PROCEEDING ISBN : 978 – 979 – 16353 – 7 – 0

P – 37

The Metacognitive Process Of Teachers College Students In Solving Mathematical Problems

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ABSTRACT

The metacognition process is the self-awareness and self-regulation of thinking during solving problems activity. It is based on a strong understanding to the problem being addressed. This is important in order to make the activity run smoothly. This research is a qualitative research which is aimed to investigate the metacognition process of teachers college students for solving formal and contextual mathematical problems. The data collection was conducted through problem solving activities such as written tasks, thinking aloud, and interviews. The data obtained were triangulated by assigning parallel newly problems to be solved at different times. The results of this research are (1) the metacognition process in solving the contextual mathematical problems is apparently more dynamic and the frequency of metacognitive activity implementation is higher than in solving formal mathematical problems, (2) this difference is higher in the subject from high skilled group, and as for the subject from low skilled group, there is only a slight difference.

Keywords: *metacognition process, mathematical problem solving*

I. INTRODUCTION

A. Background

Solving mathematical problems using a formal mathematical procedure has been widely used by students at all levels of education. The procedure is usually associated with the formal mathematical problems where the problems are presented in the form of mathematical sentences using symbols or certain variables. Moreover the using of formal mathematical procedure is expected to help user in everyday life in order to solve the various problems by generally presented them not in the form of formal mathematical problems.

Mathematical problems related to everyday life environment is commonly known as contextual mathematics problem. The use of contextual mathematical problems is based on the conciousness that learning process which is presented directly to formal mathematical concepts is quite difficult and tedious for students, because the presentation of mathematics in this way makes the students can not see the significance of what they learned (Hadi, 2005: 17). Its required a more interesting approach and

students can be directly involved in developing the process of thinking about different concepts in a familiar context.

Through the problem solving, students are stimulated to develop all the psychological potential related to thought processes. Thought processes in problem solving is an important thing to get the attention of educators, especially to help students in the developing of their problem-solving abilities. Lester (Gartman and Freiberg, 1993) suggests that the primary purpose 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 thought.

Thinking about what one's think is relates to the awareness of the ability to develop variety of ways that may be taken in solving the problem. Gartman and Freiberg (1993) propose that recognize and manage the process of thinking, known as metacognition, includes thinking about how to make the approach of the problem, choose the strategy to find solutions, and ask ourselves about the problem.

The implementation of metacognition process in problem solving is one of many factors that attract the attention of educational researchers. This is due to the advantages to be gained when solving problems done with the involvement of the awareness of thought processes and ability to self-regulation. This process allows the establishment of a strong understanding of the problem with logical reason.

In order to arouse students' metacognition skills, teachers must have sufficient insight and understanding about the process of metacognition in solving problems. It required a cultivation of awareness of teachers or teacher candidates about the process of metacognition that should be implemented in solving mathematical problems.

For the teacher candidates, the awareness and thinking arrangement are necessary not only for solving the problem, but also as the basis when they become a teacher in order to prepare a lesson that encourages students to involve metacognition. Thus the expected improvement of education quality can be realized. These improvements should be done in the beginning of the formation of teacher candidates for improvement the quality of existing teachers.

B. Understanding Metacognition

Simply metacognition is defined as thinking about thinking or cognition about one's cognition (Nelson, 1992; Livingston, 1997; Gama, 2004). There are several definitions of metacognition that developed in the field of cognitive psychology. Flavell (Lee and Baylor, 2006) defines metacognition as the ability to understand and monitor one's own thoughts and the assumptions and implications of one's activities. This opinion emphasizes metacognition as the ability to understand and monitor the activities of thinking, so the process of metacognition will be different according to one's own ability. Meanwhile, Brown (Lee and Baylor, 2006) defines metacognition as an awareness of one's own cognitive activity; the methods employed is to regulate one's own cognitive processes; and a command on how one directs, plans, and monitors cognitive activity. Brown's opinion emphasizes metacognition as an awareness of the activity of cognition. Metacognition in this case relates to how a person aware of his thinking process. This awareness will materialize in the way of a person set up and manage the activities of thinking.

Although Flavell and Brown have different ideas about metacognition, but both concept suggested that metacognition includes two aspects which are interrelated and interdependent with one another. Flavell argued that metacognition consists of (1) metacognitive knowledge, and (2) metacognitive experience or regulation (Flavell, 1979; Livingston, 1997). On the otherhand, Brown divides metacognition into: (1) knowledge about cognition, and (2) regulation of cognition (Gay, 2002).

C. Mathematics Problem Solving

Mathematical problem in this paper is assumed as an unknown entity and needs to be solved in connection to mathematics in school. Solving a mathematical problem requires students to consider the unfamiliar situations by thinking flexibly and creatively (Mousoulides et al, 2007). In the process of learning mathematics in school, teachers usually present the mathematical problems to the students in the form of questions or tasks to be completed.

Mathematical problems given to students is intended specifically to train students for gaining their intellectual ability in understanding, planing, conducting, and obtaining the solution of the problem. Thus, the improvement of students' skills in

solving problems and to be the problem solvers become an important theme in mathematics education curriculum content standards in Indonesia (Curriculum 2006) and the standard of education in some countries (Kirkley, 2003).

Mathematical problems presented in school is usually in the form of formal mathematics, that is given in the form of math sentences using symbols or certain variables. But nowadays, it is aware that to further optimize the learning outcomes then a math lesson involving the particular context is necessary.

Nelissen (1997) defines that a context is a situation which appeals to children and they can recognize in theory. This situation either might be fictional or real, and forces children to call upon the knowledge gained by experience they have. For example, in the form of their informal working methods, they make a meaningful learning activity for themselves. Another opinion about the context is also suggested by Johnson (2002: 16) that is the context meant not only related to the environment, or the outside world that can be recognized through the senses, or event that is limited by space and time, but the context also includes the knowledge or experience that has previously owned.

In this paper, context is intended as an environment or situation which may include objects, events, facts or concepts that have been well recognized by a person. In this case, that person can generate knowledge about it in terms of his own working methods. Thus, contextual mathematical problems are the problems that are presented using a particular context that has been well recognized by learners so they can generate knowledge informally and formally to determine the solution.

Problem solving is a manifestation of a mental activity that consists of a variety of skills and cognitive measures (Kirkley, 2003) intended to obtain the correct solution of the problem. In line with that view, Orton (1992: 35) suggests that problem solving is a process combining elements of knowledge, rules, techniques, skills, and concepts that have been studied to find solutions in new situations. Because of the problem solving process involves a person's cognitive activity, then the ability of each person in solving problems will be different. A problem is challenging and quite difficult for someone, perhaps be a simple matter for others.

On learning of mathematics at schools, teachers usually consider problem-solving activities as a vital part that must be implemented. It is intended to determine

the level of student mastery of subject matter, and also to train students in applying the knowledge in the different situations and problems. Gagne (Orton, 1992: 35) suggests that problem solving is the highest form of learning. Thus all the activities to learn the rules, techniques, and the content to understand mathematics, can be intended in order to students are able to solve mathematical problems.

One of the many referenced in solving mathematical problems is the idea of Polya (1973), which suggests four important phases that need to be performed. That is

1. Understanding the problem, involves understanding the various things that exist on issues such as what is not known, what data are available, what the terms, and so on.
2. Devising a plan, includes various efforts to find a relationship problem with another problem or the relationship between the data with the unknown, and so on.
3. Carrying out the plan, includes checking every step of the solution, whether the steps taken is correct or can be proven that such a move right.
4. Looking back included examination of the resulting solution.

D. Metacognition in Problem Solving

At Polya important phases, it appears that problem solving is based on the knowledge of cognition, and regulation of cognition. As discussed in the previous section, these two elements are the components of metacognition.

Thus, problem-solving ability is circumstances and the complex interplay between cognition and metacognition. When students have difficulty in solving the problem, it may arise from the inability to actively monitor and regulate cognitive processes involving the problem solving (Panaoura and Philipou, 2004). This indicates that in order to perform complex tasks in solving the problem properly, the process of metacognition is required.

Gama (2004) suggest that, from a general perspective, metacognition can help problem solvers to: (1) determine that something is a problem to be solved, (2) describe what exactly the problem, and (3) understand how to get the solution. In addition, Gama also stated that some metacognitive processes can help to recognize the input, goals, and obstacles in solving the problem.

In this paper, Metacognitive activities are focused in the activity of research subject when solving mathematical problems. The grouping metacognitive activities in solving mathematical problems is implement acording to Cohors-Fresenborg & Kaune (2007) which consists of: (1) planning, (2) monitoring, and (3) reflection.

II. RESEARCH METHODS

This research is qualitative research.The research subjects are the 1st grade students of Mathematics Education Study Program of Faculty of Education of Haluoleo University, Kendari. Subjects are divided into two groups with different abilities, i.e. the high ability group (represented by subject 01) and the low-ability groups (represented by subject 02).

In the implementation, the researcher use several supporting instruments, namely: (1) sheets of formal mathematical problems, (2) sheets of contextual mathematical problems, (3) interview guide based on the problem, and (4) basic mathematics tests that are used for the selection of research subjects.

Metacognitive activity are identified base on two data sources, namely: (1) the results of problem solving, and (2) the interviews. Problem-solving process carried out by the think aloud method where process of cognition is taking place in the mind by using words, writings, or behavior, and it can be understood by others.

During the problem solving process, we conducted a recording of audio and video. If necessary, the researcher can ask some questions to stimulate thinking or reveal the subject's thoughts, but avoid using words that are directed to the solution.

To ensure the validity of the data, triangulation done through problem-solving process is carried out at different times. The problems solved in the process of triangulation were equivalent to problems have been solved earlier.

III. RESULTS

Mathematical problem solving conducted in the form of formal and contextual mathematics problems. Each problems is presented in two numbers, and each number is solved with interval of 6 (six) months. In more detail, a formal mathematical problems

presented in problem number 1 and 2, while the contextual mathematics problems presented in problem number 3 and 4.

A. Formal Mathematics Problem Solving

Based on the analysis of metacognition process undertaken by the subject 01 in formal mathematical problem-solving, it is found the activity of metacognition has been adequate. It can be seen in the implementation of various metacognition activities during problem solving processes.

Although the subject 01 has shown awareness and thinking arrangement during the problem solving process, there are still some shortcomings. It caused by the fact that the subject is conviction with the activities undertaken, so the subject thinks that it is unnecessary to conduct a further exploration of ideas. Also because the metacognitive activity performed at each stage is inter-related, then the subject decides not to perform the metacognitive activity. Since the subject assumed it has been done in the previous stage.

On the other hand, metacognitive activities performed by subjects 02 in solving formal mathematical problems was quite simple. It is found that almost all the stages of problem solving was done without metacognitive activity. Although the final answer is correct, but the step of solving performed is less recognized by the subject. This indicates that the problem solving done relatively routinely, or just based on habit.

B. Contextual Mathematics Problem Solving

In this case, our result shows that the metacognitive activity conducted by subject 01 in contextual problem solving is fairly complete in all the stages of solving conducted. We found that there is one step that the subject does not involve the complete type of metacognitive activity. It is the stage of devising plan where the subject does not involve the type of activity monitoring and reflection. This is because the subject had actually believed that he was doing the correct thinking process, as supported by the involvement of complete metacognitive activity at other stage.

Contextual mathematical problem solving conducted by subject 02 is started with a failure of understanding the problem. It was caused by the difficulties in translating the data and the information which will be tabulated in the table. As a result,

the subject makes a wrong mathematical model. Then the next solution becomes unfocused and difficult to understand. Under these circumstances, it was decided to end the process and continued the process in the next day. Then the subject can learn the topics related to the problem more detail. In the view of researchers, the metacognition process when solving the problem doing by the subject can be observed. As a result, the subjects 02 can carry out the stage. It is clear that in the stage of understanding problem, the subject has done the metacognition activities. However, at later stages, only one metacognitive activity is done by the subject. From this results, we found the subject 02 solve the contextual mathematical problems with the same way as solving formal mathematical problem.

IV. DISCUSSION

A. Solving Problems by Subjects 01

Based on the analysis of the problems solving process and the results of interviews, The subject 01 have implemented the metacognition process when solving the formal mathematical problem. The activity varies at each stage of problem solving with different frequencies. It is clear that the subject have demonstrated the ability in aware and adjust thinking in solving formal mathematical problems through the involvement of metacognition activities at all stages of problem solving.

In contextual mathematical problem solving, it is found that the metacognitive activity more complete. Metacognitive activities include planning, monitoring and reflection happens at almost all stages. These results indicate that subject has a good ability to recognize and regulate his thinking during the problem-solving processes. It also shows that there is a progress compared with solving the formal mathematics problems. In the solving contextual mathematical problems, the involving metacognitive activity have been started in the beginning when the subject attempts to understand the problem until the last stage of the evaluation solution.

B. Solving Problems by Subjects 02

The metacognitive activity performed by subjects 02 when solving formal mathematical problem is poor. It can be seen in the many activities carried out in the solving problem without the implementation of the metacognitive activity. This

indicates that a problem solving is done as memorize solutions, or just based on habit, but it is not supported by adequate implementation of the metacognitive activity.It is also quite prominent that at all stages of problem solving, the subject never do reflection activities. This situation indicates that the subject can not involve the awareness and the regulation of thinking in the process of solving problems.

On solving contextual mathematical problems, the subjects also carry out a minimal metacognitive activity. It can be seen at each stage of problem solving. When it compared with the activities during solving the formal mathematics problems, there are not many changes. Changes occur only at the implementation of reflection activity in the stage of understanding the problem. These results indicate that the subjects tend to solve contextual mathematical problems similar to the solving of formal mathematical problems.

V. CONCLUSION

Based on our results, we can summarize as follows:

1. The subjects in this research demonstrate metacognitive activity with higher dynamics in contextual mathematical problem solving compared to the solving formal mathematical problems. That is particularly demonstrated by the subjects from high ability group (the subject 01). The dynamics of metacognitive activity is shown in the diversity of metacognitive activities and the frequency of each metacognitive activity.
2. Subject 01 shows a very good metacognitive activity in solving both formal and contextual mathematical problems. It can be seen from the ability of subject in awareness and regulation of thinking when solving problems. The subjects 02 (low ability group) also showed the increasing in metacognitive activity when solving contextual mathematical problems, than when solving formal mathematical problems. But the increasing is still minimal and limited to the stage of understanding the problem. These results shows the ability of subject 02 in recognizing and adjusting the thinking in solving the contextual mathematical problems is similar to that of solving the formal mathematical problems.

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