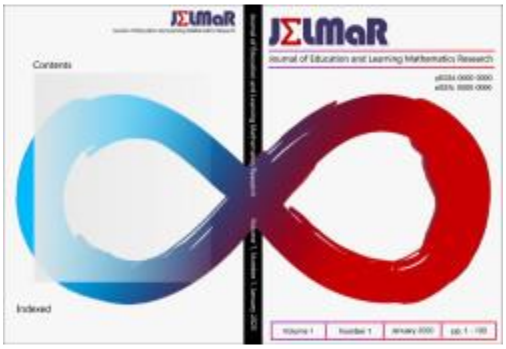

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Metacognitive Blindness in Mathematics Problem-Solving

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Abstract: *Metacognitive blindness is often found in students with unsatisfactory academic performance. However, this study aims to reveal the process of metacognitive blindness that occurs during problem solving experienced by students with quite good academic performance. The data collected is in the form of words obtained through interviews and pictures of the work of research subjects. Description of data analysis and interpretation of the meaning of findings using text analysis. Analysis is carried out in all phases of problem solving, including analyzing, exploring, planning steps to solve problems, implementing a problem solving plan, and checking again. The results of qualitative analysis show that subjects who are students with good academic performance can experience anomalous results during the problem solving process. In this study, the anomalous result in question is a condition where the subject feels anomaly during the problem solving process, where the anomaly is actually not there. In this case, subjects who have good academic performance tend to have too much confidence. This makes the performance in the problem-solving process less optimal.*

Keyword: Self-confidence, Metacognitive Blindness, Problem-solving, Mathematics Learning

INTRODUCTION

Metacognitive abilities become the main indicator in achieving learning objectives (Jacobse & Harskamp, 2012). The involvement of metacognitive abilities becomes an important component in learning activities because it can encourage higher-order thinking skills (Wismath, Orr, & Good, 2014). Metacognition is defined as part of higher order thinking skills which includes understanding, analysis, and control of cognitive processes (Dorr & Perels, 2019). In this case, metacognition can support students in solving problems more effectively (Kim, Park, Moore, & Varma, 2013) and meaningfully (Hassan & Rahman, 2012; Safari & Arezy, 2012).

In relation to the problem solving process, sometimes the subject is not aware of the mistakes that have been made which are hereinafter referred to as metacognitive blindness (Faradiba, Sa'dijah, Parta, & Rahardjo, 2019b). Metacognitive blindness is characterized by redflags during the problem solving process. Redflag is a warning to pause or step back to the previous problem solving stage, to subsequently take immediate action in the problem solving process (Goos, Galbraith, & Renshaw, 2000; Goos, 2002). There are three types of redflag in the problem solving process, namely lack of progress (lack of progress/LP), error detection (error detection/ED), and strange results (anomalous result/AR) (Goos, 2002).

Each of the roles of redflag in metacognitive blindness can be explained as follows. First, the most common type of redflag is LP. LP is a condition when someone experiences an obstacle, deadlock in the problem solving process (Goos, 2002). This LP will cause metacognitive blindness when the subject is not recognized by the subject. In this case, the subject does not feel that he is facing obstacles or deadlocks so that the subject feels quite even though there are things that have not been successfully identified in the problem solving process. Second, the next type of redflag is ED. ED is a warning when a subject experiences a process error at the problem solving stage that requires the subject to check and correct errors (Goos, Galbraith, & Renshaw, 2000). ED will cause metacognitive blindness when the subject is not aware of any mistakes that have been made so that the subject continues the problem solving process without checking or correcting the errors. Third, the last type of redflag is AR. AR is a condition where the subject finds an odd/ unusual condition (Goos, Galbraith, & Renshaw, 2000; Goos, 2002; Stillman, 2004; Ng, 2010). This AR will cause metacognitive blindness when the anomaly or unusual in the problem solving process is not realized by the subject and the subject takes the attitude to ignore it. Indicators of unusual occurrence can be known when subjects find conflicting information or conflicting solutions.

So far, metacognitive blindness as a form of metacognitive failure always occurs in students who experience learning problems, for example students who experience math anxiety (Legg & Locker, 2009; Faradiba, Sa'dijah, Parta & Rahardjo, 2019b), students with impaired mathematics (Faradiba, Sa'dijah, Parta & Rahardjo, 2019a), or have unsatisfactory academic pretensions (Erickson & Heit, 2015). This study tries to uncover the phenomenon of metacognitive blindness that occurs in students with good academic achievement. The study in this study is expected to provide new insights related to metacognitive blindness as a form of metacognitive failure.

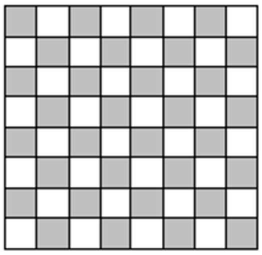
METHOD

This study aims to explore the problem and develop a detailed understanding of the phenomenon of mathematical anxiety in relation to the process of solving mathematical problems. Data collected in this study are in the form of words obtained through interviews, pictures of the subject's work in solving mathematical problems to get a picture of the subject's behavior. Description of data analysis and interpretation of the meaning of findings using text analysis. Research that has these characteristics is a qualitative study (Creswell, 2012; Fraenkel & Wallen, 2006). This research is categorized in qualitative research type with the research strategy used is case study. Case study research strategy is a strategy in which researchers investigate carefully a program, event, activity, process or group of individuals (Creswell, 2012). The case study in question is the process of solving mathematical problems carried out by the subject. In this case, the researcher explores the process to obtain the research objective, which is to describe the occurrence of metacognitive blindness when solving mathematical problems experienced by students with good academic achievement.

This research was conducted on students majoring in Mathematics Education, Universitas Islam Malang. The study lasted for four weeks. In the first week, researchers submit material related to mathematical problems that will be solved by the subject. In the second week, researchers collected data related to the subject's academic achievement in a number of courses taken in the previous semester. In the third week data collection was carried out in the form of subject work and interview results. In the fourth week the researchers analyzed and triangulated the data.

The sampling technique used was purposive sampling in which prospective subjects were selected from students with the highest academic achievement in the class. In addition, researchers who are teaching staff at the university are also one of the considerations, thus supporting data retrieval in order to obtain the results of the subject's work and interviews that really describe the condition of the subject. Next, selected subject candidates are asked to solve mathematical problems. Mathematical problems are given to the subject to reveal the existence of redflag in every stage of the process of solving mathematical problems. The mathematical problems used in this study can be seen in Figure 1.

Perhatikan papan catur berukuran 8 × 8 persegi satuan seperti yang tampak pada gambar di bawah ini:



1. Dengan memperhatikan perbedaan susunan warna pada papan catur, tentukan ada berapa macam persegi yang memiliki ukuran dan susunan warna berbeda pada papan catur tersebut!
2. Tanpa memperhatikan perbedaan susunan warna, tentukan berapa banyak persegi yang ada pada papan catur tersebut!

Figure 1. Mathematics Problem

The next step, the researcher analyzes the results of the prospective subject's work to ensure there is a potential for redflag that leads to metacognitive blindness based on indicators of metacognitive blindness during problem solving (Faradiba, Sa'dijah, Parta, & Rahardjo, 2019b).

RESULT AND DISCUSSION

The subject's answer to the first problem is 8 + 24 + 8 + 24 = 64. Meanwhile, the subject's answer to the second problem is 48 + 16 = 64. At the end answers, the subject also states that he needs more time to know (confirm) the size of all the squares that exist on the problem that has been presented.The problem solving stage by the subject in detail can be described as follows: First, the stage of understanding the problem. At this stage, the subject determines what is asked and identifies the information contained in the problem. At this stage, the subject does not experience redflag. This can be seen through the following interview transcript:

I: "What is asked in this matter?"
S: "The number of different squares that are on an 8 × 8 chessboard"
I: "What difference does it mean?"
S: "The difference in color is black and white and the size difference. To ensure there is a difference in my size use this small piece of paper as a reference"

In the dialogue snippet above it can be seen that the subject does not realize that the peculiarities that he finds are related to the unequal square sizes in the process of understanding the real problem does not exist. In other words, the subject experiences an AR type redflag. In this study, metacognitive blindness experienced by the subject has occurred since the early stages of problem solving. This is consistent with the research of Alexander, et al (1995) which states that metacognitive abilities are not related to IQ. However, metacognitive abilities can help subjects who have less ability or knowledge in the problem solving process. In line with this opinion, Swanson (1990) shows that the ability to solve problems is not related to IQ, but rather metacognitive. Students who have higher metacognitive abilities will be able to solve problems better than those who have lower metacognitive abilities.

The second stage is analyzing the problem. At this stage, the subject thinks of material related to the problem and relates the material to what is asked in the problem. The process of redflag when analyzing problems can be seen in the following interview transcript:

I: "What do you think about the first time to solve this problem?"
S: "Square is a flat shape with the same length on all four sides. So if the square has a size not the same then it will not be able to form another square with a larger size.
Therefore, answer for problem number one and problem number two the same, which is 64 square"

In this case, the subject does not realize that the peculiarities he found in the process of determining the number of squares actually do not exist. In other words, the subject experiences an anomalous result (AR) type redflag. This AR is a manifestation of the subject's excessive self-confidence in his ability to solve mathematical problems. In some studies, subjects who have low performance show excessive self-confidence than subjects who have higher performance (Kruger and Dunning, 1999; Dunning, et al, 2003, Miller and Geraci, 2011).

The third stage is exploring the problem. At this stage, S4 uses relevant information from the previous stage, which is about the concept of a square. This can be seen in the following interview transcript:

I: "What will you do to solve this problem?"
S: "By direct count, by matching the size of this small piece of paper"
I: "How do you determine whether a square is the same or different?
S: "By marking the size on this small piece of paper, if the sign is different it means the square is indeed different"

At this stage, the subject still does not realize that the peculiarities that he finds in the process of determining relevant information in the way used actually do not exist. This can be seen from the last dialog that shows the subject using small pieces of paper to ensure square size. Glaser, et al (1992) provide evidence that metacognition can differ based on the problem at hand. In general, successful problem solvers use metacognitive strategies more often than less successful problem solvers. In this case, the subject did not use a metacognitive strategy which included three stages, namely: designing what was to be learned; monitor self-development in learning; and assess what is learned. The subject since the beginning of the problem-solving phase, only focuses on sketches of square images that he thinks are not the same, so the problem presented fails to meet the definition of a square.

The fourth stage is planning problem solving. At this stage, the subject is thinking about approaches that can be used in finding a solution to a problem. This can be seen in the following interview transcript:

I: "Do you think there are other ways to solve this problem?"
S: "Yes, you can use measuring instruments with high accuracy in millimeters and nanometers"
I: "Are you sure this method you used can be used to find the solution to the first problem?"
S: "With limited equipment, I think this little piece of paper can be quite helpful"
I: "Okay, now are you sure about that way?"
S: "yes"
I: "Are there any difficulties in applying the method?
S: "No, because in my opinion this is the easiest and most likely method to be applied"

At this stage, the subject still believes that the size of the square in the sketch of the image is not the same. In this case, self-regulation can help subjects realize how much they know. However, this self-monitoring does not appear to be carried out by subjects who are overly confident. Without accurate feedback, subjects cannot choose the right self-regulation strategy to continue the problem solving process (Dunlosky, et al, 2005). Instead, the subject chooses a problem-solving strategy based on feeling of knowing (feeling of knowing) about the definition of a square and judgments of learning outcomes in a hurry related to sketches of the wrong image, both of which have been proven to be inaccurate in measuring the ability of self-related to a problem (Metcalfe and Finn, 2008). These inaccurate steps lead to the weakness of the subject in identifying the problem. Without knowing what they do not understand, subjects cannot make plans to fill the gaps in their knowledge (Erickson and Heit, 2015). As a result, the subject does not know what to do in the problem solving process.

The fifth stage is carrying out problem solving planning. At this stage, the subject applies the chosen approach and combines several approaches. This can be seen in the following interview transcript:

I: "How do you find a solution to this problem?
S: "At first I thought this was the same square, but if we zoom it turns out that the square size is not the same, so I decided to use pieces of paper "
I: "Fine, please explain how the process is?"
S: "So I put a small piece of paper on the top like this, then I marked using a pen to ascertaining its size, there are two kinds of squares of different sizes, so I give the name of the same white as big as 8, white as smallas 24, shading the bigger as much as 8, shading as small as 24 "

According to the metacognition model, subjects will stop learning when they believe that they are experts in the topic (Son and Sethi, 2010). This is what happened to the subjects in this study. In other words, the bias explained that, students who feel expert in a topic have excessive self-confidence that makes them reluctant to learn to accept new information. This phenomenon needs to be realized, so that good academic ability often backfires and is actually detrimental.

The final stage of problem solving is verification (re-checking the solution) to ensure that there are no calculation errors, concept errors, or procedural errors. This can be seen in the following interview transcript:

I: "Are you sure about this answer?"
S: "Yes, I'm sure, ma'am"
I: "What do you think of the problem presented here?"
S: "Very challenging, ma'am ... demands thoroughness and critical thinking"

Until the final stages of problem solving, AR type redflag that occur in subjects are still consistent. This means, the existence of AR is permanent. As a result, the subject experiences total metacognitive blindness where he is unable to realize that the errors/ peculiarities he discovers during the process of problem solving actually never exist.

CONCLUSION

Based on data analysis and findings it can be concluded that subjects who have good academic performance tend to have excessive confidence. This makes the performance in the problem solving process less optimal. It should also be noted that the redflag that occurs in subjects who are too confident is permanent and permanent. That is, redflag can be found at all stages of problem solving. As a result, the subject will experience total metacognitive blindness. Need further research, whether this metacognitive blindness pattern also applies to other types of mathematical problems. Future studies are expected to also be able to involve subjects in greater numbers so as to produce stronger data analysis.

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