The Metacognition of Junior High School Students in Posing Mathematical Problems Viewed From Cognitive Style

1st Abdul Rachman Taufik
Departement of Mathematics Education, Faculty of Teacher Training and Education, Musamus University
Merauke, Indoensia
taufik_fkip@unmus.ac.id

2nd Sadrack Luden Pagiling
Departement of Mathematics Education, Faculty of Teacher Training and Education, Musamus University
Merauke, Indoensia
pagiling_fkip@unmus.ac.id

3rd Dian Mayasari
Departement of Mathematics Education, Faculty of Teacher Training and Education, Musamus University
Merauke, Indonesia
mayasari_fkip@unmus.ac.id

4th Anis Munfarikhatin
Departement of Mathematics Education, Faculty of Teacher Training and Education, Musamus University
Merauke, Indonesia
munfarikhatin_fkip@unmus.ac.id

5th Irmawaty Natsir
Departement of Mathematics Education, Faculty of Teacher Training and Education, Musamus University
Merauke, Indonesia
natsir_fkip@unmus.ac.id

6th Oswaldus Dadi
Departement of Mathematics Education, Faculty of Teacher Training and Education, Musamus University
Merauke, Indoensia
oswaldus_fkip@unmus.ac.id

Abstract— **This study examines the metacognition activity of grade IX junior high school students in posing mathematical problems based on reflective and impulsive cognitive styles. The subjects in this study were selected based on the equivalent result of mathematical ability test and the results of the Matching Familiar Figure Test (MFFT). Two students were selected as research subjects. The technique of data collection is done by giving the task of problems posing and task-based interviews. Data analysis uses steps to reduce data, present data, and draw conclusions. While to get valid research data, used time triangulation. The results showed that metacognition activities at the step of understanding information, both subjects carried out planning, monitoring, but did not carry out evaluation activities in thinking of other alternative ways that could be better used in understanding information. At the step of developing a plan for problems posing, the two subjects carried out planning and monitoring activities but in the activity of evaluating the reflective subject did not conduct an evaluation in convincing himself that there were still other alternatives that could be used to make the question. At the step of formulating the problem, both subjects carried out planning, monitoring and evaluation activities. At the step of resolving the problem made, the two subjects carried out planning, monitoring activities, but in the evaluation activities of impulsive subjects did not conduct an evaluation in re-examining the results of the implementation in solving the problem. At the step of re-examining the problems made, both subjects carried out planning and evaluation activities, but in monitoring activities impulsive subjects did not carry out monitoring in thinking of ways to be able to convince themselves that the process of posing problems carried out in the task was correct. This finding provides additional evidence that by using metacognition activities, students are able to control their knowledge in posing mathematical problems.**

Keywords— Metacognition, Problem Posing, Cognitive Style

I. INTRODUCTION

Learning mathematics requires a thought process to plan what will be done when he learns, monitors and re-checks what is learned and decides whether he has mastered what has been learned. Knowledge and awareness about his own thinking and the ability to plan, monitor, and evaluate the processes and results of his own thinking are known as metacognition

Metacognition made of two separate but related aspects: knowledge about cognition and regulation of cognition. The second aspect refers to the type of decision behaviors one makes in order to: (a) Become aware of decisions necessary for planning the solution processes, and of the effective use of such decisions; (b) Monitor progress (monitoring actions and effectiveness of applying strategies); (c) Assess the situation and evaluate solution Kazemi, Fade, & Bayat [1]. North Central Regional Educational Laboratory (NCREL) Metacognition consists of three basic elements: (1) Developing a plan of action, (2) Maintaining/monitoring the plan, and (3) Evaluating the plan [2].

Kuhn and Dean [3] states that awareness and management of one's own thought. While Sternberg [4] states that metacognition is knowledge and awareness of cognitive processes and ability to monitor, regulate and evaluate one's thinking. Therefore, student metacognition has an important role in solving mathematical problems. Ozsoy & Ataman revealed that students with high metacognition skills have better performance in problem solving [5]. Kazami et al. [1] emphasized that success in solving complex problems requires various metacognition processes, namely by examining themselves for accuracy and controlling the process of problem solving step by step, so that learning and thinking carried out by students in solving problems becomes more effective and efficient.

Resnick [6] says that to improve problem solving skills, students can be trained by stimulating them to analyze problems, make questions and predict situations. Siswono [7] says problem posing activities have positive influences on students 'ability to solve or resolve mathematical problems and provide a chance to gain insight into students'

understanding of mathematical processes and concepts. When students make a problem themselves, students 'sense of ownership of these problems can help improve students' ability to build their own knowledge. By posing a problem will increase the ability and reinforce the students' mathematical concepts and principles.

Siswono [8] defines problems posing is a simple question formulation or reformulation of existing questions with several changes to be simpler and can be mastered. This happens in solving complex questions. This understanding shows that problems posing is one step to solving problems. Meanwhile, according to Suyanto [9] problems posing is to solve the problem by elaboration, which is to reformulate the problem into simpler parts so that it is easy to understand. Problem posing is the basis for developing students' metacognition abilities. Students who have good metacognition so that their cognitive abilities will also be better.

According to experts. Palobo [10] states the step in posing a problem by asking students to examine the questions and solutions produced then asking to compile new questions that are related and solve them. Silver and Cai [11] It has been noted that the term "probem posing" is quite distinct form of mathematical cognitive activity: (a) pre-solution posing, a student makes a question based on the information provided. This means that students make problem posing based on the task information that has been given. (b) within-solution posing, a student recreates the question as it has been completed. It aims to train students in establishing an understanding of a mathematical concept or solving mathematical problems that have been learned; (c) post-solution posing, a student modifies the condition of the completed problem to make a new question. This study uses the problems posing in the form of a post solution posing, because in the secondary school level, students are required to solve various problems, especially in mathematics. By applying this type students can increase students' understanding of certain mathematical concepts.

Students in posing a problems need the ability of metacognition. The ability of metacognition to be influenced by how these students obtain, store, and use the information they receive. The way a person processes, stores and uses information to respond to various types of environmental situations is called cognitive style. Students who have different cognitive styles will be different in responding to a problem. There are students use time quickly in solving problems but tend to be wrong and there are students use a long time in solving problems but tend to be right. These two different characteristics are each called reflective cognitive style and impulsive cognitive style. Hassan [12] states that impulsive children make quick decisions, with more errors, while reflective children take decisions, and make fewer errors. They term this set of individual differences the Reflective-Impulsive (RI) dimension.

II. METHODOLOGY

The purpose of this study was to obtain an in-depth understanding of the metacognition activities of grade IX junior high school students in problems viewed from reflective and impulsive cognitive styles. To determine the research subject, the researcher was guided by the MFFT (Matching Familiar Figure Test) test developed by Al-

Silami with 22 items to classify reflective and impulsive cognitive styles and also mathematical ability tests (MAT). This criterion was proposed so that differences in the metacognition process of students did not tend to be influenced by mathematical abilities and gender but only influenced by cognitive style. Selected students can communicate well when expressing ideas verbally or in writing based on interviews with mathematics teachers. The selected research subjects were given mathematical problems posing test (MPPT) and conducted interviews to obtain data about the students' metacognition process directly and to explore data that was not revealed from the written results. To test the credibility of the data, researchers used time-type data source triangulation, which was triangulated data obtained from MPPT 1, MPPT 2 and interviews. Researchers take data from the same research subject at different times. While the data analysis includes the phase of data reduction, data presentation in the form of descriptions of student metacognition, and conclusions.

III. RESULTS AND DISCUSSION

Selected subjects were given questions about problems posing twice in different times, with each problem consisting of 2 question items. After that the subject was interviewed to dig up information that was not revealed on the answer sheet. The following are indicators of student metacognition in problems posing.

TABLE I.   STUDENTS METACOGNITION IN PROBLEMS POSING

Steps of Problems Posing	Indicator of Metacognition in Problems Posing
Understanding information	*Planning* Be aware of the processes and results of thinking, in developing planning when understanding problems by Thinking about how to understand the information contained in the problem that are by reading questions, making pictures, or other representations
	Monitoring Be aware of the processes and results of thinking, in monitoring implementation when understanding problems by Convincing himself that the way to understand the information done is correct.
	Evaluation Be aware of the processes and results of thinking, in evaluating actions when understanding problems by Thinking of better alternative ways to better understand information
Developing a plan for problems posing	*Planning* Be aware of the processes and results of thinking, in developing planning when thinking of plans by: Thinking of a strategy plan that will be used in making a question
	Monitoring Be aware of the processes and results of thinking, in monitoring the implementation when thinking of plans by Convincing himself that the strategy to be used is in accordance with the objectives of the question
	Evaluation Be aware of the processes and results of thinking, in evaluating actions when thinking of plans by: Thinking of other alternative strategy plans that

	can be used to make questions
Formulating problems	**Planning** Be aware of the processes and results of thinking, in developing planning when formulating problems by: Thinking about how to formulate problems by writing down the problems that are thought of.
	Monitoring Be aware of the processes and results of thinking, in monitoring the implementation of actions when formulating problems by: Monitoring their knowledge in determining possible errors in writing. Monitor his knowledge that problems are made easy to understand
	Evaluation Be aware of the processes and results of thinking, in evaluating actions when formulating problems by: Re-examine and decide that the problem is made in accordance with the plan in mind.
Resolving the problem made	**Planning** Be aware of the processes and results of thinking, in developing planning actions when solving problems by: Think of ways to implement procedures for resolving problems made
	Monitoring Be aware of the processes and results of thinking, in monitoring actions when solving problems by: Convincing himself that the procedure for implementing the strategic plan carried out was correct
	Evaluation Be aware of the processes and results of thinking, in evaluating actions when solving problems by: Re-check the correctness of the procedure for implementing the strategic plan in resolving the problem made
Re-examining the problem made	**Planning** Be aware of the processes and results of thinking, in developing planning when re-examining problems made by: Thinking of ways to re-examine the process of the problem posing task. Thinking about what needs to be checked again
	Monitoring Be aware of the processes and results of thinking, in monitoring actions when re-examining problems made, by: Convincing himself that the way to check back is done correctly.
	Evaluation Be aware of the processes and results of thinking, in evaluating actions when examining problems made by: Correcting his own potential in posing problems

To gain a deep understanding of student metacognition activities, results from student work are analyzed using indicators in the table I.

Task 1
Anita and Dinda are catering entrepreneurs. Today they have to shop at a supermarket to buy sausages and meatballs. Anita goes to a supermarket to buy 5 kg of meatballs and 3 kg of sausages, she pays to the cashier Rp 155,000.00. Dinda shop at the same supermarket to buy 2 kg of meatballs and 8 kg of sausage at a price of Rp. 164,000.00.   a. What is the price of 1 kg of meatballs and 1 kg of sausage?   b. After solving the problem, make a different question and related to the question information! Complete the problem you

A. The Reflective Cognitive Style Subject.

- Understanding information.

P	How do you understand the information in this matter?
SR	Read it repeatedly and underline the information in the question.
P	Is that way you can understand the problem well?
SR	Yes

At metacognition activities at the step of understanding information, reflective students carry out planning activities in thinking about how to understand information, namely by repeatedly reading the tasks given and marking important information contained in the questions so that it takes more time to understand the information. This is in line with Haghighi, et al. [13] that reflective people, reffered to as thoughtful are slow and accurate, took longer to respond, and consequently made fewer errors. Reflective students carry out monitoring activities in believing themselves that by reading the questions repeatedly and marking the information contained in the task can understand information better and mention things that are known and asked from the questions correctly, but do not carry out activities evaluation in thinking of alternative ways that are better than the methods used to understand information on the task.

- Developing a Plan for Problems Posing.

P	How do you process the initial problem so that you can make new questions?
SR	I noticed the example of the problem, Sis. Then I made a question similar to the one you give.
P	What kind of problem do you imagine?
SR	I changed the price paid by Anita and Dinda
P	What do you mean??
SR	You see, the price of 5 kg of meatballs and 3 kg of sausages paid by Anita is Rp. 155,000. Na, now I change it to Rp. 39,000, while in Dinda Rp. 164,000 to Rp. 36,000
P	Then, why are you thinking about a problem like that?
SR	Because I am looking for the easiest way.

Metacognition activities when developing a plan for problem posing, reflective students carry out planning activities in completing the task part b and explain the reason for the source of the idea in making the question. Reflective students do monitoring activities in convincing themselves that the strategic plan used in making questions is in accordance with the purpose of the question. They plan to make easy

questions by changing the numbers related to the problem or changing the requested price according to the initial problem and changing the question on the initial question. This is in line with the findings of Silver and Cai [11] in formulating problems by modifying objectives or conditions of problems that have been resolved to produce new problems. Reflective students carry out evaluation activities in discussing other alternatives that can be used to make questions.

• Formulating Problems.

Translation:

Anita and Dinda are catering entrepreneurs. Today they have to buy sausages and meatballs at the supermarket. Anita went to the supermarket to buy 5 kg of meatballs and 3 kg of sausages for Rp. 39,000, -. Dinda bought in the same supermarket to buy 2 kg meatballs and 8 kg sausages for Rp. 36,000, -. What is the price of 1 kg of meatballs and 1 kg of sausage?

P	What kind of questions will you write about this?
SR	Like this. (students show the width of the answer)
P	Is this question that you wrote right?
SR	Yes (pay attention again to the question he wrote)
P	Is this question you wrote easy to understand?
SR	Yes (re-reading the question he wrote)

Metacognition activities at the step of formulating problems, reflective students carry out planning activities when thinking about writing down the problem in mind. After that the reflective students carry out monitoring activities in convincing themselves by investigating the truth written and convincing themselves that the problem is made easy to understand, namely by re-reading the problem made. Next the reflective students conduct evaluation activities while investigating the suitability of the plan with what is written by reobserving the problem.

• Resolving The Problem Made

P	What method do you use to solve the problem you wrote?
SR	Mixed methods
P	Apart from the method that you use, are there still other methods that can be used to solve the

	problem you are posing?
SR	Elimination, subitutution. and graph
P	Why is not the method you mentioned, which you used to solve the problem you made?
SR	Because the mixed method is easier.
P	Okay, now explain the steps in the mixed method that you used in solving this problem?
SR	I suppose x = meatballs and y = sausages. I made a mathematical model that is Anita 5x + 3y = 39,000 and Dinda 2x + 8y = 36,000. Then I eliminate the variable x. So that it yields y = 3000. Then I substitute y to the equation 5x + 3y = 39,000 so that x = 6000 so the price of 1 kg of meatballs and 1 kg of sausage is 6000 and 3000
P	Why suppose that x = meatballs and y = sausages?
SR	To make it easier to work on the problem
P	Can you replace variables x and y with a and b?
SR	You can, Sis.
P	Is every step that you do right?
SR	Yes already (paying attention to every step of completion)
P	Are you sure of the results you got?
SR	Sure.

Metacognition activities at the problem solving step, reflective students carry out planning activities in thinking about the procedure for implementing the strategic plan. Conduct monitoring activities in believing in themselves that the procedure for implementing the strategic plan carried out is correct and states to himself whether the use of knowledge possessed is correct, and conducts evaluation activities in re-examining the truth of the procedure for implementing the strategic plan in solving the problem. This is in line with Kuzel's [14] findings that success in solving complex problems requires the process of metacognition, especially in making mental representations by selecting and evaluating the effectiveness of the strategies used.

• Re-examining the problems made.

P	How do you know that your work is correct?
SR	I looked back at the question
P	What do you notice in your answer sheet?
SR	The question I made with the results of the solution.

The metacognition activity at the step of re-examining the problem is made. Reflective students carry out planning activities in thinking about ways to re-examine tasks that have been made, conduct monitoring activities in thinking of ways to be able to believe in themselves that the process of re-checking is done correctly, namely by examining tasks and paying attention to each step of completion. This is in accordance with the conclusions of the results of Kazami Et Al's [1] research that success in solving complex problems requires various metacognition processes, namely by examining themselves for accuracy, and

controlling the process of problem solving step by step. Furthermore, reflective students carry out evaluation activities in correcting their own potential in posing problems by saying they have difficulty in posing questions according to the purpose of the task.

B. *The Impulsive Cognitive Style Subject*

- Understanding information.

| P	How do you understand information in tasks?
SI	By reading it
P	How many times did you read it?
SI	Just once
P	Are you can understand the problem well by that way?
SI	Yes I Can

Metacognition activities at the step of understanding information, impulsive students do planning activities in thinking about how to understand information, namely by reading the questions once to identify what is known and asked. This is in accordance with Kenny's findings [15] that impulsive students are more concerned with speed in answering. Impulsive students carry out monitoring activities in convincing themselves that by reading the questions can understand the information and can mention things that are known and asked from the questions correctly, but do not conduct evaluation activities in thinking of alternative ways that are better than the methods used to understand information on tasks.

- Developing a Plan for Problems Posing

P	How do you process the initial problem so you can make a new question?
SI	I made a question similar to the previous question
P	What do you imagine that is like? What does it look like?
SI	Just change the name and numbers
P	Is that the only way to make a question?
SI	I think yes

Metacognition activities at the step of developing a plan for problem posing, impulsive students do planning activities in choosing the strategies that will be used in making a question that is changing the numbers and words contained in the initial problem. This is in line with the opinion of Silver and Cai [11] in formulating a problem by modifying a problem that has been resolved to produce a new problem. Impulsive students carry out monitoring activities in convincing themselves that the strategies to be used are in accordance with the objectives of the questions and believe that the questions they think can be resolved but do not carry out evaluation activities in convincing themselves that there are other alternatives that can be used to make questions.

- Formulating Problems
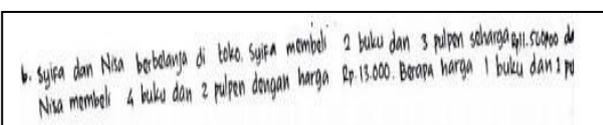
Translation:
Syifa and Nisa can shop at the supermarket. Syifa bought 2 books and 3 pens for Rp. 11,500, -. Nisa bought 4 books and 2 pens at a price of Rp. 13,000, -. How much is one book and one pen?

P	Is this question that you wrote right?
SI	I think it's correct
P	Is this question you wrote easy to understand?
SI	I think it's easy
P	Has this problem been in accordance with what you have planned??
SI	Already

Metacognition activities at the step of formulating the problem, impulsive students do planning activities in thinking about how to formulate a problem, namely by writing down the questions that have been thought of. After that the students impulsively carry out monitoring activities in convincing themselves by investigating the truth written and believing themselves that the problem is made easy to understand, namely by re-reading the problem made. Furthermore impulsive students carry out evaluation activities while investigating the suitability of the plan with what is written by re-observing the problem.

- Resolving The Problem Made

P	What method do you use to solve the problem you wrote down?
SI	I use the mixed method
P	Aside from the mixed methods are there other methods that can be used to solve the problems you make?
SI	There can be by elimination method or by subtitution method
P	Then, why do you use mixed methods to solve problems?
SI	I think it's easier to use mixed methods
P	Then, can you explain the steps in this mixed method?
SI	First I suppose that the question is asked by x and y then eliminate so that one variable is found. Furthermore, the variables found are inputted by one of the equations. So that these two variables are found.
P	Are you sure about this result?
SI	Sure
P	How can you be sure?
SI	Re-examine, and pay attention to the ways.

Metacognition activities at the step of resolving problems, impulsive students do planning activities in thinking about the procedure for implementing the strategic plan, conducting monitoring activities in believing themselves that the procedure for implementing the strategic plan is done correctly and stating to himself whether the use of knowledge possessed is correct, but do not carry out evaluation

activities in re-examining the truth of the procedure for implementing the strategic plan in solving the problem.

- Re-examining the problems made

The metacognition activity at the step of re-examining the problem made. Impulsive students carry out planning activities by examining the methods used in the task, but do not carry out monitoring activities in thinking about ways to be able to convince themselves that the process carried out in the task is correct. That is in accordance by Kazami et al [1] that success in solving complex problems requires various metacognition processes, namely by examining themselves for accuracy, and controlling the problem solving process step by step. Furthermore impulsive students carry out evaluation activities in correcting their own potential in raising problems by saying they have no difficulty in problem posing according to the purpose of the task.

IV. CONCLUSION

To be able to posing a problem, students actively plan, monitor, and carry out self-evaluations. In using this metacognition strategy, these students are constantly involved in how to understand information, develop a problem posing plan, formulate problems, resolving problems that are made and re-examine at the complete solution.

The results of this study indicate that the activities of students' metacognition in posing problems in terms of reflective cognitive style and impulsive cognitive style are different in carrying out planning, monitoring and evaluation activities at each step of posing problems. Based on the results of data analysis, it can be concluded that reflective students are better at conducting metacognition activities in planning, monitoring and evaluating the processes and results of their thoughts at each step of the problem posing. At the step of developing a plan for problem posing, reflective students do not conduct an evaluation because there is not enough time and feel confident about the plan they are thinking. While impulsive students do not carry out evaluation activities in solving problems because they do not have sufficient knowledge in solving problems made and do not carry out monitoring activities in look back the truth for the tasks that have been made. Based on the results of this study, it is recommended that teachers should pay special attention to students who are impulsive. Familiarize students to work on open questions, provide guidance to students about the steps in the process of posing problems step by step so that they can improve the accuracy of impulsive students and improve their metacognitive abilities, and students should develop their metacognitive abilities, so that they can obtain the purpose of the problem given.

REFERENCES

[1] F. Kazemi, M. R. Fadaee, and S. Bayat, "A subtle view to metacognitive aspect of mathematical problems solving," *Procedia - Soc. Behav. Sci.*, vol. 8, no. 5, pp. 420–426, 2010.

[2] NCREL 1995 Metacognition in Strategic Teaching and Reading Project Guidebook. Online: Http://Www.Ncrel.Org/Sdrs/Areas/Issues/Students/ Learning/Lr1-Metn.Htm.

[3] D. Kuhn and D. D. Jr, "Metacognitive, Cognitive Psychology and Learning," vol. 43, no. 4, pp. 268–274, 2004.

[4] Sternberg, R. J. (2004). Definitions and Conceptions of Giftedness. Corwin Press. Thousan Oaks. California.

[5] A. Ozsoy, G. & Ataman, "The Effect of Metacognitive Strategy Training Mathematical Problem Solving and Achievement," *J. Psychol. Psychother.*, vol. 03, no. 04, 2013.

[6] Resnick, L. B. 1987. Education and Learning to Think. Washington, D. C: National Academy Press

[7] Siswono, T.Y.E. 1999. Metode Pemberian Tugas Pengajuan Soal (Problem Posing) Dalam Pembelajaran Matematika Pokok Bahasan Perbandingan di Mts Negeri Rungkut Surabaya. Tesis Magister Pendidikan Matematika Surabaya.

[8] Siswono, T.Y.E. 2008. Model Pembelajaran Matematika Berbasis Pengajuan dan Pemecahan Masalah Untuk Meningkatkan Kemampuan Berpikir Kreatif. Surabaya: Unesa University Press.

[9] Suyanto. 2009. Menjelajahi Pembelajaran Inovatif. (Sidoarjo: Masmedia Pustaka).

[10] M. Palobo, "Mengembangkan Kemampuan Berpikir Kreatif Melalui Pembelajaran Problem Posing Dan Problem Solving," *Semin. Nas. Mat. dan Pendidik. Mat.*, pp. 875–882, 2015.

[11] E. A. Silver and J. Cai, "An Analysis of Arithmetic Problem Posing by Middle School Students," *J. Res. Math. Educ.*, vol. 27, no. 5, p. 521, 1996.

[12] Hassan, A. 2016. Influence of Reflective and Impulsive Cognitive Styles on Academic Self-Efficacy among Senior Secondary Students in Kaduna State. Master's thesis submitted to the department of educational psychology and counseling, A. B. U. Zaria.

[13] M. Haghighi, M. Ghanavati, and A. Rahimi, "The Role of Gender Differences in the Cognitive Style of Impulsivity/Reflectivity and EFL Success," *Procedia - Soc. Behav. Sci.*, vol. 192, pp. 467–474, 2015.

[14] A. Kuzle, "Patterns of metacognitive behavior during mathematics problem-solving in a dynamic geometry environment," *Int. Electron. J. Math. Educ.*, vol. 8, no. 1, pp. 20–40, 2013.

[15] R. F. Kenny, "Digital Narrative as a Change Agent to Teach Reading to Media-Centric Students," vol. 1, no. 11, pp. 459–467, 2007.