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Identification of Metacognitive Regulation Difficulties in Polya's Problem Solving

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ABSTRACT

The thought process is an activity that is carried out every day. The flow of thinking is a way of directing cognitive processes in solving problems. The ability to manage cognitive processes is metacognitive. The branch of metacognitive is metacognitive regulation. Metacognitive regulation and problem-solving ability have a linear relationship, so to increase problem-solving ability, the step that can be used is to increase metacognitive regulation. The aim of the research is to identify difficulties in metacognitive regulation in students in the medium, low and high groups so that educators can overcome these difficulties so that problem-solving abilities can be increased. This research is qualitative research. The research subjects are students of the Mathematics Education Department Ivet University. The data collection instruments were problem-solving ability test questions and interview guide sheets. Data collection techniques are tests and interviews. The data analysis technique is an analysis technique from Miles and Huberman. The data credibility technique used is technical triangulation. The research results obtained are the difficulty of metacognitive regulation on the indicators (a) determining the steps to be taken after understanding the problem, (c) making a settlement plan, (d) implementing the plan at the coherent implementation stage of the plan, (e) determining a more appropriate way of problem-solving.

Keywords: *flow of thought, cognitive processes, metacognitive regulation, problem-solving abilities.*

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INTRODUCTION

Thinking is a human activity that must be carried out in daily activities. Thinking is a personal human activity that produces inventions that are directed toward a goal (Wasahua, 2021). The thought process involves using the knowledge stored in one's memory to receive information, process it, and make conclusions (Widyastuti, 2015). The process of thinking toward a goal requires a coherent and systematic flow of thinking. The flow of thinking is the sequence of steps or processes followed in solving a problem or developing an idea. It is the way humans organize their thoughts, analyze information, and reach conclusions or solutions.

The flow of thinking and cognitive processes are closely related. Cognitive processes refer to the way the human mind processes information, including perception, attention, memory, problem-solving, judgment, and decision-making. The flow of thinking is a way to organize and direct these cognitive processes in the context of problem-solving or idea development. In the context of the flow of thought, cognitive processes occur in various stages or steps. For example, when meeting a problem, the cognitive process starts with identifying and understanding the problem (perception). Furthermore, the mind will process information related to the problem and collect relevant knowledge from memory (attention and memory). The cognitive process continues by analyzing the information, identifying patterns or relationships, and generating a deeper understanding of the problem (problem solving). Then, the cognitive process involves selecting the most appropriate solution or action (decision making) and implementing it (action). Flow of thought is a guide or framework that directs cognitive processes when thinking, solving problems, or developing ideas. Through cognitive processes, factors that support students can be identified in constructing their knowledge in an effective way, so that meaningful learning can be achieved (Salsabila, 2017).

The ability to guide cognitive processes is a metacognitive ability. Metacognitive is an awareness of thinking about what is known and what is not known. Increased metacognitive abilities will also improve learning outcomes (Hayati, 2011; Kusuma & Nisa, 2019). Metacognitive is an important factor in problem-solving (Risnanosanti, 2008). Problem-solving is one of the aspects tested on PISA. PISA 2018 results, Indonesia's average score is 378, this score is below the country's overall average score of 490 (OECD, 2019). Based on these PISA results, it is necessary to conduct research to improve problem-solving. Improved problem-solving can be done by conducting metacognitive training (Danoebroto, 2013; Fasha, Johar, & Ikhsan, 2019).

One of the metacognitive components in the context of problem solving is metacognitive regulation, namely the activity of choosing a plan, goals, choosing a strategy, implementing and developing the plan taken. (Wahyuningsih, 2019). There are 4 aspects in metacognitive regulation namely orientation, planning, monitoring, and evaluation (Backer, Keer, & Valke, 2012). Metacognitive regulation is the ability to plan strategies, set goals, and choose problem-solving strategies (Wahyuningsih, 2019). Strategic planning is the process of making plans coherently in solving problems. In this activity, students recall various concepts and understandings that will support the problem-solving process. Setting goals is the ability to determine the goals of the planned strategies used to solve problems. Strategy selection is the ability to select and use the most effective and efficient strategy for problem solving. The higher the level of student ability, the higher the ability of metacognitive regulation (Wahyuningsih, 2019) . Based on the results of PISA and the existence of a positive linear relationship between

problem-solving and metacognitive abilities, especially metacognitive regulation, it is necessary to conduct in-depth research on metacognitive regulation. The purpose of this study is to provide information to educators about the types of difficulties from metacognitive regulation to the Polya problem-solving process. If the difficulties of metacognitive regulation can be known early, then educators can provide treatment or prevention to overcome the difficulties of metacognitive regulation so that problem-solving abilities can be increased. Research related to metacognitive regulation (Binali, Tsai, & Chang, 2021; Stephanou & Mpiontini, 2017; Tibrani, 2017) and problem-solving (Davita & Pujiastuti, 2020; Mawaddah & Anisah, 2015; Sumartini, 2016) have done by many researchers before. The novelty of this study with other studies is to focus on the metacognitive regulation difficulties experienced by the low, medium, and high group when solving Polya's problem-solving problems.

In this study, indicators of metacognitive regulation use indicators of planning strategies, setting goals, and choosing problem-solving strategies. The problem-solving indicators in this study used Polya's problem-solving indicators, namely understanding the problem, planning problem solving, carrying out problem solving, and correcting the results. (Purba & Lubis, 2021)

METHOD

This research is a qualitative research that describes the results of an exploration of the difficulties of metacognitive regulation in the problem-solving process. The research subjects were students of the Ivet University Mathematics Education Study Program. Data collection techniques are using tests and interviews. The data collection instruments used were problem-solving test questions and interview guide sheets. The research procedure began with the researcher choosing to give trial test questions to Ivet University Mathematics Education Study Program students who had passed the Basic Mathematics course. The value of the trial results is then sorted from the smallest to the largest. 30% of students from the smallest order fall into the low group category. 30% of the students from the largest are in the upper group category, and the rest are in the medium group. Each of the low, medium, high groups then selected 1 student. The researcher also prepared problem-solving test questions before being given to students, the contents were validated by the validator. The indicators in the validation process are (does not cause multiple interpretations, (2) the boundaries given are sufficient to solve the problem, (3) the boundaries of the problems given are clear and functional. The results of the validation of the contents of the problem-solving test questions are valid. The items on the interview guide sheet content validation was also carried out with indicators (1) using language appropriate to the EYD, (2) sentences used communicative, (3) sentences not causing multiple interpretations. The results of the validation of the interview guide sheet were valid. Problem-solving ability test questions were then given to research subjects When working on the questions, the working process was recorded to anticipate new data findings that might be important in research. After working on the questions, the research subjects were interviewed in depth in turn to find out the difficulties in metacognitive regulation. The data analysis technique of this study was the data analysis technique Miles and Huberman, namely data condensation (noting comments that appear when making observations, interviews, and comments on student answer sheets), data presentation, and drawing conclusions. The data credibility technique is by triangulation techniques using different techniques, namely test and interview techniques.

RESULTS AND DISCUSSION

Determination of students in the low, medium, high groups, namely by giving test questions as presented in Figure 1. These test questions are given to students and then the results are used to determine the low, medium, high groups.

Diketahui trapesium sama kaki ABCD, dimana AD dan BC adalah sisi-sisi kakinya. Titik P adalah sisi pertengahan AB. Titik Q adalah pertengahan sisi DC. Buktikan $PQ \perp AB$ dan $PQ \perp CD$!

Figure 1. Trial Question Test

The problem-solving test questions given consist of 3 questions from the branch of mathematical geometry. Problem-solving test questions are presented in Figure 2.

1. Diketahui jajar genjang ABCD, titik P terletak di dalam bidang ABCD dan dihubungkan dengan keempat titik sudutnya.
   Buktikan: $Luas\ \Delta APB - Luas\ \Delta PCB = Luas\ \Delta PAD - Luas\ \Delta PCD$
2. Diketahui persegi panjang ABCD, titik P terletak dalam bidang ABCD.
   Buktikan bahwa: $PA^2 + PC^2 = PB^2 + PD^2$
3. Diketahui jajar genjang ABCD. Garis bagi dalam $\angle A$ dan $\angle D$ berpotongan di E. Panjang AB = 20 cm, AE = 16 cm, DE = 12 cm. Hitung luas bidang ABCD!

Figure 2. Problem-solving Test Questions

The results of research on metacognitive regulation on low group students, namely students in the low group think about what steps they will take after understanding the problem, but these students experience difficulties in algebra, namely when moving terms to other sides so that the formula is proven. Students think of changing the checking step in solving number 1 by separating the pictures in the checking step to make it easier to understand. However, there is a discrepancy in the images made against known information. For example in number 1, in the question point P lies in the plane ABCD without any information it is located at the intersection of the diagonals, but this student makes an image with point P located at the intersection of the diagonals as shown in Figure 3.

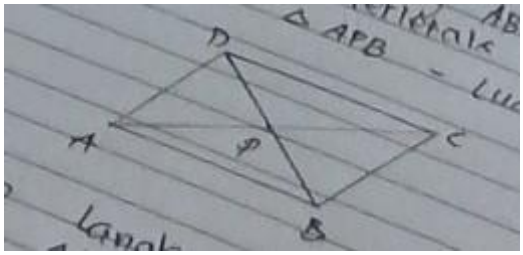

Figure 3. Visualization of the low group in Problem Number 1

Students in this low group can identify the purpose of the problems presented, students can identify what is known and what is required to be solved in the problem. Students also think of making a completion plan by noting the important

things from each problem to make it easier, even though the activity of making a completion plan is not an easy activity for them. This is consistent with previous research that students in the low group experienced difficulties in writing a completion plan because they did not know what to write in making a completion plan (Ninik, Hobri, & Susanto, 2014). All plans that have been made are also carried out, all are in the implementation stage of the plan, but in carrying it out, there is not exactly the same as the completion plan. Students think that there is a more appropriate way, namely in number 2 (in Figure 4), which was originally written multiplication, should have written addition. Based on the results of the interviews, students did not find it difficult to understand the problem, but still had difficulty planning problem solving.

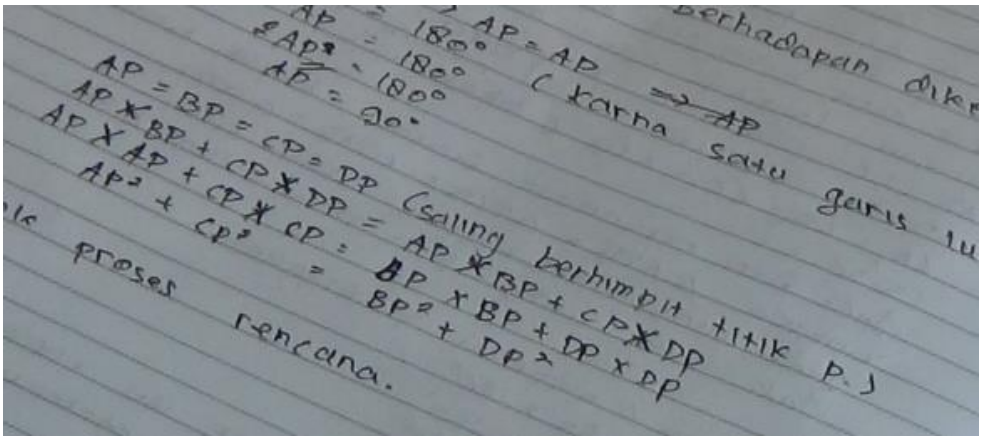

Figure 4. Visualization of the Low Group in Calculation Number 2

Students in medium group think about determining the steps to be used after understanding the problem. Students have the desire to complete the solution steps for number 3 by associating the congruence in the triangles and using the area formula of any arbitrary triangle presented in Figure 5.

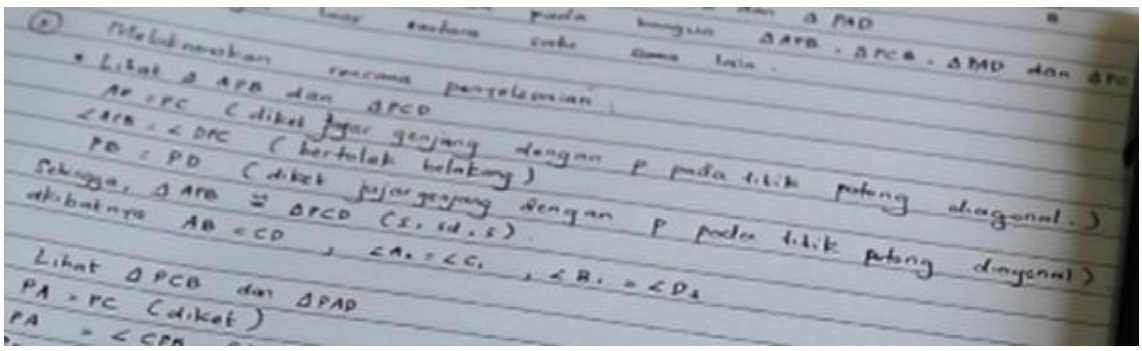

Figure 5. Visualization of the Medium Group in Calculation Number 1

Students can understand the goals expected in problems number 1, 2, and 3, but for number 3 the student has not had time to work on it due to lack of time. Students also think about making steps to solve the problem for each number, except for number 3 because the time allotted is insufficient. All the steps in the settlement plan were all carried out but number 2 was not coherent. Students sometimes insert additional completion steps when carrying out plans, but they are not written in the completion plan. Based on the results of the interviews, students in this group do not think to replace their answers with other, more

appropriate ways.

Students in the high group use pictures in order to understand the problem well. This was also done by students in the low and medium groups. Students can express their understanding of the problem in the form of an image, so that it will simplify the process of solving the problem. The ability to visualize shapes is needed in solving geometry problems (Muhassanah, Sujadi, & Riyadi, 2014). Students in the top group think about determining the steps to solve the problem but students are still confused about determining the sequence of steps to be carried out. Students do not think of changing the way of solving with other ways, but for number 3 the student feels that he thinks too highly so that some of the basic concepts are forgotten, namely the area of a parallelogram, which is presented in Figure 6.

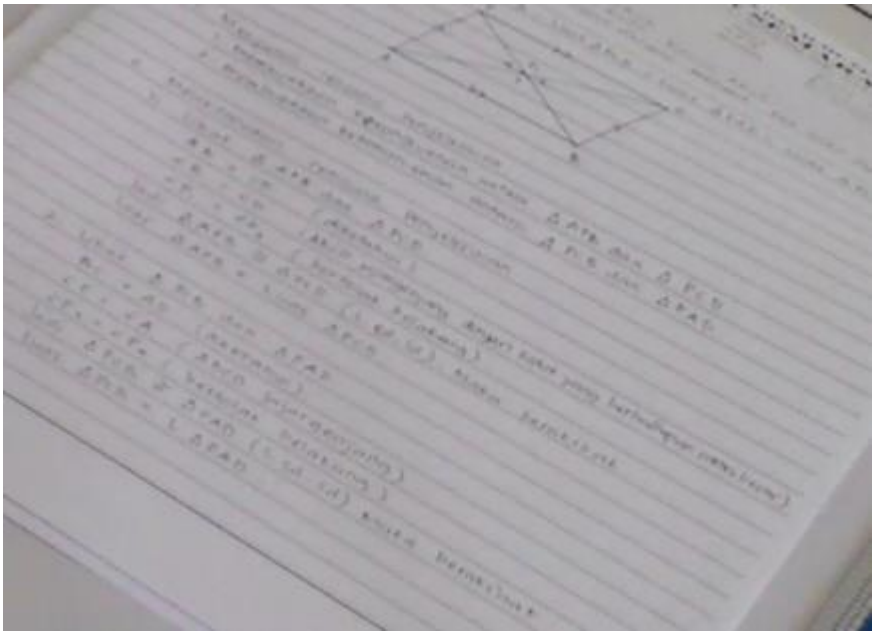

Figure 6. The Process of High Group of Working on Problem Number 1

In order for the problem-solving process to run efficiently, students need to know carefully what they have mastered and use it effectively. Selection of the wrong concept will affect the problem-solving process. There are 4 factors that influence the process of problem solving, namely motivation, wrong beliefs and attitudes, habits and emotions (Maulidya, 2018). Students can identify the goals/requested to be completed for each number. Students think about making steps in solving problems number 1, 2, and 3. Not all steps are carried out coherently, specially in number 1. Students write a plan to connect point P with the four vertex of the rectangle, the plan is carried out not at the implementation stage plan but at the stage of understanding the problem. Students think that the steps in the completion plan are coherent and there is no other, faster way to solve the problem. Based on the results of the interviews, students in the high group determined the steps in solving them after understanding the problem. Students also feel confident about solving the problem and do not think of using other methods.

CONCLUSION

The conclusions of this research are:

1. The difficulty of metacognitive regulation of students in the low group is determining the steps to be taken after understanding the problem, making a solution plan, using algebraic concepts in problem solving, implementing the plan at the stage of implementing the plan in a coherent manner, determining a more appropriate way of solving the problem.
2. The difficulty of metacognitive regulation of students in the medium group is determining the steps to be taken after understanding the problem, implementing the plan at the coherent stage of implementing the plan, determining a more appropriate way of solving the problem.
3. The difficulty of metacognitive regulation of students in the high group is implementing the plan at the stage of implementing the plan sequentially.

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