Representation of students metacognition in constructing of graphics

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Abstract. The concept of representation is one of the psychological concepts used in mathematics education to explain some important phenomena about how to think. Metacognition knowledge is an indicator of how well a person uses methods and strategies to control and improve their learning and knowledge. The purpose of this study is to describe the representation of students' metacognition in constructing graphics. This type of research is descriptive qualitative. Research subjects were 6 second semester students at the Department of Mathematics UNNES in 2018. The data collection technique used was a test in the form of constructing a graph. Test results are analyzed by referring to aspects of metacognition, which are revealed through student representation in resolving the problem of constructing a function graph. Based on the results of the analysis, can be grouped into 3 groups; namely Group (1): Students, able to plan problems by understanding the problem and choosing the right strategy, able to monitor the problem through illustrating the picture correctly can then find the results by connecting information obtained from prior knowledge and can relate to other material and be able to evaluate problems indicated by the ability to draw conclusions; Group (2): students have been able to plan the problem correctly but there are still errors in the writing of the settlement procedure, and are able to evaluate the problem through conclusions drawn from the results of the solution, although still not thorough, seen in the absence of units on the results obtained; Group (3): students have not been able to plan problems in writing but can explain the procedure through direct explanation, have not been able to monitor the problem because understanding of the concept is still wrong so it cannot solve the problem and is unable to evaluate the problem correctly.

1. Introduction
In education, metacognition is closely related to thinking activities or student cognition in solving problems. Metacognition consists of metacognitive knowledge (metacognitive knowledge) and experience or metacognitive regulation (metacognitive experiences or regulation). Metacognitive knowledge refers to obtaining knowledge about cognitive processes, knowledge that can be used to control cognitive processes [10]. While metacognitive experience is processes that can be applied to control cognitive activities and achieve cognitive goals. Metacognition knowledge is an indicator of how well students use methods and strategies to control and improve their learning and knowledge.

Representation is the ability of students to communicate mathematical ideas or ideas that are learned in certain ways. Variety of representations that are often used in communicating mathematical ideas include: diagrams or presentation of concrete objects, tables, mathematical statements, written texts, or a combination of all of them. Representations can be expressed as internal and external. Thinking about
mathematical ideas which are then communicated requires external representations whose forms include verbal, pictures and concrete objects. Thinking about mathematical ideas that allow one's mind to work on the basis of these ideas is an internal representation. Internal representations cannot be observed because they are mental [5]. It was also said by [5] that the best way to help students understand mathematics through representation is to encourage them to find or make a representation as a tool or way of thinking in communicating mathematical ideas. Mathematical representations involve the way students use to communicate how they find the answers.

Discussion of graphics has an important role in scientific studies, graphics are the center of scientific studies, especially the Cartesian graph is the center of world representation in natural science. Graphs are not only used to construct phenomena but can also be used to prove the existence of phenomena, and predict a phenomenon.

Students must be able to: (1) describe and represent tables, graphs, and rules; (2) construct, read and interpret tables, diagrams and graphs; (3) analyze tables and graphs to identify the properties and their relevance [14]. Mastery of graphics involves interpretation and construction. Interpretation refers to the ability of students to read charts and capture information from the graph. Graph construction refers to the action of building a graph based on data. To uncover the ultimate metacognition ability Students in using methods, strategies to control and increase their knowledge in constructing charts, they must represent them externally. Based on the background presented above, the problems in this paper are: What is the most representative representation of metacognition? Students in constructing the graph? The purpose of this paper is to describe the representation of student metacognition in constructing a graph.

2. Methods
This type of research is qualitative descriptive. The research subjects were 6 students in the second semester of the Unnes Mathematics Department in 2018. The data collection technique used was a test in the form of the task of constructing a graph. The test results are analyzed by referring to the aspects of metacognition, which are revealed through the ultimate representation. Students in solving problems construct the graph.

The process of data analysis begins with examining all available data, namely the results of written tests, interviews. The next step is to analyze the answers to the research subjects, examine the relevance of the subject's representation by comparing the data obtained with the theory (indicators). The final step is to conclude about the grouping of metacognitive representations of the research subjects studied in constructing the graph.

2.1. Theory Study
2.1.1. Metacognition Ability
Metacognition consists of metacognitive knowledge and experience or regulation of metacognition. Knowledge of metacognition is shown by ways of gaining knowledge about cognitive processes, and knowledge that can be used to control cognitive processes. The experience of metacognition is demonstrated by processes that can be applied to control cognitive activities and achieve cognitive goals [10].

Metacognition as thinking about thinking or thinking about thinking. Metacognition, is the ability to think that the object of thought is the process of thinking that happens to oneself. Some other experts argue that metacognition as thinking about thinking, learning to think, learning to study, learning how to learn, learn to learn, learning about learning [10].

Metacognition is knowledge, awareness, and control of cognitive processes that occur in oneself. Metacognition, as a form of cognition, or the process of thinking two levels or more that involves controlling cognitive activity. Therefore, metacognition can be said as thinking someone about his own thinking or someone's cognition about his own cognition.

From the several definitions that have been stated in the description above, we conclude about the following points of understanding of metacognition.

a. Metacognition is an ability included in the cognition group.
b. Metacognition is the ability to realize, know, the processes of cognition that occur in oneself.

c. Metacognition is the ability to direct the cognitive process that occurs to oneself.

d. Metacognition is the ability to learn how learning should be carried out which includes the planning,
monitoring and evaluation processes.

e. Metacognition is a high-level thinking activity. This is said because this activity is able to control the
ongoing thinking process in oneself.

2.1.2. Components of Metacognition

There are three important metacognitive skills, namely planning, monitoring, and evaluating. Planning,
involves choosing the right strategy and giving ways that affect results, for example making predictions
before reading, stages or sequence of strategies, and dividing time or paying attention selectively before
starting the task. Monitoring (monitoring), referring to one's awareness of understanding and results of
tasks, the ability to do self-testing regularly while studying is a good example. Evaluating refers to an
assessment of the results and accuracy of one's learning, for example reevaluating one's goals and
conclusions [16].

The ability of metacognition in efficient problem solving includes capabilities in: (1) planning
(planning) which includes estimating results, and scheduling strategies, (2) monitoring (monitoring)
which includes testing, revising, and rescheduling strategies done, and (3) checking (checking) which
includes evaluating the results of the implementation of a strategy based on criteria of efficiency and
effectiveness.

Activities such as planning, approaches to be given in learning tasks, monitoring capabilities and
evaluating plans in order to carry out tasks are the basic characteristics of metacognition.

Based on several explanations in the components of metacognition, then in this study researchers used
indicators of metacognition according to Schraw, namely planning, monitoring, and evaluating. Then the
indicators in this study are as follows [16].

| Table 1. Indicators of Metacognition |
|-----------------------------|-----------------------------|
| **Aspect**                  | **Indicator**               |
| Planning                    | 1. Students can plan what will be done |
|                            | 2. Students can plan the objectives to be carried out |
|                            | 3. Students can choose the right strategy |
|                            | 4. Students can sort the strategic steps that will be carried out |
| Monitoring                 | 1. Students can do calculations carefully |
|                            | 2. Students can check the answers to the results |
|                            | 3. Students can correct mistakes |
| Evaluating                 | 1. Students can assess the results done |
|                            | 2. Students can re-evaluate goals |
|                            | 3. Students can make conclusions |

2.1.3. Ability of Metacognition in Problem Solving

The development of metacognition skills in students is a valuable educational goal, because these skills
can help them become self-regulated learned. The metacognition strategy that involves the process of
designing, monitoring the implementation process and assessing each action taking, has an important role
in the learning process. The benefits are as follows:

a. Help solve problems effectively

Through designing strategies, it involves the process of knowing the problem, understanding the
problem that needs to be found a solution and understanding effective strategies to solve it.

b. Helps compile the right concept

Solve each concept that is learned from something complex to sub concepts that are easier, connect
previous knowledge to the concepts learned, know the theories and principles needed to understand
each concept that is learned. Using theory and assessing concepts that are learned to be applied in new
situations is a strategy of metacognition that is very necessary for students to formulate concepts appropriately.

2.1.4. Concept of Representation

Representation is a new form as the result of the translation of a problem, or the translation of a diagram/physical model into symbols or words [14]. Representations can be expressed internally or externally. Thinking mathematical ideas communicated in verbal form, images, graphics, tables, diagrams, and concrete objects are external representations [5]. Thinking about mathematical ideas that allow one's mind to work on the basis of these ideas is an internal representation. Internal representations cannot be observed because they are in the mental. Through external representation, mathematical ideas become more concrete. With this representation one can construct understanding and mathematical reasoning, can communicate and demonstrate understanding and reasoning. Representation can be used to describe the problems solving process in mathematics learning.

Representation can also be used to describe the Student's metacognition process in solving problems in mathematics learning. One's success in solving problems is supported by their ability to arrange representations of problems and use these representations as assistance in understanding situations and relationships between situations. In other word knowledge is represented internally, and that internal representation is structured. To think and communicate mathematical ideas, it is necessary to represent them in a certain way. Communication requires physical representation, namely external representation, in the form of spoken language, written symbols, images or physical objects [3].

One of the issues emphasized by Lester, is the role of metacognition in problem solving, where metacognition refers to what students know about their thinking processes, and how they monitor and regulate their thinking when working to solve mathematical tasks [10].

From the description that has been delivered in advance, it can be seen that in solving problems not only able to process cognitive with formulas that have been learned, but also must be able to look back on the thought process carried out in each activity. This is where the role of metacognition Students in solving problems is also needed, metacognition involves knowledge and awareness of the thought process in working on the task. This study will reveal the ultimate representation of metacognition. Students in constructing charts, by revealing their internal representation.

2.1.5. Concepts Graph of Functions

The discussion of functions is closely related to graph discussion, that graphics are central to scientific studies, graphs have been understood as something important from general process skills that are part of scientific activities. Especially the Cartesian graph is the center of the representation of natural science. Graphs can be used to construct phenomena, prove the existence of phenomena, can even be used to predict a phenomenon. In discussing graphics, it involves interpretation and construction. Interpretation refers to the ability of students to read charts and capture the meaning/purpose of information from the graph. There are 3 stages of the information process related to graph interpretation: step 1, is the basic stage that involves extracting data; stage 2, is the intermediate stage tends to see parts of the graph; and step 3, which is a high stage involving deep structural knowledge of the data.

2.1.6. Research instrument

This study will describe the representation of ultimate metacognition. Students in constructing the graph. The process of collecting data in this study uses task-based interviews, where subjects are asked to do several tasks to do on paper with a pencil /pen, asked to explain in detail what was done, discuss why to draw conclusions and other possibilities. The process of data analysis in this study is carried out by steps: transcribing the collected verbal data, examining all available data from various sources, interviews, observations already written in the field notes, and the results of graph construction, making data reduction by making abstractions. Abstraction is an attempt to make a core summary, process, and statements that need to be maintained to remain in it, analyze the thought process, analyze interesting things, and conclude. There are 3 tasks that must be done by students, all related to constructing graphics.
3. Results and Discussion
The results of the research of student metacognition can be grouped into 3 groups.

3.1. Group 1
Planning stage, students can: plan what will be done by explaining what information is known in the matter; Plan the objectives that will be done by clearly expressing the problem of what is sought; Choosing the right strategy to use in answering the problem; Sorts the stages of the strategy to be performed through a charting procedure by linking the information obtained with the knowledge it possesses; Breaking through the potential of completion activities in thinking and operating the results, can conclude from the outcome of potential activities without the need for settlement activities.

Monitoring stage, students can: illustrate problems in the form of images correctly according to existing concepts that have been previously pre-owned; Check the results obtained correctly; Fixing errors is seen at the completion of a stroke and then replacing them with the correct result; Demonstrate the ability to anticipate results from potential activities without having to complete all activities that are thought

Assessment stage, students can: assess the outcome by explaining that the resulting answer is correct; Re-evaluate the objectives indicated by expressing the task in trouble and linking it to the results already obtained; Conclude the problem of the work; Think of structures as objects and be able to make decisions about them without the effort of physical form or mentally represent the method of completion.

3.2. Group 2
Planning stage, students can: Explain what information is known in the question indicating that the student can plan what will be done; Explaining what information is sought in the matter indicating that the Student can plan the objectives to be performed; Choosing a strategy that is used in resolving the problem is appropriate although still using a quick way but already shows that the Student can choose the right strategy.

Monitoring stage, students can: break through previous activities in thought, and can anticipate potential difficulties; Check the answers of the results obtained correctly; Fixed error resolving problems. But the described problem solving procedure has not been resolved in sorting the stages of the strategy to be performed. The calculations are done carefully and correctly according to the procedures that have been compiled with the help of drawing illustrations made.

Assessment stage, students can: assess the outcome by explaining that the resulting answer is correct; Re-evaluate what objectives are sought in the problem and associate it with the results already obtained; Gives conclusions of the problem solving results.

3.3. Group 3
Planning stage, students can: clearly reveal the problem of what is known in the question that suggests they can plan what will be done; Reveal the purpose to be done by showing what is sought in the matter; Identify activities from previous tasks that are relevant to complete the new task. But not yet able to choose a strategy because it still feels difficult to implement strategies to be used when solving problems. Not able to sort the stages of the strategy to be done in solving problems in working on new tasks.

Monitoring stage, students can: illustrate the problem in the form of images but still wrong so that in the calculations some are still not true and yet thorough; Check the answers of the results but there are still errors; Identify the problem structure that is being encountered, but does not automatically turn into a representation or description that may represent the issue. But it hasn't been able to fix errors resolving problems.

Assessment stage, students can: reflect a process, but require the rules or the relationship underlying the problem. To achieve that goal, they must recall the structure they had gained on previous activity and use it in subsequent activities; Reevaluating what objectives are sought in trouble and linking them to the results that have been obtained even though it is still wrong; To conclude the outcome of the problem solving, but still wrong in taking conclusions because in resolving the problem also still there is a
mistake. Mahaiswa feel confident with the answers that are produced right when what is done there is still an error it shows that they have not been able to assess the results.

4. Conclusions
Representation of student metacognition in solving mathematical problems based on student thinking skills can be summarized as follows (1) Representation of metacognition students who have high ability in solving problems constructing graphs is done very well starting from planning shows when understanding the problem can do by expressing the problem clearly what is sought and what information is known. Can choose the right strategy according to the way of thinking. Can sort the stages of the strategy to be carried out through the completion procedure when constructing the graph by linking information obtained with the knowledge it has; Monitoring by illustrating the questions in graphical form according to the concepts that have been studied, the solutions made are appropriate in accordance with the planning in stages. Can check the answers to the results obtained correctly. Can fix errors seen at completion there are streaks and then replace them with the correct results; Evaluating is indicated by the belief that the answers that have been generated are correct, can re-evaluate the objectives indicated by revealing what is sought in the problem and connecting with the results that have been obtained and are able to provide conclusions from existing problems with what is done. (2) Representation of metacognition students who have the ability to construct a graph are done well starting from planning that is able to inform well what is known and what to look for in a problem that shows that students are able to understand the problem. The problems solving procedure described has not yet collapsed in sorting out the stages of the strategy that will be carried out and has not been explained in detail; Monitoring that shows the calculation is done carefully and correctly according to the procedures that have been prepared with the help of graphic illustrations made even though it is not equipped with known information. Can check the answers to the results obtained correctly. Can correct errors in solving problems; Evaluating is indicated by the belief that the answers that have been produced are correct even though not in detail. Can re-evaluate what goals are sought in the problem and relate them to the results that have been obtained. Able to provide conclusions from the results of problem solving. (3) Metacognition of students who have low ability in mathematical problem solving starts from planning which shows that it is able to express the problem clearly what is known on the questions that indicate that students can plan what will be done. Can express the purpose to be done by showing what is sought in the problem. Unable to choose a strategy because they still find it difficult to apply the formula to be used when solving problems. Cannot sort the strategic steps to be taken in solving problems in written form. But can express strategies correctly through words directly; Monitoring when illustrating the problem in the form of images is able to describe it well but there are also those that are still wrong so that in the calculations some are still not correct and not thorough. Can check the answers to the results obtained but there are still errors. Not able to fix errors in solving problems; Evaluating (assessment) which is indicated by confidence with the answers generated correctly even though what is done is still a mistake, this indicates that students have not been able to assess the results done. Not able to reevaluate what goals are sought in the problem and relate them to the results that have been obtained. Not yet able to give conclusions from the results of problem solving because in solving the problem there are still errors.

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