P – 5

Using Metacognition In Learning Mathematics Toward Character Building

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Abstract

The Ministry of National Education (Kemdiknas) plans to implement character education. Mathematics is one subject that has a big influence in preparing the students to be able to think logically, analytically, systematically, critically, and creatively, and have the ability to cooperate, allowing to be given values to build students character. Metacognition is the awareness of cognitive processes. By using metacognition, someone does all the activities with full awareness. When learning mathematics by involving his metacognition, he will be able to observe the relationship between data in the problem with the prior knowledge, to re-examine its accuracy, aswell as solving a complex problem with the simple steps, and asks himself and tries to clarify his opinion. This paper aims to develop learning Mathematics materials that consist of values and involve students metacognition to form a competent human resources and human character, discipline, honest, who perform all acts by full awareness. always make good planning, monitoring and evaluating their action.

Keyword: character, values, metacognition

A. BACKGROUND

In this era of globalization, the world seems increasingly integrated, barriers become increasingly vague; so that everyone will be more easily communicate with others, not limited by distance and time. This will result in increasingly vague cultural barrier that will further result in the character of a nation will be depleted. Nowadays the nation is in the damage moral alarming phase, because it occurs in almost all lines, both the state bureaucracy, law enforcement officials, even in the education world. If this is allowed, the nation will be heading for destruction.

National education carries out the task to develop everyone to be an intact human being and a characterized developmental resource all at once. School as an educational institution is a vehicle to prepare students with character in order to survive in the global era. Start from the 2011/2012 new academic year, the Ministry of National Education (Kemdiknas) plans to implement the character education. In accordance with the theme of this year's National Education Day (Hardiknas), which is, "Character Education as the Pillar of The National Awakening", with the sub-theme is "Reaching Higher

Achievement by character building", character education materials will be given start from early childhood education (Pendidikan Anak Usia Dini) to college, including non-formal and informal education.

As a part of the culture, mathematics has a contribution to realize the entire goals of the society. Mathematics helps people to understand life and the outside world, and provides the tools to deal handle all scope and experiences of human. The goals to give the mathematics courses listed in Kurikulum Tingkat Satuan Pendidikan (KTSP) is to have the ability to think logically, analytically, systematically, critically, creatively and also to have the ability to cooperate (KTSP).

In accordance with the goals of mathematics education and the characteristics of mathematics, it can be a vehicle to implant the student's character, by applying the learning methods that contains values and involve student's metacognition. Students will be accustomed to make a plan before doing something, monitoring, and evaluating all their actions, so that it will form a competent and good character human resources .

B. DISCUSSION

This section described character, metacognition and their implementation on learning mathematics.

1. Character Education and Values

Character education at schools refers to the process to implant the values, as understandings, the procedures of nurturing and living the values, and how a student has the opportunity to practice the values significantly (Koesoema, 2010: 193). Thomas Lickona states that "character education is a deliberate effort to help people understand, care, and act upon core ethical values." As a character educator, the teacher must have the vision and mission to establish positive student character. As long as it does the learning will guide the students to properly assess a value, understand the good and the bad and does it, cares about the right thing that has to do.

According to Linda (1997: xxvi), values divided into two categories, that are values of being and values of giving. Values of being includes honesty, courage, love of peace, the reliability of self, potential, self discipline, knows the limit and the purity. While the values of giving includes loyalty, trustworthy, respect, love, affection, sensitive, unselfish, kind, friendly, fair, generous.

A teacher has duty to teach and educate. According to Ki Hajar Dewantara (Soeratman, 1985: 77):

> mengajar berarti memberi ilmu pengetahuan, menuntun gerak pikiran serta melatih kecakapan kepandaian anak didik kita agar kelak menjadi orang yang pandai. Mendidik berarti menuntun tumbuhnya budi pekerti dalam hidup anak didik, supaya kelak menjadi manusia berpribadi yang beradab dan bersusila. Keluhuran budi manusia itu menunjukkan sifat batin manusia misal kesadaran tentang kesucian, kemerdekaan, keadilan, ke-Tuhan-an, cinta kasih, kesetiaan, kesenian, ketertiban, kedamaian, kesosialan dan sebagainya, sedang kesusilaan atau kehalusan itu menunjukkan sifat hidup lahir manusia yang serba halus dan indah

Ki Hadjar Dewantara (Soeratman, 1985: 80) also taught that in learning everything we should use principles: "*tetep* (tetap/straight) – *mantep* (mantap/steady) – *antep* (berbobot/ weighted)", to achieve what we want is necessary that we always stay in our jobs, faithful and obedient to our principles. Then no one will hold or deflect our steps. "*ngandel* (percaya/believe) – *kendel* (berani/brave) – *bandel* (tahan uji/time-tested) - *kandel* (tebal/thick)". Anyone who can believe, would be brave, and strong and then he will have thick body. And "*Neng* (*meneng*/peaceful), - *ning* (*wening*/clear mind) – *nung* (*hanung*/strong) – *nang* (*menang*/win, has authority)". Anyone who can be calm, can clear his mind, he can easily distinguish the deserve or not, right or wrong, so he will be strong, strong in his will, strong physically and mentally, to achieve what he wanted, eventually he will win, and entitled to the results of his efforts (Suratman, 1985).

Because of the objects of mathematics are abstract, we need special techniques to learn it. In solving mathematics problems, one should be focusing mind, taking steps orderly accordance with the principle, taking steps consistently and steadily, until he is able to perform well, which in the end surely will be able to solve the problem. If this value implanted when studying mathematics, it will become culture that sticks into students and influence their behavior. As Swadener and Soedjadi's ideas (1988) which declare that values can be derived into cultural values, practical values, educational values and historical values.

According to Sheah and Bishop (Dede, 2006), values in mathematics education is divided into two groups, value of the mathematics itself and value of the mathematics education. Value of mathematics itself consists of Rationalism, Objectivism, Control,

Progress, Mystery and Openness. Value of mathematics education consists of accuracy, clarity, conjecturing, creativity, effective organization, efficient working, enjoyment, flexibility, open mindedness, persistence, and systematic working.

In this paper, those values will implemented and showed into mathematics learning, so these values will implanted into the students.

2. Metacognition

Definition of metacognition

The term of metacognition introduced by John Flavell, a psychologist from Stanford University at around 1976. According to John Flavell, metacognition is defined as thinking about one's thinking processes. It has to do with the active monitoring and regulation of cognitive processes. Metacognition also defined as one's knowledge concerning one's own cognitive process or anything related to them (Flavell, 1976:232). According to Woolfolk (1998), in information processing model, executive control process called as metacognitive skill because the process can be used intensively to direct or regulate cognition process. Metacognition is an executive function, it means a cognitive process which controls and regulates another cognitive process, which manage and control how one utilize one's mind and the highest and the most advanced cognitive process. Metacognition is an activity where someone stands outside one's head and tries to contemplate the way one thinking or how the cognitive process is done. Then Woolfolk expressed that there are three essential skill which able to control cognition process, such as planning, monitoring and evaluating. Brown (Gamma, 2004) said that metacognition is knowledge about executive control systems and the evaluation of cognitive states such as self appraisal and self management. Blakey (Blakey, 1990), considered that metacognition is thinking about thinking, knowing "what we know" and "what we don't know".

From those definition, metacognition can be defined as one's knowledge, awareness, and control towards one's process and thinking result, so that one knows what they know and know what they don't know, and by metacognition one can solve the problem by linking the information with the knowledge that they have, choose the right strategy to develop the planning, monitor implementation and evaluate the thinking process.

Metacognitive Strategy

Metacognitive strategy refers to the way to improve awareness about thinking process and learning process happen. If this consciousness is present, one will be able to controls their mind by designing, monitoring and evaluating what they learn. By using metacognitive strategy, student can control their learning through these processes : (i) Designing what to learn (ii) Monitoring self learning improvement (iii) Evaluating what they learn. Specifically, three steps of metacognitive strategy are:

a. Designing process

In this process, student:

1) Guessing what to learn, how the problem mastered and impression of learned problems.
2) Providing themselves physically, mentally and psychologically
3) Making plans from a way to the best way to obtain answer of a problem.

b. Monitoring process

In learning process, student needs to ask to themselves from a problem to another problem, such as

1) Is there any problem I can do?
2) Does this mean something to me?
3) How can this problem explained?
4) Why do I unable to understand this story?

c. Evaluating process

Through this process, student makes reflection to understand:

1) How does he master a skill, value and knowledge?
2) Why do I easy/difficult to master it?
3) What step do I have to take?

With this knowledge, student is able to think the most suitable strategy to master a new subject.

North Central Regional Educational Laboratory (NCREL,1995) expresses three basic elements from metacognition specifically to face task, such as:

1) Developing plan of action
2) Maintaining/monitoring the plan

3) Evaluating the plan

Furthermore, NCREL provided explanation to implement those three element of metacognition as follows:

a. ***Before*** - When you are *developing* the plan of action, ask yourself:
1) What in my prior knowledge will help me with this particular task?
2) In what direction do I want my thinking to take me?
3) What should I do first?
4) Why am I reading this selection?
5) How much time do I have to complete the task?

b. ***During*** - When you are *maintaining/monitoring* the plan of action, ask yourself:
1) How am I doing?
2) Am I on the right track?
3) How should I proceed?
4) What information is important to remember?
5) Should I move in a different direction?
6) Should I adjust the pace depending on the difficulty?

c. ***After*** - When you are *evaluating* the plan of action ask yourself:
1) How well did I do?
2) Did my particular course of thinking produce more or less than I had expected?
3) What could I have done differently?
4) How might I apply this line of thinking to other problems?
5) Do I need to go back through the task to fill in any "blanks" in my understanding?

Excerpted from *Strategic Teaching and Reading Project Guidebook.* (1995, NCREL, rev. ed.).

According to Livingston (1997: 2) cognitive strategy is used to help individual to reach certain target, while metacognitive strategy is used to ensure that the goal has achieved. Metacognitive strategy refers to the way to improve awareness of thinking process and applied learning. If this awareness present, one can control their mind by designing, monitoring and evaluating what they learn. That's why in using metacognitive strategy, student can control their learning by these processes: (i) Designing what to learn (ii) Monitoring self learning improvement (iii) Evaluating what they learn.

3. Mathematics Learning Contain Values by Involving Student's Metacognition to Build Student's Character

According to Herman Hudoyo (2003), mathematic related to abstract ideas, which symbolized, arranged hierarchically and deductive reasoning. Learning mathematics is a highly mental activity. Learning mathematics is hierarchically, which means that there are knowledge and skill parts which is a prior knowledge that needed to learn the next

part of mathematics knowledge. This kind of view contained within Piaget intellectual development theory. Piaget said that series of four steps (sensory-motor, pre-operational, concrete-operational, formal-operational) which form developmental hierarchy. Student should master those operations on a step before being ready to think and start the next step. A topic should be able to be learned if the prior hierarchy has been learned. A topic from a certain level in that hierarchy perhaps is supported by one or more topics on the next lower level. One maybe unable to learn certain topics because he failed to learn the topics below which support that certain topics (Gagne, 1977: 166). It means mathematic learning processes will occur smoothly if it is done continuously. Learning mathematics is in steps and consecutively and also based on previous learning experiences. So, to learn B concept which based on A concept, someone has to understand the A concept. Without understanding the A concept, it is impossible for someone to understand the B concept.

According to Sheah and Bishop (Dede, 2006), inside the mathematics is values which cover rationalism, objectivism, management, progress, mystery and openness. Whereas values in mathematics include accuracy, clarity of thought, ability to predict, consistency, creativity, effective organization, working efficiently, happiness, flexibility, open mindedness, persistence, and working systematically. These values are able to implanted by learning that involve students' metacognition, because of by involving metacognition, someone did something with a full consciousness, always make good planning, monitoring and evaluating their action.

Metacognitive experience involves metacognitive strategy or metacognitive regulation. This process consists of planning and monitoring of cognitive activities and evaluating on the result of this activity. Planning activities such as objectives setting and task analysis help to enable relevant prior knowledge to facilitate organizing and understanding the subject matter. Monitoring activities include the person's attention when he reads, and understands the problem and integrate it with prior knowledge. Setting activities include the adjustment and improvement of students' cognitive activities. These activities help to increase performance by overseeing and correcting his behavior at the time he completed the task.

The use of metacognitive strategies in solving mathematical problems, is a sequential process that is used to control cognitive activities and ensure that the

cognitive objectives have been achieved. Metacognitive experiences involve metacognitive strategies or metacognitive regulation.

Blakey, (1990) argued that The basic metacognitive strategies are:

a. Connecting new information to former knowledge.
b. Selecting thinking strategies deliberately.
c. Planning, monitoring, and evaluating thinking processes.

According to Livingstone (1977), teaching with metacognition will:

a. Helps develop a repertoire of thinking and learning skills.
b. Fosters the student's confidence and independence.
c. Encourages the students to self-regulate their learning
d. Improves decision-making and goal-setting skills
e. enables students to self-assess the quality of their thinking
f. enhances responsible citizenship
g. increases awareness of other learning styles
h. Helps to decide which strategies to use in which learning situation.
i. Strengthens essential skills and employability skills

Learning Mathematics involves metacognition for example by problem solving. In mathematical problem solving, Polya (1973) referenced four stages as follows:

a. Understanding the problems
   Knowing what is known and unknown, and what requirements known. Familiarize student to write what is known and what is asked in the problem, so they can think about the requirements needed and know which direction to go.
b. Devising the plan
   Find relations between data and the asked one or the proven one. Choosing the most suitable theorem or concept, and choosing and determining the most appropriate way to solve the problem. Familiarize student to write down the needed formula or theory which related with the problem. If necessary marked with certain signs, for example draw a box or color pen.
c. Carrying out the plan
   Carrying out the plan. Checking each step. Proving that the steps are correct.
d. Looking back
   Re-checking the obtained result by comparing obtained answer with the problem and writing down the conclusion of the asked question.

The usage of metacognitive strategy on mathematics problem solving is a consecutive process that used to control cognitive activity and ensure that the cognitive goals have reached. By always connecting new information with previous knowledge and choosing the appropriate solution strategy, besides making the students better understand the concept, it will implant values such as strict accordance with principles, consistent, self-control, honest, objective, rational, openness. While by making the

planning, monitoring and evaluating of thinking processes, students can choose the most appropriate way of solution, or settlement of the most controlled. This can implant the values of accuracy, clarity of thinking, the ability to estimate, creative, effective organization, work efficiently, flexibly, openness of thought, perseverance, tenacity and work systematically.

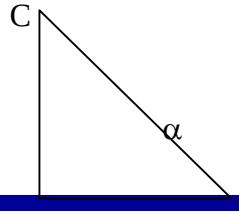
The learning can be implemented with lectures, then proceeded with the group discussion and class discussions. For enrichment, students are given individual tasks. (1) In the group activities, students work on group worksheets, students work with a group of friends to find a solution, discussion, questions and answers among group members, and agree the final results of the work of the group. In this case the student may request assistance from the teacher if all members of the group can not find the answer. Teachers inform the background of the importance of learning, previous knowledge to remember, and give motivation to the students. (2) In the classically activities, representatives of the group presenting the results of group discussions, the others give response, then get the result of discussions. (3) At the individual activity, students work on independent worksheets, students work alone, and if students find difficulty, students can ask to the teacher, not to their friend.

As an example to this following contextual problem:

> On the top of a monument, there's a flame statue. Someone wants to measure the height of the flame statue on the top of the monument by measuring angles. From a place as far as 100m from the bottom of the monument, he sees the base of the flame, the line forms 45^o with the horizontal line. Whereas when he looks at the top of the flame, the line forms 60^o with horizontal line. What is the height of the flame on the top of the monument?

This problem can be solved by some different ways, such as:

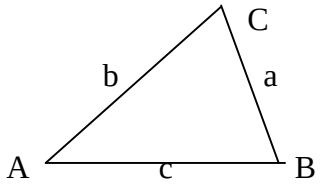
1. Using the special properties of triangle and length comparison of the sides, and then using Phytagoras theorem. Besides that, it also uses the properties of congruent triangles.
2. Using tangent formula



B A

$$\text{Tangen A} = \frac{side\ length\ front\ of\ angle}{side\ length\ beside\ of\ angle} = \frac{BC}{AB}$$

3. Using sinus formula



$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

In solving problems, students are accustomed to complete in accordance with the Polya steps, by writing down something known from the problem, if necessary, make sketch or drawing. Furthermore, students are also accustomed to write down what is asked in the problem. Thus, students is expected to be familiar with the problem, know where have to go, know the previous knowledge that required, so they can make a great plan by choosing the most suitable way. They always do monitor each step of problem solving so they always tread with caution and consideration. Then they do evaluate or reflect on what has been done. This will instill values such as persisted in holding the principle, consistent, self-control, carefulness, honesty, objective, rational, openness.

The students are accustomed to choose and apply the formula and choose their own problem solving method. In this matter, the students can finish it by group discussion or individually. Then discuss the possibilities that exist by accommodating and appreciating all the opinions from each student. In this way, students will be able to find, choose, and apply the formula properly. The students will be able to find the other solving alternative and choose the most suitable or the most efficient. These things can implant the values of accuracy, clarity of thought, predictive ability, creative, effective organization, working efficiently, discipline, flexibility, open mindedness, persistence, and working systematically.

When it has finished, the students are accustomed to re-evaluate their work. By re-evaluating all of their works, they will get the right result, allowing the students to assess their own quality of thinking will also train the values of carefulness and accuracy.

C. CONCLUSION

By mathematics learning contains of values which involve students' metacognition, teacher can add the noble values in accordance to the characteristics of mathematics to build the student's character. And by involving metacognition, which is the thinking skills about their thoughts, will make someone's view become clear, so that the learning process will become more meaningful. The learning process starts from something already known, the students build their own knowledge, they are trained to make plans, monitoring and evaluating their work. Thus, the student will be familiar to do every activity with a great planning, properly monitored and evaluated with full awareness, which will ultimately form competent. These things can infuse the values of accuracy, clarity of thought, predictive ability, creative, effective organization, working efficiently, discipline, flexibility, open mindedness, persistence, and working systematically.

Involving metacognition in learning mathematics, the teachers can infuse the values of confidence, predictive ability, creative, effective organization, work efficiently, discipline, diligence, and work systematically. By working cooperatively, the teachers can infuse the value of mutual respect, openness, tolerance, self-confident, honest. By working individually, the teachers can infuse the values of discipline, honesty, hard work, confidence.

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