analysis will implement to the result of mathematics ability test, the result of word problem test and interview result. The results of the mathematical ability test were analyzed by grouping the students into categories of students' mathematical ability level. The grouping of these capabilities refers to the rating scale according to Ratumanan and Laurens (2011).

Table 1. Categories of Mathematical Ability Level

The Level of Mathematical Ability	Score Range
High	80-100
Medium	60-80
Low	0-80

The results of word problem tests are analyzed in accordance with the metacognitive skills of students in solving word problem and the steps of word problem solving. While the results of interviews are analyzed through three stages, namely data reduction, data presentation, and conclusion.

RESULT AND DISCUSSION

Based on the scores of mathematical ability test and consultation with partner teachers, then the selected subjects of research are presented in the following table

Table 2. The Subjects

No.	Name Code	Score	Mathematical Ability
1.	ST	85	High
2.	SS	79	Medium
3.	SR	20	Low

Here are the results of research and data analysis of students' metacognitive skills in solving word problems.

1. Subject With High Mathematical Ability (ST)

At the stage of understanding the problem, ST thinks about how to understand the problem and the prerequisite concepts used to understand the problem. ST is aware of the reasons for writing known data and what is asked. ST thinks the compatibility and checks the prerequisite concepts are used to understand the problem. ST checks how his understanding of the problem.

At the stage of devising a plan, ST thinks about the relationship between the known data and what is asked, the benefits of the known data, and the plan to be used in problem solving. ST monitors every step of the plan being made and how compatible it is to be used in solving the problem. ST checks the correctness of the plan to use in problem solving. ST believes that the plans and the steps are correct and compatible to use in solving the problem.

At the stage of carrying out the plan, ST thinks of what the first step is to implement the plan and how to implement the plan. ST monitors and controls the implementation of each step of the solution plan carefully to avoid mistakes. ST checks the correctness of solution steps and compatibility with the previous plan has been made.

At the stage of looking back, ST thinks about how to checks the correctness of the solution and what needs to be checked. ST recognizes the lack of understanding. ST believes that the evaluation has been done correctly and the results of the solution is correct and matchs with the meaning of question.

Based on the description above, ST demonstrates metacognitive skills include planning, monitoring, and evaluating at each stage of word problem solution stages starting from understanding the problem, devising a plan, carrying out the plan, and looking back. In addition, ST has good plans and then monitor what was already planned so that can minimize mistakes at the moment of working process. ST ensures or evaluates his thinking process about what has done it correct. ST is also able to solve the word problem correctly.

2. Subject With Medium Mathematical Ability (SS)

At the stage of understanding the problem, SS thinks about how to understand the problem and the prerequisite concepts used to understand the problem. SS is aware the reasons for writing known data and what is asked. SS thinks the compatibility and checks the prerequisite concepts are used to understand the problem. However, the prerequisite concepts that SS think is less appropriate to be used in understanding the problem. SS also check how his understanding of the problem.

At the stage of devising a plan, SS thinks about the relationship between the known data and what is asked, the benefits of the known data, and the plan to be used in problem solving. SS monitors every step of the plan being made and how compatible it is to be used in solving the problem. SS checks the correctness of the plan to use in problem solving. SS believes that the plans and the steps are correct and compatible for use in solving the problem. But SS do not check how the truth of the plan he had made to use in solving the problem.

At the stage of carrying out the plan, SS thinks of what the first step is to implement the plan and how to implement the plan. SS monitors and controls the implementation of each step of the solution plan carefully to avoid mistakes. SS does not check the correctness of solution steps and compatibility with the previous plan has been made. The solution is an incorrect solution.

At the stage of looking back, SS thinks about how to checks the correctness of the solution and what needs to be checked. SS recognizes the lack of understanding and carrying out the plan. SS thinks the compatibility of the results with the meaning of question but SS is not sure whether the solution has been done correctly.

Based on the description above, SS demonstrates metacognitive skills of planning, monitoring, and evaluating at the stage of understanding the problem and looking back. Whereas at the stage of devising a plan and carrying out the plan, SS does not show any evaluation activity. In addition, SS has good plans but he is often confuse when monitor what planned so it makes a fault at the moment of the working process. In evaluating his own thinking process, the subject is capable to recognize his shortcoming and asks what has done it correct. Overall the subject is good in planning.

3. Subject With Low Mathematical Ability (SR)

At the stage of understanding the problem, SR thinks about how to understand the problem but SR doesn't think the prerequisite concepts used to understand the problem. SR is aware of the reasons for writing known data and what is asked. SR also check how his understanding of the problem.

At the stage of devising a plan, SR thinks the benefits of the known data and the plan to be used in problem solving. SR monitors every step of the plan being made and how appropriate it is to be used in solving the problem. SR does not check the correctness of the plan to use in problem solving. SR believes that the plans and considers the plan is incorrect plan.

At the stage of carrying out the plan, SR thinks of what the first step is to implement the plan and how to implement the plan. SR monitors and controls the implementation of each step of the solution plan carefully to avoid mistakes. SR does not check the correctness of solution steps and compatibility with the previous plan has been made.

At the stage of looking back, SR thinks about how to checks the correctness of the solution and what needs to be checked. SR does not believe if the evaluation has been done is correct. SR thinks about the compatibility of the result with the meaning of question, but according to him the compatibility of the result he obtained with the meaning of question is not compatible.

Based on the description above, SR demonstrates metacognitive skills of planning, monitoring and evaluating at understanding the problem stage. Whereas at the stage of devising a plan and carrying out the plan, SR does not show evaluation activities. And at looking back stage, SR does not show monitoring activities. In addition, SR has not good plan that can help him for solving the given problem. SR reveals, he does monitoring and evaluating but not convinced of what he has done. So the awaraness of SR to his own thinking process is still low.

CONCLUSION

Based on the analysis of research data, we can draw the following conclusion. Student with high mathematical ability demonstrates metacognitive skills include planning, monitoring, and evaluating at each stage of solving word problems. Student with high mathematical ability has good plans, able to monitor what was already planned so that can minimize mistakes, and evaluates his thinking process. Meanwhile, student with medium mathematical ability and low mathematical ability are not able to demonstrate the evaluating at the stage of devising a plan and carrying out the plan. More over, student with low mathematical ability also not able to demonstrate the monitoring at the stage of looking back. Student with medium mathematical ability has good plans but he is often confuse when monitor what planned so it causes him for making mistakes. In evaluating his own thinking process, the student is capable to recognize his shortcoming. Student with low mathematical ability is not able to make a good plan that can help him for solving the given problem. The student reveals, he does monitoring and evaluating but not convinced of what he has done. So the awaraness of student to his own thinking process is still low. Based on the above description, it appears that the three students show metacognitive skills but the form and frequency of metacognition activities demonstrated differently. This shows that the difference in students' mathematical ability can influence the students' metacognitive skills in solving word problem.

SUGGESTION

Based on the results of research, researchers give some suggestions as follows.

1. All students from each category actually have the potential to solve the given problem correctly if they can use their metacognitive skills well. However, students with low mathematical ability should be given special attention in the learning process in order to develop and explore their metacognitive skills well. It means that, teachers should begin to involve metacognitive skills in mathematics learning.
2. For other researchers who will conduct similar research to this one expected, it is conduct detailed and in-depth interviews, because if the interview is not detail and deep, then the researcher will find difficulties to describe the involvement of students' metacognitive skills in solving word problem. In addition, it is better not to use material that has long been taught to students for research.

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