Description of Student's Metacognitive Ability in Understanding and Solving Mathematics Problem

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Abstract. This research was conducted qualitative which was aim to describe metacognitive ability to understand and solve the problems of mathematics. The subject of the research was the first year students at computer and networking department of SMK Mega Link Majene. The sample was taken by purposive sampling technique. The data obtained used the research instrument based on the form of students achievements were collected by using test of student's achievement and interview guidance. The technique of collecting data researcher had observation to ascertain the model that used by teacher was teaching model of developing metacognitive. The technique of data analysis in this research was reduction data, presentation and conclusion. Based on the whole findings in this study it was shown that student's metacognitive ability generally not develops optimally. It was because of limited scope of the materials, and cognitive teaching strategy handled by verbal presentation and trained continuously in facing cognitive tasks, such as understanding and solving problem.

1. Introduction

One of the things that distinguish school mathematics with one as a science is the presentation of the object study. The Mathematics materials at school, the presentation of objects of mathematical study should not start with a definition or theorem, but should be adjusted to the intellectual development of students. Another thing that distinguishes school mathematics with mathematics as a science is its degree of abstraction. Unlike the object of direct study that becomes main target in learning mathematics, the object is not directly regarded as the impact of accompaniment, so it does not receive more serious attention from teachers and students. This is reflected in measurement of the achievement of mathematics learning results that have not involved these indirect objects. This is reinforced by [2] describes that the mathematical studies is one of the object of a difficulty of a teacher to teach mathematics school. Consequently, a teacher should try to "reduce" the abstract nature of mathematical objects (facts, concepts, operations or principles) to make it easier for students to grasp the subject matter of mathematics at school. In other words, mathematics teacher should teach mathematics concretely.

The development of cognitive psychology in this recent years, there are also ways to evaluate the achievement of learning outcomes, especially for the cognitive domain. One of the interesting efforts is the development of educational experts in revising "Bloom's Taxonomy" about the cognitive dimension. The domain of knowledge in the 2013 curriculum using [1] Bloom Bloomfield taxonomy revises Bloom's Taxonomy of cognitive aspects into two dimensions: (1) the dimensions of cognitive processes and (2) the dimensions of knowledge. The relationship between cognitive process and knowledge dimension of students' thinking development which is known by cognitive process dimension based on the formulation of Basic Competence of knowledge (KD-3) has relationship with the knowledge form (knowledge dimensions) [4]. Remembering process (C1), understanding (C2), and applying (C3). The analysis thinking development process (C4) to creativity one (C6) has a relationship with metacognitive knowledge form will be described in table 1.

Learning strategy (cognitive strategy) is one of the cognitive components that is closely related

to the student's activity in capturing and understanding material. The [6] classifies the cognitive strategies as learning outcomes, so they need to teach and train to students. According to [2] Metacognition is concerned with students thinking about their own thinking and their ability to use certain learning strategies appropriately. The relation with this line to understanding an idea of metacognition concept as the process of "thinking about own thinking" in order to build a strategy to solve the problem.

The [7] explain that self-knowledge is an important component of metacognition. In [7] self-knowledge model includes the strengths and weaknesses of a person about cognitive and learning. For example, students who know that they generally work easier on multiple-choice tests than essay tests have self-knowledge to face the test. While [11] suggests the notion of metacognition as one of the thinking process about own thinking processes in order to build a strategy to solve the problem.

The theoretical descriptions above, supported by [8] finds that: (a) metacognition plays an important role in problem solving, (b) students are more skilled at solving problems if they have metacognitive knowledge, (c) teachers emphasize specific strategies for solving problems and pay less attention to important features of other problem-solving activities; The result finds more achievements at the secondary level in elementary school on the important of mathematical reasoning and problem-solving strategies.

The metacognitive ability is enough potential to improve the meaningfulness of students' learning mathematics in classroom, so one of the dimension aspects of interesting knowledge to study more deeply, both theoretically and empirically through the mathematics learning study is the metacognitive knowledge because it is the most complex and the highest aspect in the taxonomy and the metacognitive aspect is more related to the object of indirect study of mathematics which has been less attention from teachers and students. Based on the considerations above, the researchers are interested in analyzing and describing the students' metacognitive ability to understand the material and solve mathematics problems.

2. Models

The research was conducted field research, the researchers obtained by collecting data based on empirical experience in the field using qualitative research design. This research intended to conduct an investigation by describing the state of the object/subject of research at the present based on the facts [5].

The subject of the research was 20 students of the first year at computer and networking department at SMK Mega Link Majene.

The flow diagram in the study of students' metacognitive ability description to understand and solve mathematics problems can be seen in Figure 1.

The main instruments in this research were self-researcher and supporting instrument:

a.　Test

The test used to obtain data about students' metacognitive abilities. Types of the tests in this study was a description test consisting of two types namely (1) test to understand the materials and (2) test to solve mathematics problems.

The metacognitive ability Indicators to understand the material were (a) Students can highlight important formulas from the matrix subject, (b) Students can make marginal notes on concepts and principles on the matrix subject, (c) Students can make a summary of the matrix discussion, (d) Students can create a concept mapping from the subject matter of the matrix. Besides that, The indicators of metacognitive ability to solve mathematical problems were (a) Students can use heuristic strategy, (b) Students can apply reverse thinking strategy, (c) Students can apply forward thinking procedure, (d) Students can apply inductive thinking procedure, (e) Students can apply deductive thinking procedure.

b. Interviews

The Interviews aim at obtaining information about the students' metacognitive ability to understand the material and solve mathematics problems. The participants were taken 9 participants as a sampling technique. The ability of students in the classroom was divided into 5 categories namely students with very high ability, high ability, middle level ability, low level ability and very low ability.

The validity of a data based on triangulation data. Triangulation data involves validity of the data by utilizing to compare others data [10]. In this research the triangulation data was obtained on students answers' analysis result.

Data analysis technique that used in this research was qualitative descriptive data analysis technique. [9] mentions that there are three steps in processing qualitative data such as data reduction, data presentation, and conclusion or verification.

3. Results

3.1 The students metacognition ability in understanding the material

Based on the analysis of metacognitive ability type in understanding the materials, the research finding 2 students who reached the category in very high ability category $(3,5 \leq x \leq 4)$ based on the four indicators of understanding the material, it turned out the fourth indicator was making concept mapping of the matrix as subject matter was relatively more difficult to understand by the students, when compared to the other indicators that highlight the important formulas were make marginal notes about concepts and principles, and make material summaries. Here is an example of students work with high category. The following table analysis of student's metacognitive ability in understanding the material can be seen in table 2.

The student example of work (high category) can be seen in figure 3. Based on the students work at number 4 (make a map of the concept of matrix material you have learned) find one student is able to create concept maps correctly).

3.2 Metacognitive ability of students in solving problems

The result of metacognitive ability test in solving problems based on the indicators of retrograde thinking in solving mathematical problems were relatively more difficult, when compared to other strategies such as heuristics, forward thinking, inductive thinking, and deductive thinking. Here in example of student work in the high category. The following table analysis of student's metacognitive ability of students in solving problems can be seen in table 3. Example of student work (high category) can be seen in figure 3.2, in question number 2 students were asked to solve the problem by using a backward thinking strategy. The subject appeared at the first step was correct by answering the question from the beginning, but the subject made an error in operation 4 (-2) - 3 (-1) the result should be -8- (-3) = -8 + 3 = -5. The subjects did not solve the mathematics problems carefully.

4. Conclusion and discussion

The researcher collected data in this research based on the data analysis types of understanding test as well as in-depth interviews, the researcher findings one of the indicator is making concept mapping considered more complicated by the students, while for the test in solving mathematical problems type and in-depth interviews finding that the indicators using backward thinking were considered more complicated by the students.

From the overall findings in this research illustrated that in general metacognitive ability of students have not grown / developed optimally. This was because the scope of the material is limited, i.e. only in one subject and teaching cognitive strategy was not enough just by verbal delivery, but

should be constantly trained in dealing with cognitive tasks, such as understanding and solving a problem, these findings were correlate to [6] explanation, he said that cognitive strategies (metacognitive) by which a person regulates his own behavior in attention, learning, remembering and thinking, is not studied in the once-so, but through improvement over a long period of time.

5.   References

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Table 1. The Relationship between Dimensions of Cognitive Process and Dimensions of Knowledge

No	Thinking Development of Bloom's Taxonomy Revised by Anderson (*Cognitive Process Dimension)*	Knowledge Dimension	Evidence
1	Remembering (C1)	Factual Knowladge	Lower Order Thinking Skills (LOTS)
2	Understanding /Interpreting concept (C2)	Conceptual Knowladge	
3	Applying (C3)	Procedural Knowladge	
4	Analyzing (C4)	Metacognitif Knowledge	Higher Order Thinking Skills (HOTS)
5	Evaluating (C5)		
6	Creating (C6)		

Table 2. Analysis of student metacognitive ability in understanding the material.

Number subject	Indicator understanding the material				Final score	Category
	Underline	Make marginal note	Make a material summary	Create a mapping concept		
1	4	4	4	4	4	Very high ability
2	4	4	4	3	3,75	Very high ability
3	4	3	3	2	3	High ability
4	4	3	3	1	2,75	High ability
5	3	3	3	2	2,75	High ability
6	3	3	2	1	2,25	Middle level ability
7	3	3	1	1	2	Middle level ability
8	2	2	1	0	1,25	Low level ability
9	1	1	0	0	0,5	Very low level ability

Table 3. Analysis of student metacognitive ability of students solving problems.

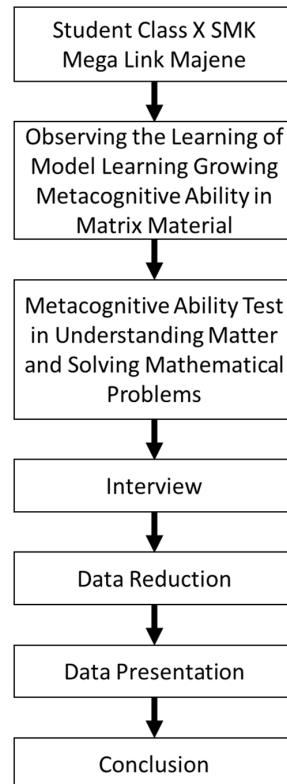| Number subject	Indicator metacognitive ability of students in solving problems					Final score	Category
	Heuristic strategy	Reverse thinking strategy	Forward thinking procedure	Inductive thinking procedure	Deductive thinking procedure		
1	4	2	4	3	3	3,2	High ability
2	4	2	3	2	2	2,6	High ability
3	3	1	2	2	2	2	Middle level ability
4	3	1	2	2	2	2	Middle level ability
5	2	0	2	1	1	1,2	Low level ability
6	3	0	1	1	1	1,2	Low level ability
7	2	0	1	1	1	1	Low level ability
8	1	0	1	0	0	0,4	Very low level ability
9	2	0	0	0	0	0,4	Very low level ability

Figure 1. Flow diagram in the study of students' metacognitive ability description in understanding and solving mathematics problems.
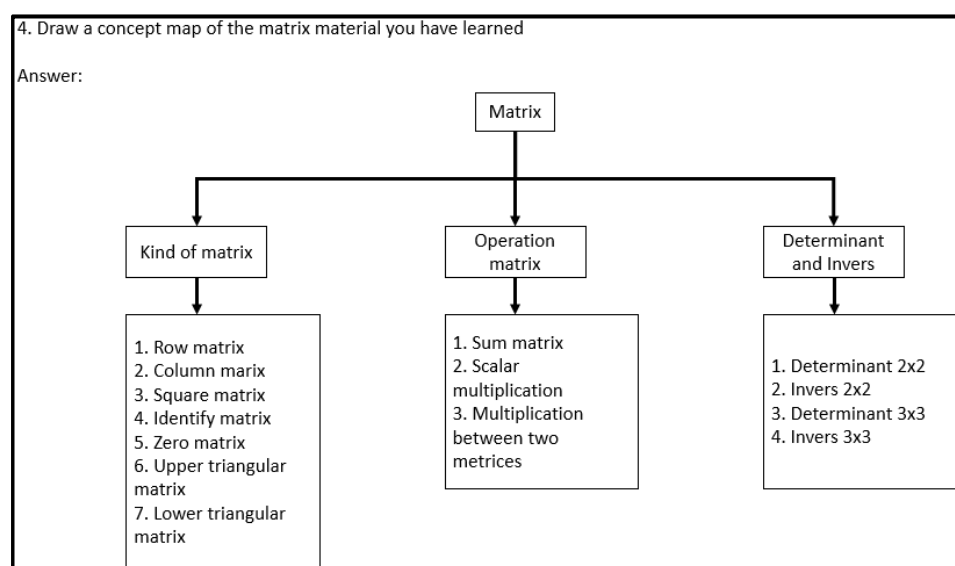

Figure 2. Answer about the number 4, draw a concept map of the matrix material**.**

2. Given two matrix $A = \begin{bmatrix} 4 & -1 \\ 3 & -2 \end{bmatrix}$ dan $B = \begin{bmatrix} a & x \\ -b & c \end{bmatrix}$ if $A^{-1} = B^T$, then the value b.

Answer:

$A^{-1} = B^T$

$B^T = A^{-1}$

$\begin{bmatrix} a & -b \\ x & c \end{bmatrix} = \frac{1}{det.A} \begin{bmatrix} -2 & 1 \\ -3 & 4 \end{bmatrix}$

$\begin{bmatrix} a & -b \\ x & c \end{bmatrix} = \frac{1}{(4.(-2)) - (3.(-1))} \begin{bmatrix} -2 & 1 \\ -3 & 4 \end{bmatrix}$

$\begin{bmatrix} a & -b \\ x & c \end{bmatrix} = \frac{1}{-8 - 3} \begin{bmatrix} -2 & 1 \\ -3 & 4 \end{bmatrix}$

$\begin{bmatrix} a & -b \\ x & c \end{bmatrix} = \frac{1}{-11} \begin{bmatrix} -2 & 1 \\ -3 & 4 \end{bmatrix}$

$\begin{bmatrix} a & -b \\ x & c \end{bmatrix} = \begin{bmatrix} \frac{2}{11} & -\frac{1}{11} \\ \frac{3}{11} & -\frac{4}{11} \end{bmatrix}$

$-b = -\frac{1}{11}$

$b = \frac{1}{11}$

Figure 3. Answer about the number 2, students were asked to solve the problem by using a backward thinking strategy. The subject appeared at the first step was correct by answering the question from the beginning, but the subject made an error in operation 4 (-2) - 3 (-1) the result should be -8- (-3) = -8 + 3 = -5. The subjects did not solve the mathematics problems carefully.