ANALYSIS METACOGNITIVE SKILLS ON LEARNING MATHEMATICS IN HIGH SCHOOL

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ABSTRACT

This study aimed to: (1) the extent to which the metacognitive awareness of high school students when answering a series of questions metacognitive on mathematics learning?; (2) the influence of metacognitive awareness of the cognitive skills ?; (3) the influence of metacognitive awareness of the metacognitive skills ?; and (4) how the relationship between cognitive skills and metacognitive skills?. The subjects of this study were students of class XII Public Senior High School Kersana Brebes (SMA N 1 Kersana Brebes). The results showed that: (1) the ability of the students regarding the metacognitive awareness is more dominant in the high and medium criteria, while the average ability in metacognitive awareness in the category of being; (2) there is a positive linear relationship between metacognitive awareness and cognitive skills; (3) there is a positive linear relationship between metacognitive awareness and metacognitive skills; and (4) there is a positive correlation between the variables of cognitive skills and metacognitive skills with sufficient criteria/ medium.

Keywords: metacognitive awareness, cognitive skills, and metacognitive skills.

1. Introduction

Criteria of learn if the person can do things that previously could not he do. So teachers can establish that the student has declared learn math if he had been able to complete and demonstrate the ability or specific skills in mathematics that previously could not he do (Hudojo 2005: 9). Meanwhile, according to Herbst (2006: 317), teaching and learning in mathematics is not just a student can complete a task in which they connect between problems and new ideas, but also an attempt to maintain the students' responses to always be involved in the learning process.

Mathematics teaching and learning process is influenced by many factors, including factors of learners and teachers. According Hudojo (1988: 6) learning math would work better if the learning process that involves intellectual learners optimally. While Brousseau (in Herbst 2006: 315) states that the necessary role in the ability to learn mathematics is the ability to bring relations theory in mathematics in the form of a concept, formula, and methods to answer questions that can be vouched for.

Learning mathematics requires creativity of learners and learning mathematics optimal. Hudojo (2005: 20) argues that the learning process should involve mental mathematics (such as motivation and awareness) are active learners. Mental activities to learn this very hard to see and be observed unless the learning activity followed by physical activity. But physical activity that looks do not always show the mental engagement in mathematical thinking.

Difficulty in learning mathematics by Verschaffel et.al. (in Kramarski, Mevarech and Aramaic, 2002) is very complex. Difficulties occur at all stages of the process solution, from the first stage (about understanding what the problem is), the planning process solutions and choose the right strategy, and the stage of deciding whether it makes sense or not. Another fact that is happening in the learning of mathematics is very seldom giving authentic tasks. Kramarski, Mevarech and Aramaic (2002) revealed that the rare authentic tasks presented in math class, so there are few who know how to improve the ability of students complete these tasks. Instead the default task that is commonly used by teachers, which is a task that only depicts a simplified situation, involving some quantitative information, and that there is a ready-made algorithms to be applied in solving specific problems

.Another problem in mathematics learning is that learning is more passive than active learning (traditional learning) that can cause silent knowledge structures (Schraw & Moshman, 1995). Learning more just emphasize on knowledge of cognition, not the knowledge of metacognition, whereas according to Carr, Alexander & Foldes-Bennet (1994), metacognitive knowledge has the capacity to play a critical role in student achievement. Metacognition beneficial to students as they require increased metacognitive ability and require tasks appropriately developed and adapted to the capacity of students.

To improve student's metacognitive skills, metacognition teaching process is required. According Kramarski, Mevarech and Aramaic (2002), the main elements of metacognition is teaching students to work in small groups to reason mathematically formulate and answer a series of questions or tasks metacognitive. Hacker (in Downing, 2009) noted the differences between cognitive tasks and tasks metacognitive. Cognitive tasks emphasis on the ability to remember things more easily studied that may be assisted with advanced task or problem, while tasks metacognitive monitoring and directing the emphasis on problem-solving process, emphasizing the need to learn and think.

Based on the above, the problem in this study include: (1) the extent of metacognitive awareness students when answering a series of questions metacognitive on mathematics learning?; (2) the influence of metacognitive awareness of the cognitive skills?; (3) the influence of metacognitive awareness of the metacognitive skills?; and (4) how the relationship between cognitive skills and metacognitive skills?.

2. Theory of Metacognition

Metacognition means "thinking about thinking" or "second-level cognition" is the ability of self-reflection of the ongoing cognitive processes, is something that is unique to the individual, and plays an important role in human consciousness. It shows that metacognition include a person's thinking (Kuhn & Dean, 2003; Setya Murti, 2011). Metacognition also concerned with knowing how to reflect, how to draw conclusions on the analysis, and how to put what has been taught in practice. In other words, metacognition also concerned with how the performance has a significant cognitive tasks such as remembering, learning, and problem solving (Downing, 2009).

Kuhn defines metacognition as awareness and management of cognitive processes and products are owned by someone (Kuhn, 2000). While Schneider & Lockl (in Setya Murti, 2011) defines metacognition as knowledge or activity that regulate cognition. This concept is widely

covers the individual's knowledge of the existence of essentially as an individual who has the ability to recognize, knowledge of the basic tasks of different cognitive and knowledge about strategies that allow for the new different tasks. Thus, people do not just think about objects and behavior, but also on cognition itself. For Matlin (1994), metacognition is knowledge and awareness about the cognitive processes - or someone thinking about thinking. Two important types of metacognition is metamemory (eg, realize when you need a strategy to remember a person's name) and metacomprehension (eg, trying to decide whether you understand the definition of metacognition).

According Asington et al (in Schraw & Moshman, 1995), the theory of metacognition is part of Theory of Mind (ToM). ToM is a theory that talking about mental events such as emotion, personality, and so on. Metacognition theory are in ToM where he learned to focus with regard to cognitive aspects in mind. On the theory of cognition, individual creativity and synthesize metacognitive knowledge. Meanwhile, according to Flavell (in Misailidi, 2010), the theory of metacognition and ToM actually provide the same goal, namely to investigate the development of students' knowledge and cognition about mental events. According to Kuhn (2000), one of the main characteristics of metacognition theory is that it allows an individual to integrate diverse aspects of metacognition in a single framework. Metacognition theory is built for two reasons: (a) systematize the metacognitive knowledge , and (b) to understand and to plan the cognitive activity in a formal framework (Schraw & Moshman, 1995).

3. Metacognition and Learning Mathematics

The most common differences in metacognition is split between metacognitive knowledge and metacognitive skills. Metacognitive knowledge refers to a person's declarative knowledge about the interaction between the characteristics of people, tasks, and strategies, metacognitive skills while procedural knowledge refers to a person to organize and problem-solving learning activities learning (Veenman et al, 2006).

Metacognitive knowledge has the capacity to play a critical role in student achievement. Metacognitive knowledge affects the use of strategies to mediate the effect of motivational variables, such as the reduction of confidence and self-concept, the use of strategies and achievements. Metacognitive knowledge beneficial to students when they need metacognitive and requires tasks appropriately developed and adapted to the capacity of students (Carr, Alexander, & Foldes-Bennett, 1994).

Meanwhile, according to Schneider & Pressley (in Carr, Alexander & Foldes-Bennet, 1994), metacognitive knowledge about reading and memory development strategies used by students in providing knowledge about when, where, and why they use different strategies, information about the ability of their own, and knowledge of the tasks. For Borkowski, et.al. (in Carr, Alexander & Foldes-Bennet, 1994), affecting the use of metacognitive strategies to mediate the effect of motivational variables, such as the reduction of confidence and self-concept, the use of strategies and achievements.

The result of the discussion experts say not too difficult to distinguish between metacognitive skills with metacognitive knowledge. Flavell (in Veenman et al., 2004) states that the metacognitive skills, assessing declarative knowledge occurs more about the interplay between personal characteristics, characteristics of the task, and strategies in the learning situation. Knowledge does not automatically lead to the appropriate task behavior. For example, students can come to know about the activity plan, but he still refrained from working with a variety of reasons.

On the other hand, Brown and Flavell (in Veenman et al., 2004) suggests that metacognitive skills are also concerned with procedural knowledge through real rules and the necessity to use

more control over learning activities. Task analysis, planning, monitoring, checking, and recapitulation is a manifestation of such expertise.

Meanwhile, according to Jacob and Paris (in Schraw & Moshman, 1995), there are three metacognitive skills are essential, namely: planning, monitoring, and evaluation. Planning means choosing the right strategy and provide resources that affect performance. Monitoring with respect to the ability to monitor one's awareness on the overall and performance tasks. Evaluation with respect to assess products and processes regulate one's learning.

Metacognition capability can be assessed by a number of ways, but there is one method currently used is the major ones by using questions to explore perceptions of student thinking, problem solving skills, and strategies (Weinstein in Downing, 2009). According Kramarski, Mevarech, and Aramaic (2002), these metacognitive questions focus on: (a) understand the problem; (b) establish the relationship between prior and new knowledge; (c) use appropriate strategies to solve problems; (d) reflect the processes and solutions.

Student success in solving the problem depends on the consciousness of thinking. According to Wilson and Clark (2004), awareness of one's thinking can be observed. So that the level of awareness of students' thinking can be observed on the steps done in solving a problem. In this case, Lester (in Kramarski et al, 2002) argues, good problem solvers tend to focus their attention on the structural features of the problem, while the poor problem solvers only see the surface features. For Hegarty, Mayer, and Monk (Kramarski et al, 2002), better problem solvers build a model of the problem is given based on all the information given in the text problems, poor problem solvers only translate key words given in the text of the problem then directly into mathematical operations without considering the other information given in the text.

Schraw and Dennison (1994) emphasizes that learning is done with metacognitive awareness better than those who did not have a metacognitive awareness. Metacognitive awareness means that the individual doing the planning, sequencing, and monitoring (supervision) of the learning process. This is reinforced by Veenman et al (2006) which states that metacognitive skills are built of metacognitive awareness. Generally there are three types of metacognitive awareness, namely: declarative knowledge, procedural knowledge, and knowledge of the conditional.

To make an assessment of metacognitive awareness, Schraw and Dennison (1994) developed the assessment instrument called *Metacognition Awareness Inventory (MAI)*. MAI presents a 52 item questionnaire used to measure cognitive abilities and knowledge about the regulation of cognitive abilities. Knowledge of cognitive abilities that include: (1) *declarative knowledge* (knowledge of one's skills, intellectual resources, and capabilities as a learner); (2) *procedural knowledge* (knowledge of how to apply the learning procedure); and (3) *conditional knowledge* (knowledge about when and why to use the learning procedure). While the regulation of cognitive abilities include the ability to: (1) *planning* (measuring activities of planning, goal setting, and allocate resources before the study); (2) *information management strategy* (measure of skills / expertise and sequencing strategy used to process information more efficiently); (3) *comprehension monitoring* (measuring about one's learning assessment or strategy use); (4) *improvement strategy* (measuring strategies used to improve understanding and error performance); and (5) *evaluation* (measure of performance analysis capabilities and effectiveness of the strategy after completion of study).

4. Research Methodology

This study uses a mix method (qualitative-quantitative). A qualitative approach is used to describe data from student metacognitive awareness questionnaire adapted from MAI, while the

quantitative approach is used to examine the effect of metacognitive awareness of the cognitive skills and metacognitive skills.

Subject used in this study were students of Kersana Brebes Public Senior High School (SMA N 1 Kersana Brebes). The population is the entire class XII students of Kersana Brebes Public Senior High School. While the sample is taken by using random sampling techniques to grade levels used in the study, in this case XII.IPA.2 class. Researchers believe that Public Senior High School in Kersana Brebes quite describe the condition of high schools in the Bradford district, so that the results of this study can be used as an overview of the metacognitive skills of high school students in the Bradford district.

4.1 Variables Research

The variables in this research that metacognitive awareness in the students' learning of mathematics (X), cognitive skills of students in mathematics (Y_1), and metacognitive skills of students in mathematics (Y_2)). Meanwhile, to obtain research data, an instrument which is used include: (1) Instruments matter specific to the skills of cognitive achievement test; (2) Instrument test questions specific to the skills metacognitive learning outcomes; and (3) The questionnaire's ability (level of consciousness) metacognitive adapted from *MAI*.

4.2 Data Analysis Techniques

Analysis of qualitative data in this study conducted on the results of the questionnaire metacognitive awareness level of students . This analysis is used to answer about the extent of metacognitive awareness students when answering a series of questions on the metacognitive learning of mathematics . While quantitative data analysis using dual paradigm with one independent variable and the two dependent variables . Formulated hypothesis that associative hypothesis by using simple regression and hypothesis testing correlation with Pearson bivariate correlation .

5. Results and Discussion

Data on students' metacognitive awareness can be seen in Table 1 below.

Table 1. Data Metacognitive Awareness of High School Students

Aspects and Sub Aspects		Metacognitive Awareness Categories					N	Mean	Criteria
		very high	high	medium	low	very low			
Knowledge about cognition									
1.	Declarative Knowledge	2	10	10	11	1	34	0.51	Medium
2.	Procedural Knowledge	3	8	13	8	2	34	0.51	Medium
3.	Conditional Knowledge	6	10	7	8	3	34	0.64	High
Regulation of cognition									
1.	Planning	14	5	12	1	2	34	0.68	High
2.	Information management strategies	3	11	16	4	0	34	0.62	High
3.	Comprehension	10	2	14	4	4	34	0.56	Medium

	monitoring								
4.	Debugging strategies	14	13	7	0	0	34	0.84	Very High
5.	Evaluation	7	5	7	9	6	34	0.50	Medium
Metacognitive Awareness		**4**	**12**	**16**	**2**	**0**	**34**	**0.60**	**Medium**

From Table 1 can be explained that, *first,* the ability of students with respect to the declarative knowledge is more dominant on the criteria of low, medium, and high, while the average ability of students in regard to the criteria being declarative knowledge. This indicates that the student has sufficient knowledge of himself as a learner and quite understand the factors that affect its performance. The most powerful is the awareness of students about why the teacher expects her students' learning and understanding of the strengths and weaknesses of intellectual, while the weakest part is the ability to recall information and the ability to judge for themselves on their ability to understand something.

Second, the ability of students with regard to procedural knowledge is more dominant on the criteria of medium, low and high, while the average ability of students in regard to procedural knowledge on the criteria being. This indicates that the student has sufficient procedural capabilities are thus quite capable of using the skills automatically, quite capable of using regular strategy effectively, and use qualitatively different strategies to solve problems. The most powerful is the belief of students that he always has a purpose for each of the strategies used, while the weakest part is the speed of the students in finding learning strategies used and useful

Third, the ability of students with respect to the conditional knowledge fairly evenly at very high criteria to low, while the average ability of students in regard to knowledge conditional on high criteria. This indicates that the student has a high ability / well in knowing why and when to apply various cognitive action. The most powerful is the awareness of students to learn the maximum when they want to know a topic and the ability to motivate yourself to learn at the time of need, while the weakest part is the ability to determine the most effective strategies used.

Fourth, the ability of students with regard to planning more dominant in the medium and very high criteria, while the average ability in all aspects of planning into the high category. This indicates that the student has a good ability / high in planning, goal setting, and allocate resources before learning. The most powerful is the awareness of students reading instruction carefully before starting the task, while the weakest part is the student's ability to regulate the current study in order to have a longer learning time.

Fifth, the ability of students with regard to information management strategy is more dominant in the medium and high criteria, while the average ability in the aspects of information management strategy included in the high category. This indicates that the student has a good ability / high manage and process information more efficiently (eg, organizing, outlining, summarizing, selective focus). The most powerful is the awareness of students to slow read when finding important information and efforts of students trying to translate new information into his own words, while the weakest part is the students 'ability to create drawings or diagrams to enhance the students' understanding of and ability to use the map concepts to help understanding.

Sixth, the ability of students with respect to the dominant understanding of monitoring over the medium and very high criteria, while the average ability in all aspects of planning into the category of being. This indicates that the student has sufficient ability to perform self-assessment of learning or in assessing the strategies it uses. The most powerful is the ability of students to consider some alternative settlement before answering and awareness of students to stop regularly

to check for understanding, while the weakest part is the awareness of students in analyzing the usefulness of the strategy at the time they learn.

Seventh, the ability of the students regarding the performance improvement strategy is dominant at high and very high criteria, while the average ability in all aspects of planning in the category very high. This indicates that the student has the ability excellent / very high in revealing the strategies used to improve understanding and performance errors. The most powerful is the awareness of students to ask for help from others when needed and awareness of students to stop and reread when experiencing confusion, while the weakest part is the students' ability to evaluate the steps that have been working on when faced confusion.

Eighth, the ability of students with respect to the ability of the evaluation looks evenly in all categories, from very low to very high, but it is more dominant in the low category. While the average ability in this aspect into the category of being. This shows that the average student has sufficient capability / medium but tend to be low in analyzing the performance and effectiveness of the strategy after completion of learning. The most powerful is the awareness of students to ask themselves about how well they have achieved the goal (after the task has been completed), while the weakest part is the awareness of students to make a summary of what he had learned.

Overall, the ability of the students regarding the metacognitive awareness is more dominant in the high and medium criteria, while the average ability in metacognitive awareness into the category of being. This indicates that the student has sufficient capability / being in control thinking or learning, and build a meaningful theory on their own cognition

While the data recap the results of research on cognitive and metacognitive skills XII.IPA grade students Kersana Brebes Public Senior High School (SMA N 1 Kersana Brebes) mathematics courses can be seen in Table 2 below.

Table 2. Data Recap Cognitive and Metacognitive Skills

	Cognitive Skills	**Metacognitive Skills**
N	34	34
Mean	76	76
standard deviation	8.00	10.00
Maximum	94	91
Minimum	60	60

Normality test produces sig variables cognitive skills, metacognitive skills and metacognitive awareness are respectively 52.6%, 14.7%, and 99.3%, which means sig> 5%. This suggests that the data on all variables with normal distribution so that if the data can then be performed using parametric statistics.

To test the effect of metacognitive awareness of the cognitive skills of students is done by a simple linear regression test. Results of testing to get the value of F is 7290 and sig is 0,011 or 1.1%, which means that H0 is rejected, meaning that the linear regression. The magnitude of the effect can be seen from the R-square value is 0186 which means that 18.6% of students cognitive skills influenced by metacognitive awareness, and 81.4% are influenced by other factors, and the shape of the regression equation is. This shows that there is a positive linear relationship between metacognitive awareness and cognitive skills.

The higher a person's level of cognitive awareness, will also increase the cognitive skills, and vice versa. This is in line with the results of research conducted by Carr, Alexander, and Foldes-Bennet. In their study on the effect of metacognitive knowledge on student achievement obtained that (1) metacognitive knowledge has the capacity to play a critical role in academic achievement (cognitive) students; (2) affect the use of metacognitive strategies to mediate the effect of

motivational variables, such as the reduction of confidence and self-concept, the use of strategies and achievements; (3) metacognition beneficial to students when they need metacognitive and requires tasks appropriately developed and adapted to the capacity of students (Carr, Alexander, & Foldes-Bennett, 1994).

Variable regression test metacognitive awareness of the metacognitive skills produce F value is 39.363 and sig is 0.000 or 0% which means that H0 is rejected, meaning that the linear regression. The magnitude of the effect can be seen from R square value is 0.552, which means 55.2% of metacognitive skills of students influenced by metacognitive awareness, and 54.8% are influenced by other factors, and the form of the regression equation is. This shows that there is a positive linear relationship between metacognitive awareness and metacognitive skills. The higher a person's level of metacognitive awareness, will also increase the metacognitive skills, and vice versa.

Test bivariate correlation using Pearson's correlation test to get the value of r is 0.566 and sig is 0.000 or 0% which means that H0 is rejected, meaning that there is a positive correlation between the variables of cognitive skills and metacognitive skills with sufficient criteria or moderate. This indicates that the level of the relationship both showed a fairly close relationship and mutual support. The closeness of their relationship are specifically expressed by Kramarski and Mevarech (2001), that in general metacognitive group perform tasks with interpreting qualitative graph, while the quantitative cognitive interpreting graphs; in terms of the ability of metacognitive expressions, mathematical discussion in groups metakiognitif directed to encourage the group perform verification and checking, while the cognitive group to discuss all issues on points and context specific.

6. Conclusion

Based on the explanations that have been described earlier then obtained some conclusions as follows:

(1) High school students have sufficient ability or being in control thinking or learning, and build a meaningful theory on their own cognition.

(2) There is a positive effect of metacognitive awareness of the cognitive skills of high school students 18.6% N where the cognitive skills of students influenced by metacognitive awareness.

(3) There is a positive effect of metacognitive awareness of the metacognitive skills that 55.2% of high school students metacognitive skills of students influenced by metacognitive awareness.

(4) There is a fairly close relationship and mutual support between cognitive skills and metacognitive skills with correlation index r = 0566.

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