MATHE*dunesa*
Jurnal Ilmiah Pendidikan Matematika *Volume 8 No. 3 Tahun 2019*
ISSN :2301-9085

COGNITIVE PROCESSES OF HIGH MATHEMATICS ANXIETY STUDENT IN SOLVING AREA CONSERVATION PROBLEM

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Abstract

Area conservation is a concept to modify the shape or position of a geometrical figure without changing its area. Skipping the concept of area conservation in learning area measurement causes students' difficulties in this topic. One of students' activity in math class is problem solving which is a cognitive process of the brain to search a solution for a given problem. Cognitive process is an activity that consist of receiving, processing, and using information. Cognitive process may affected by mathematics anxiety. Mathematics anxiety is a condition in which students experience unexplained anxiety during learning mathematics. This study is qualitative descriptive research which aimed at describing the cognitive processes of high mathematics anxiety student in solving area conservation problem. The data were collected by using mathematics anxiety test, area conservation problem test, and interview. The result showed that at the stage of receiving information, high mathematics anxiety students read the given problem and observe the given figures. At the stage of processing the information, the students devising plan by linked the received information with their knowledge, solving the problem, and evaluating the obtained solution. Student with high mathematics anxiety use the concept of area conservation to modify some figures. Moreover, high mathematics anxiety student did a simple estimation to determine the area of the given figures. At the stage of using information, student with high mathematics anxiety re-explain the given problem, the idea to solve the problem, every single steps in solving problem, and the obtained solution.
Keywords: Cognitive process, area conservation, mathematics anxiety

INTRODUCTION

Mathematics is one of the educational programs that develop critical, creative, logical, and systematical thinking capabilities (Moma, 2017). As one of the education programs, mathematics was taught to students from the beginning of their school life. One of the topics learned in mathematics is area measurement. To determine the area of a geometrical figure, students tend to calculate the area using formula or count the total squares inside the figure. Once they faced an irregular shape of geometrical figure, they found some difficulties to determine the area, because the teacher tend to skipped the concept of area conservation in the learning activities. By conservation, the modification of the shape or area of a geometrical figure will not change the area (Kordaki and Potari, 1999). So that, area conservation is a concept to modify the shape or position of a geometrical figure without changing its area. Based on Kordaki and Potari (1999), skipping the concept of area conservation in learning area measurement causes students' difficulties in this topic, specially when they face a mathematical problem related to area conservation.

Schoenfield (1985) explain that problem is a task that required significant effort for some students but it could be a routine exercises for others. A mathematical task can be called as a problem if: (1) understanable; (2) challenging; (3) solved by non-routine procedure (Wibawa, 2016). The procedure of problem solving is following this five steps (modified from Wang and Chiew (2010) and Polya (1945, in Van de Walle (2013)).

1. *Understanding the problem*: identifying the given information and question.
2. *Devising a plan*: determining the procedure/strategy to solve the problem.
3. *Carrying out the plan*: executing the determined procedure/strategy.
4. *Looking back*: evaluating the result and the procedure.
5. *Representing the result*: making a conclusion based on th result and procedure.

Referring to Schoenfield's statement that some students may called a task as a problem and the others are not, it can

be happen because of the students' differences in experience and cognitive development. Basically, all children pass through the stages of cognitive development even in a different time (Slavin, 2018). That is why someone's potential is not the same with others even at the same age. It was supported by Sudijono (2011) who said that each student has their own potential, so that they have different abilities. Cognitive development and students' knowledge affect students' cognitive process. Cognitive process is a human activities when receiving information (Brandimonte *et al*, 2006). While Jones (2006) state that cognitive process can be understood as information processing. Information processing is an activity that involve receiving information, organizing the information with known knowledge, storing information, and recalling information (Slavin, 2018). On other hand, Syah (2010) said that cognitive process is an acitivity that consist of receiving, processing, and using information. In this study, authors will describe the students' activity during receiving, processing, and using information. Cognitive process can be done by the role of human's memory system that consist of sensory register, working memory, and long term memory. Working memory is the most active memory during information processing (Slavin, 2018). Based on Arem (2010), working memory capacity is limited. Similar with Arem, Slavin (2018) explain that working memory capacity is limited and different to each other. That difference is affected by personal knowledge. On other hand, Trezise and Reeve (2017) said that working memory capacity is affected by the level of mathematics anxiety, it also affecting the level of mathematics anxiety.

Mathematics anxiety is a condition in which students experience unexplained anxiety during learning or doing something related with mathematics that affects their performance (Shannon, 2008). There are three level of mathematics anxiety, low, moderate, and high mathematics anxiety (Ambarwati, 2016). Based on Ambarwati (2016), each level has different effect to the students' performance in mathematics. Student with high mathematics anxiety tend to have more errors than the moderate and low mathematics anxiety. Moreover, they lack confidence in their mathematical ability. Yamani (2018) said that mathematics anxiety is able to disturb the students' cognitive process by decreasing working memory's activity. So that students can not process the received information well and finally can not solve a problem as expected.

METHOD

This study is qualitative descriptive research which aimed at describing the cognitive processes of high mathematics anxiety student in solving area conservation problem. Three students with high mathematics anxiety from VIII-B of SMPN 1 Sukodono, Sidoarjo were volunteered to have a paper and pencil test. The high mathematics anxiety student then called SHMA (Subject of High Mathematics Anxiety).

Students' mathematics anxiety was assessed by using modified mathematics anxiety test by Freedman (2017). Then, the students' cognitive processes were described from the students' work on the written test related with area conservation problem and the interviews. The task given in the written test consist of the shape modification concept of area conservation. See the tasks given at Figure 1.

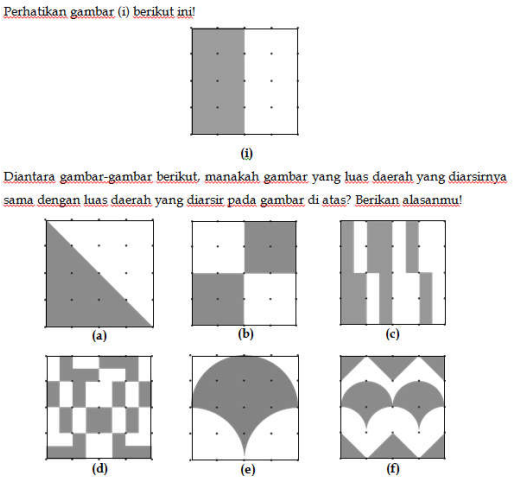

Figure 1. The area conservation problem used in this study

RESULT AND DISCUSSION

Written Test Result

According to the written test result, two students wrote that figures (a), (b), and (c) have the same area of gray colored region as figure (i) and one student wrote that figures (a), (b), (c), and (d) have the same area of gray colored region as figure (i). High mathematics anxiety students estimated the area of the gray colored region and use the concept of area conservation by modify the shape of the gray colored region. The estimation method were used to estimate the area of the gray colored region in figure (i), (a), and (b). Based on the result of the estimation, the three figures have the same area of the gray colored region. The student argued that all of the figures given in the problem are a rectangle with the same size. The area of the gray colored region in figure (i), (a), and (b) is half of the total area of the rectangle. The rectangle in figure (i) is vertically divided into two same sized regions. While the rectangle in figure (i) is diagonally divided into two same sized regions. That is why the two figures have the same area of the gray colored region, which is half of the total rectangle's area. The student figured that a rectangle in the figure (b) is divided into four same sized regions, two parts being gray colored and the rest is white colored. If the area of each

region is quarter of the total rectangle's area, then the area of two regions is half of the total rectangle's area. In some figures, high mathematics anxiety student modify the gray colored region's shape to make it look like the gray colored region in figure (i). The gray colored region in figure (b), (c), and (d) is moved to the white colored region on the left side of the rectangle, so that the gray colored region look like the same as the gray colored region in figure (i). All of these activities to determine which of the figures having the same area of gray colored region are the part of processing information when carrying out the plan.

Interview Result

At the stage of understanding the problem, SHMA received the information by observing the figures given. Then, processed the information by linked the question in the problem to the figures given. SHMA used the information by re-explain the problem to the authors. At the stage of devising a plan, SHMA processed the information by determining the procedure to solve the problem. SHMA used the information by explaining his planned procedure. SHMA said, "Firstly, all of the figures are rectangular in the same size. I need the area of the gray colored region in figure (i), then find which figures having the same area of the gray colored region as in the figure (i). By seeing the shape of the gray colored region, I might know the area without calculating it."

At the stage of carrying out the plan, SHMA processed the information by executing the planned procedure. He applied the concept of area conservation to modify the shape of the gray colored region and estimated the area of the gray colored region in each figure. SHMA used the information by explained his procedure to solve the problem. According to SHMA, the area of the gray colored region in figure (i), (a), (b), (c), and (d) is exactly the same. Here is the figure of SHMA's working sheet to show that the rectangle in figure (i) and (a) is divided into two regions.

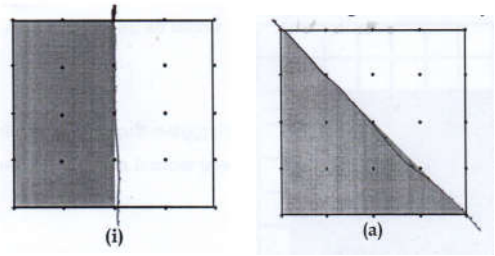

Figure 2. SHMA showed that rectangle in figure (i) and (a) is divided into two same sized regions

Then, SHMA explained, "The rectangle in figure (i) is divided into two the same regions, the first one is gray colored in and the rest is white colored. That is why the area of the gray colored region is half of the total rectangle's area. Then, the area of the gray colored region in figure (a) is also half of the total rectangle's area. In figure (a), the rectangle is divided into two diagonal parts to be two the same sized triangles." Here is the figure of SHMA modified the shape of gray colored region in figure (b) and (c).

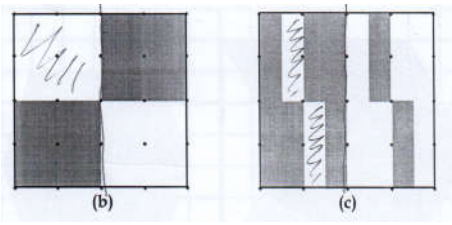

Figure 3. SHMA modified the gray colored region in figure (b) and (c)

SHMA argued that the gray colored area of figure (b) and (c) is the same like the gray colored area of figure (i). He just need to move some parts of the gray colored region to the other suitable parts. He said, "This one is suit to this part (pointed out the suitable parts which is possible to did the cut and paste method of area conservation), so if I move this part to this part, I got the same shape and size of the gray colored region as the gray colored region in figure (i). That is why the gray colored area of figure (b) and (c) is the same like the gray colored area in figure (i)." Based on SHMA, the gray colored area of figure (d) is the same like the gray colored area in figure (i). But, first he thought that the area of the gray colored region in figure (d) is different with the area of gray colored region in figure (i), then he drew a line on the figure as in the Figure 4.

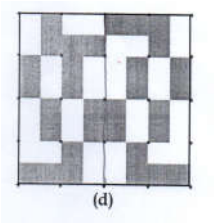

Figure 4. SHMA drew a line in figure (d)

He told, "Firstly, I thought that the gray colored area in this figure is different with the gray colored area in figure (i). The gray colored region in this figure makes me confuse whether the gray colored area is half of the total rectangle's area or not. Then I re-observe the figure and made this line (he made a vertical line to divide the rectangle into two same regions) to make figure (d) looked like figure (i). I found that the left side has the same gray colored region and white colored region with the right side. Then I have an idea to move the gray colored region in the right side to the left side so that the left side is shaded in and the right side is not. By moving the gray colored to left side, I have figure (d) which is looked like figure (i), so the area of the

gray colored of figure (d) and (i) figures is half of the total rectangle's area."

Then, SHMA stated that the area of the gray colored region in figure (e) and (f) is different with the area of the gray colored region in figure (i). SHMA explained that the area of the gray colored region in figure (e) and (f) is bigger than the area of the gray colored region in figure (i) because of the curve shaped. He said, "The area of the gray colored region should be bigger because of this curve shaped. But I don't know what is the exact area of the gray colored region in the figure. It was difficult to calculate it, this part (pointed out the half circle shaped region) may use the formula of circle's area, but this one (pointed out the bottom shade in region) is a weird shape that I don't know what formula I can use." Then HMA conclude the figures which having the same area of the gray colored region as figure (i) are figure (a), (b), (c), and (d).

At the stage of looking back, SHMA processed the information by re-observe the figures to make sure that the area of the gray colored region is half of the total rectangle's area. He did the re-observation for figure (b) and (d). According to SHMA, figure (b) showed that the rectangle is divided into four same sized regions, two of them is gray colored and the rest is white colored. If the area of each region is quarter of the total rectangle's area, then the area of two regions is half of the total rectangle's area. While, SHMA re-observing figure (d) because he was not sure whether the area of the gray colored in this figure is half of the total rectangle's area. Firstly, he thought that the area of the gray colored region in figure (d) is not half of the total rectangle's area. Then, SHMA re-observing the figure and found that the area of the gray colored region is half of the total area. At the stage of representing the result, SHMA used the information by wrote the conclusion of his obtained solution and explained his answer. Here is the conclusion written by SHMA.

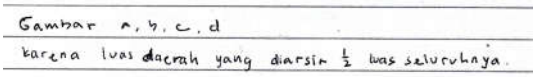

Figure 5. SHMA's conclusion

Discussion

Based on the results of this study, high mathematics anxiety student determine the area by a simple estimation and modify the shape of gray colored region. But, high mathematics anxiety student can't solve problem correctly. The gray colored region in figure (a), (b), (c), (d), (e), and (f) is modified from the gray colored region in figure (i). So that the area of the gray colored region in all figures should be half of the total rectangle's area, but the high mathematics anxiety student doesn't realize it. The reason why high mathematics anxiety student can't solve the problem correctly because they were panicked by the limited time given to solve the problem. Moreover, student with high mathematics anxiety is lack of confidence and motivation. They tend to avoiding math or solving math problem. High mathematics anxiety student got stuck by the complicated gray colored region in figure (d), (e), and (f). But they easily determine the area of the gray colored region in figure (i), (a), (b), and (c). Here is indicate that once they found difficulties in solving a problem or faced a complicated problem, they tend to end the problem solving process. These findings also showed that high mathematics anxiety student is lack of knowledge about the concept of area conservation. As known by the findings, teacher may help the student with high mathematics anxiety to improve the student's motivation and confidence to learn mathematics. Math teacher should be the one who help high mathematics anxiety student control their anxiety when faced mathematics. If high mathematics anxiety student can't control his anxiety and keep avoiding math, his mathematical ability will got stuck and he got higher mathematics anxiety. As the statement of Arem (2010), Arem said that students' mathematics anxiety will be lessen and students gain more confidence if they can control their anxiety.

CLOSURE

Conclusion

In solving area conservation problem, high mathematics anxiety student pass through the problem solving procedure and cognitive processes stage. At the stage of understanding the problem, high mathematics anxiety student received the information by reading the given problem and observing the given figures. Then, the student processed the information by linked the question in the problem to the figures given. High mathematics anxiety student used the information by re-explain the problem.

At the stage of devising a plan, high mathematics anxiety student processed the information by determining the possible procedure to solve the problem. Then used the information to explain the planned procedure. At the stage of carrying out the plan, high mathematics anxiety processed the information by executing the planned procedure and used the information by explaining the procedure to obtain the solution. Student with high mathematics anxiety used a simple estimation to estimate the area of the gray colored region. Moreover, high mathematics anxiety student modify the shape of the gray colored region to make it looked like the gray colored region in figure (i). High mathematics anxiety student can't realize that the gray colored region in all figures in the given problem is modified from the gray colored region in figure (i).

At the stage of looking back, high mathematics anxiety student processed the information by re-observing the given figure to make sure that the area of the gray colored region is half of the total rectangle's area. At the stage of representing the result, high mathematics anxiety student used the information by writing the conclusion of the obtained solution in the answer sheet and explaining the obtained solution to the authors.

Suggestion

Based on the results of this study, we have suggestion as follows.

a. The concept of area conservation helps students to determine the area of an irregular shape by modified the shape to the simple one. So that, it is better to introduce the student to the concept of area conservation in the beginning of learning area measurement.
b. Teacher who has high mathematics anxiety student may help the student to control the anxiety so that the student can gain more confidence and being motivated to learn mathematics.

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