

**THE METACOGNITIVE REFLECTION ABILITY TO ARRANGE THE STRATEGY
OF MATHEMATICAL PROBLEM SOLVING**

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Abstract

Most of people don't born with carrying and teaching capability. Capability of teaching can be learnt and be advanced continually. One of the method to proceed continually the effectivity of its root is by personality estimation. As far the reflexion must be understood as one of some of metacognitive effectivities. Metacognitive reflection needs the learning situation which gives more focus to the learner to think the action. In breaking the mathematical problem the learners need to have metacognitive ability for arrange the strategy. So that the reflective thinking is one the thinking forms which prepare some finishing to a problem that appears and the metacognitive guards all of the finishing cognitive process for finding the best and right finishing.

Keyword : Metacognitive, reflection, mathematical problem solving.

INTRODUCTION

Factor of success of a child future is determined by how the development of all aspects of themselves, namely the physical development, cognitive, emotional and spiritual develop optimally. Reflection is a way of thinking about what just be learned or think in the past. Reflection is needed because the knowledge must be contextualized in order to be fully understood and applied largely. Based on categorical system that classified the cognitive activity. **First part** of this paper shows how far the reflection must be understood as one of some met cognition activity. This case then shows that the case proved useful for consider the situation which different from reflection, illustrated with example taken from mathematical class in primary school level. **Second part** shows how seen based on given task that cause student doing reflection and how to stand before the demand of student to reflect the different cases in mathematical education.

Based on Permendiknas no. 16 of 2007 about teacher competition mentioned that the teacher must do reflective action for improving the quality of learning (pedagogical competition). In this case the teacher is demanded to do reflection towards the learning that has be done in the class and use that reflection for repairing and developing in learning subject matter. When this reflection activity is done continually shall can help to improve the professionalism of teacher. Reflection in learning is a way of thinking about what that just be learned or think back about what that have be done or learned in the past. Learning reflection is a responds towards activity or knowledge and skill that just be received of learning process.

At the end of learning process is better when the teacher keep time so that the student to reflection that being existence in form :

- Direct statement about learners obtained that day.
- Journal of learning in the private book of learners.
- Impression and suggestion of learners about that day learning.

Learning reflection is not a diary about learning that only notes the event and activity of learning from time to time but the teacher record the reflection and the teacher's thinking. Write in reflection usually focused on the response/ value of a teacher toward what that have learned. Metacognition is thinking awareness of someone about the thinking process of them. Metacognition has two components namely : (1) Metacognition knowledge and (2) Metacognition skill. Meta cognitive knowledge related to declarative knowledge, procedural knowledge and conditional knowledge. Just metacognitive skill related to planning skill, prediction skill, monitoring skill and evaluating skill. Together with cognitive psychology development, it is develops the way of teacher in evaluate the reaching of learning result for the first rate to cognitive domain. In this time in evaluate the result of learning the teacher only give pressure to cognitive direction without mind the dimension of cognitive process especially metacognitive knowledge and meta cognitive skill. The result of expedient for introduction the meta cognitive in finishing mathematical problem to student is too few or inclining is neglected. That's why one of the aspect of knowledge dimension and skills that attractive to be analyzed deeply especially in mathematical learning is meta cognitive aspect.

Schoenfeld (1992) shows in more specifically that there are three ways for explaining the metacognition in mathematical learning namely : (a) Conviction and intuition (b) Knowledge about thinking process and (c) Self regulation. Conviction and intuition accord to mathematical ideas whatever be prepare to finish mathematical problem. Knowledge about thinking process according how accurate someone in realizes his thinking process in another case self proficiency or self regulation according to someone accurate in keep and regulate what must be done to finish the mathematical problem and how accurate someone using input from his observation to direct the activities to finish the problem. Begin from all cases mention above can be said that meta cognition has important role in arrange and control someone cognitive process in learning and thinking so that learning and thinking done by someone can be more effective and efficient. That's why the metacognition of student in finishing mathematical problem will be a topic in study in this writing.

REFLECTION USEFUL IN MATHEMATICAL LEARNING

There is an old proverb says that "you are not know yet so you write it". By said to own self what have been learnt, we can follow the learning onward that we have done. We also begin to pay attention in distance between knowlegde and skill that we have. Fact that note what ever we have learnt is an intensive for more learning.

When teacher doing write the reflection journal, the useful can be found from this activity is :

- First, journal can be an instrument to control the working that has be done.
- Second, as self assesment.
- Third, as self mirror and
- Forth, as connecting document.

The best for teacher in make reflection journal is :

1. **Description.** Descript what happened /what you see / what you experience / what you do.
2. **Feeling and Thinking.** What you feel / think in according with what tou experience?.
3. **Evaluation.** What good/ not good, useful/ not useful from the happening/ experience?.
4. **Analyze.** What you understand from the experience happening? For instance, why only some children active work in group work?.
5. **Conclusion.** What must be done/ better be done?
6. **Future Planning.**

This follow is one of the example of learning reflection journal making by teacher after finish doing learning process in the class.

“To days learning, for me is very satisfactory, I feel that there is a successfully in many cases; the activity of students is so high, their creativity is very good, their courage is very improve, nobody not active. I am very glad to see their very closely relation to devide experience. The learning product of studeent is a concreate proof of their success in learning. But there is also happening that make me sad, namely there is a student not success making decision the sum that I have given although many ways I have done to motivicate. I feel difficult. For that I will try to look for another way in order he can follow his friends that success before. I think the learning scenario I have done is good enough. The problem of one child may be only a case that I have to approach him to help to make solution in the problem he has faced.

REFLECTION, IS UNDERSTOOD AS A METACOGNITION ACTIVITY

Central ideas about mathematical education in stand before challange as general and for excite the student thinking is a process connecting with mathematic, has presentet in mathematical literature of didactics along 2 last decate. So, the term “reflection” is seldom used. Kilpatrick (1986, page 8) says how the conotation of this term, first is used for explain physis and geometick fenomena change and right now as methefore for many kinds of cognitive process. Sjuts (1999 a, page 40) determined “reflection, thinking and examination towards to a problem that sign by diffensiation, detacement and their deeping explanation. First can find another description such as “for contain in soulsearching”. “For past in Revue” and “ for connected problem”. So, “reflection” is used fo explain certain kinds of cognitive thinking process in high level. Dubinsky (1901a, b) pressed reflection using for understand the mathematical by says :

“That however we change to another dimension when we meditate what we have done”

Kilpatrick (1986, page 9) points that reflection have been done from superior points that reflection have been done from superior point of view and by perspective-meta. Since the year of 1970 the term “metacognitive” has presented in cognitive psychology for kind of cognitive activity (compare Boekaerts 1996). Prefix “meta sgows that the internal process is central for this concept.

Wang, Haertel & Walbergt (1993, page 272) impress that metacognitive relevantion for study prestaton in generally. On metaanalysis of emperical study in study success at school also observed that metacognition in very good level about influence on prestaton study. Schoenfeld(1992) andDeCorte(1995) reported the importance for improving the activity of thinking process and learn mathematic.

Konrad(2005, page23) and Sjuts(1999a, page 40-44) different the term “cognition and “metacognition” from one each other. But (1979) shows in one side that “reflection” not be used consistenly in daily conversation and in other side for example shows too that the two concepts are not clear different and documented relevantion in explain student prestaton. By transcript way the part and student solution the action mecanism is demonstrated by certain activity from cognitive process.

CATEGORY SYSTEM FOR CLASSIFICATE THE METACOGNITIVE ACTIVITY

4.1. Category System Forming

From the year of 2001 untill 2004, a project supported by "Deutsche Forschungsgemeinschaft" (Jerman Research Foundation), sub-topic “Analysis of situation of

education and training reflection and metacognitive in mathematic in secondary school of education “is done in” Institute für kognitive Mathematic (IKM) of University of Osnabruck. Its topic has showed connection between metacognition and reflection. In this project built “metacognition” under mathematical didactic aspect. A single activity that identified and used for build a large category system metacognition activity is observed is interaction of teacher-student in mathematical education. This system then used in some part of transcription. Analyses come from Algebra lesson. In this process of forming category however being clear that the activity is observed and is identified also is pictured in more generally style. Its result, the categorial system can be used more general so that right now can be divided into group as a good mathematical activity (compare with Cohors-Fresenborg & Kaune 2005a).

The importance of metacognition for understand the mathematic so that in metamathematical science, think about the mathematical conception character and special procedure used when train mathematic (counting, proving, abstract, reifying), direct to main component of classic metamathematics (mathematical logical), computability theory, formal logical, axiomatic group theory).

4.2. To do the Categorial System to Analyse Lesson Problem

A lesson about “the same finishing” is choosed to picture the process to large interaction “Reflection” and metacognition”. This case shows too what criteria is adapted to make different the reflection from another metacognitive activity.

Arrangement of First Situation :

The student Ela stands in front of blackboard that write message :

$$0.\bar{6} \cdot (x - 5) - \frac{2}{3} \cdot (11 - 2x) = 1 + x$$

that must be finished. Moderate procedure Ela, She will call student, who is permitted to detect one term of writing and write it. This is a part of class culture that student stand in blackboard not for control the input that given by class about their completeness and truth. Also she is forbid to change the content of what have been dictated.

Heni : Yeah, with good, first time I turn $0.\bar{6}$ to $\frac{2}{3}$ because that time is a little (Ela draws the sign of equivalent and write fraction $\frac{2}{3}$ below $0.\bar{6}$ She then turned and being Heni)

Ela : It's not finished, right?

Heni : And now, of course, write down the reminder. And, well, you of course can be done directly the distributive law, too, humming, two-third times five with minus two-third equals with one plus X.

[Ela wrote what Heni dictation aloud in class].

Ela : Moni !

Moni : I think (...) in the second row not work out entirely namely on two-third of a second time, the algebra sign appears for the second time in front of number and in front two-third of negative sign, humming, after first bracket sign so that, the two-third negative and when you then (While Moni speaking, Ela already change the minus in front $\frac{2}{3} \cdot 2x$ being plus), apply the distributive law and then you must, $-\frac{2}{3} \cdot 11$, and then and then, hum Heni not, not dictated “plus” but must being negative sign again in front of two-third.

Ela : I only put it there

Moni : Yeah, but wait a minute. Oh, I see.

Ela had put it there, yes it works now

Heni : So, did I do mistake?

Ela : if he makes mistake. Can we look for some one in right side and inspect again on the blackboard?

Heni : I don't find, not all.

The mistake making be clear on object. Especially the student making clear the variable substitution. When do the distributive law.

Heni : So, now I have done mistake in seldom time. I am neglected and be less after drone, after $(x-5)$, because, humming, I only have idea in my head that I always good, terms first in front of sign the same with, humming, I am divides into two parts, $0,6 \cdot (x - 5)$ is the first part and other parts are $2/3 (11 - 2x)$. And between humming. I have minus that means how I must always less the two parts of the first. So it seen as in my head. And that's wrong.

Pepen : Yeah, humming, I like to add something for what.

Heni only says that he makes mistake with cases like that, good, humming whwn I do this job at home or more and they hum a liittle again and have cases like this, make not enough, so I put under line the parts, much more part of time.

So, humming, that my way to see, that there is negative sign infront that you must calculate then, whwn you the distributive law. Yes, this way will work good enaough whwn you thin continually all the time.

Interpretation

An analyse from before line reveals the difference between discursive and meta cognitive activity of participant. Moni not onlycritics the school mistake. At the second line not work fully "but She shows his conciousness of mathematical method, She look carefully the wrong application of distributive law. This is a specification of observer one category of categorial system. "Metagocnitive activity in count and proof" (Cohors-Fresenborg & Kaune 2005a) used for classificatate the metacognitive activity in mathematical education in that IKM. Which makes mirror the value category and evaluation, says then "which works now" include in second category, which mention reflection. Heni position "I don't get, not yet, all fall in another sub categorial observation. The same case for journey to overcome the wrong conception after the mistake is already discussed in object level. This case is clearly that she ask herself what for to continue the mistake that can be make make clearly the result of wrong general conception.

This case can be assumed that this follow understanding interaction happens. Since the conception of Heni's wrong address, Pepen bring the conception and metacognitive process that hooked. Ela's activity must be evaluated differently. Along counting, she monitores the contribution of her class friend. "This is not finish yet, what's that"? She has corrected Moni, mistake before her sentence finish yet. This research withher, while the control of what be wrote and said is happened and make correction whwn it is needed, falls in another sub categorial research. All what Heni says consist of metacognitive activity that different with what she says formerly, before dicts the term of writing again the next step in counting "I am first". She also explains this step "because then that is a little more consist. So that, she follows th consistence of number note. Acting to make clear the next step about calculation or strategy before, as be observed here in local truth that results profit that falls

Suggestion from teachers for arrange, hold the reins "Control again on the blackboard" is according is connected with the same category but different with the same category but different with sub category. In its contribution for discussion, Pepen shows discursive quality and meta cognitive activity that is evaluated differently, explanation to her home work. At the line she reports on appear format is chosed purposely, mark purposely the certain part of equally "I under line much more of timing part". At last, she evaluates her procedure "this way works good enough". It is involve the reflection research on the planning size.

Three acts, planning, research and reflection are main categories fill with some sub

category, each from more large category system consist of meta cognitive activity of students and teacher. In first changing, the activity “planning, research and reflection” is different clearly. The planning that making first on the beginning discuss, research “on line” in mental reflection of activity process according with re-observe after that it is finish. Clearly reference to time has fuction as different aid for metacognitive activities. But on inspection more nearly planning or research process also can be given analysis, process research can be planned, may be it is planing steps also can be showed for reflection. Even research process of reflection and planning that can be believed.

This analysis shows that the activity of “planning”, “research”, “reflection” are needed to be differently towards each other. Also, differensiation at that time is mentioned not absolutly one each other but only relatively. This case also can be observed in line analyse. We here have matter with not special reality in mathematic in one level can be an object from a higher level. In mathematic, we usually have ideas that the function argument other (for example when making different or making integration). Student metacognitive activity is documented in transcript as mirror of result of continually steps taken in mathematic especially education a long a teaching year. Probability of student way to act we observe in transcription. One of the steps that shows in demodification of teacher role to improve mathematical education (Bundesministerium für Bildung und Forschung [Kementarian Federal Jerman pendidikan dan penelitian], 2001, page 49) press that mathematical teacher idealy must take mediatory role that not “eat” information to student, but give opportunity for develop and change their thinking alone. As mediator, teacher place student ideas into lesson contexts, according to what have said, thinking one each realization of ideas. While that goals are realized as goal for teacher behavior, student class, this individual has shown some of behavior and activity of them.

Other Problems

For students analyse solution of following problem make simple the following form if necessary

$$\sqrt{\sqrt{18 - 4,5} \cdot \sqrt{18 + 4,5}}$$

Heni : “First I think, the result will not be found, but now, I know, it must be $-\sqrt{2,25}$ dan itu adalah - 1,5 ”

Eva : “It is impossible, because the solution is a wrong syntact”.

Ela : “not only solution but first line must wrong”.

Ari : “Every lines are wrong. I think we may not even begin to count”.

- Where of Heni coment do you agree?
- Why Eva thinks that her solution wrong in syntact?
- Do you agree with Ela?
- Please evaluate that comment of Ari.

Problem Analysis

Heni’s comment in problem part, “express student attitude that can be pictured as improver manipulation of term. They don’t think the basic rule that make basic. They adjust part of this term in the way of advanced manner pleasantly. A combining correct calculation and wrong one, and not enough attitude and student wrong under standing is showed in fictive dialogue form. On problem, student explain non obedient of domain function root and meaning of same level term in order doen’t problem in clear at the first looking the difference is entered in root function while build terms of heart doesn’t pictured name number but doesn’t pictured

name number but doesn't entered into function domain of outer root.

This problem is entered to the kind "Take a position" principals! Design and intension effect of problem like have been cleared in Kaune (2001, page 44). Kind of this problem push student to do meta cognitive activity "Reflection" that Kilpatrick (1986, page 8) explains like follows. Although so, the reflexion idea changes thinking of some one who is a strong person for thinking about thinking alone of someone.

Linguistic and logical complex, Heni's comentair is scattered into different parts. If "This doesn't work" is interpreted like that so that the Term write again is impossible, someone can agree with first sentence. A counting that separate from

$$(\sqrt{18 - 4,5}) . (\sqrt{18 + 4,5}) \text{ the result } - 2,25.$$

Amount of result $-\sqrt{2,25}$ shows correctly without root. Design of Heni's second sentence is agreed with last of same level term.

Marion's answer of question a

"First assumption Heni is right because $\sqrt{-2,25}$ is not the name of a number.

There is no amount that the result 2,25 times with himself. You are not be permitted only for write algebra sign.

So that, metacognition consist of ability to ask and answer following question

- What do I know what must I know?
- Do I know what must I know?
- Do I know where can I get some information, knowledge?
- How many time I need for learn this?
- What strategy and tactic that I can use for learn this?
- Do I understand what I hear, read or see?
- How I know if I am learning on suit level.
- How I can see if I do a mistake?
- How must I change my plan if it not suitable with hope/my satisfication.

CONCLUSION

- Metacognitive activity in counting and proving that are used to classify the meta cognitive activity in mathematical education.
- Reflection thinking is a thinking from that apply some finishing for a problem that appear while meta cognitive is more to how keeping all cognitive processes for getting the best and exact finishing.
- Reflection is used for pictures special kind of cognitive thinking process in high level.
- Self reflection is an important part of learning process that better do by a teacher.
- By writing learning reflection journal teachers will record their experience in teaching.
- As learning agent, teachers need to make usual their self for learning reflection journal. The truth learning reflection journal made by teachers can be an instrument to repair learning quality in class, when it is done continually can ends in more higher of teacher professionalism.

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