A Cognitive Analysis of Students` Mathematical Problem Solving Ability on Geometry

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Abstract. The purpose of this research is to analyze of mathematical problem solving ability of students in one of secondary school on geometry. This research was conducted by using quantitative approach with descriptive method. Population in this research was all students of that school and the sample was twenty five students that was chosen by purposive sampling technique. Data of mathematical problem solving were collected through essay test. The results showed the percentage of achievement of mathematical problem solving indicators of students were: 1) solve closed mathematical problems with context in math was 50%; 2) solve the closed mathematical problems with the context beyond mathematics was 24%; 3) solving open mathematical problems with contexts in mathematics was 35%; And 4) solving open mathematical problems with contexts outside mathematics was 44%. Based on the percentage, it can be concluded that the level of achievement of mathematical problem solving ability in geometry still low. This is because students are not used to solving problems that measure mathematical problem solving ability, weaknesses remember previous knowledge, and lack of problem solving framework. So the students` ability of mathematical problems solving need to be improved with implement appropriate learning strategy.

1. Introduction
Mathematical problem solving ability is one of process standard in learning mathematics [1]. The ability of mathematical problem solving is the heart of mathematics [2]. Given the importance of problem solving ability in learning mathematics, it is necessary to do an effort that aims to determine the extent to which the problem solving ability based on students` answer on geometry. These efforts can help educators to find ways to solve the problems in mathematical problem solving of students. In fact, students` mathematical problem solving ability is still low. The students have difficulties to solve a problem that measures problem solving ability. Based on the research, the students` problem solving ability has low score on aspect of make model that is 23.53% and interpret result obtained that is 32.35% which including very bad qualification [3]. Other research said that, students` problem solving ability is low because students are not familiar to solve problem solving problems (non-routine problem) [4]. If the mathematical problem solving ability compared to other mathematical abilities such as mathematical communication ability, students` problem-solving ability also has lower average score than the average score of mathematical communication skills. This is seen in the results of research, the average score of pretest and postes in the control class and experiment to measure the problem solving ability is lower than the ability of mathematical communication. So that, we should to analyze the ability of mathematical problem solving if we want to improve the student`s ability [5].
Another thing that is important in view of the extent of the problem solving ability of students is to see what kind of errors that student made in solving mathematical problems. Error analysis has proven to be an effective method for identifying patterns of students’ mathematical errors. Based on that opinion research related error analysis is very important and should be developed so that teachers know what mistakes made by the students so that teachers can identify and review mistakes that are often made by students who in the end of the teaching process teachers can choose the right strategy for students no more mistakes [6]. The type of error is categorized into 4; facts error, concepts error, operations error and principles error [7]. Other opinion said that student errors are classified into several types of errors: type I, type II, and type III errors. Type I errors include the concept of understanding that students know what is known and know what is being asked. Type II errors include stages of problem solving that is students make a mathematical model, have accuracy in solving the problem, and true or not in operate. Type III errors are true or not students in conclusion [8]. This research is focused on the analysis of students’ errors in solving mathematics problems with the type of errors are concept error, principle error, operation error, and mistake of conclusion. The purpose of this research is to analyze of mathematical problem solving ability of students in one of secondary school on geometry.

2. Experimental Method
This research was conducted by using quantitative approach with descriptive method. Population in this research was all students of one secondary school and the sample was twenty five students that was chosen by purposive sampling technique. Data of mathematical problem solving were collected through essay test. The topic of the test tested was geometry “quadrilateral”.

3. Result and Discussion
The results of this research showed the percentage of achievement of indicator mathematical problem solving ability of students were: 1) solve closed mathematical problem with context in math was 50%; 2) solve closed mathematical problems with contexts outside mathematics was 24%; 3) solving open mathematical problems with contexts in mathematics was 35%; And 4) solving open mathematical problems with contexts outside mathematics was 44%. Based on the percentage of achievement of each indicator, it can be concluded that the level of achievement of mathematical problem solving ability in solving the problem in segiempat topic by using conventional learning still low with the average indicator was 38.25%, so the students’ ability of mathematical problem solving on quadrilateral topic need to be improved. This can be seen from the analysis of the following student answers.

The problem number 1 with indicators solving closed mathematical problems with contexts in mathematics is: “Length DC = OE = 5cm, FO = OD = 6cm, dan OG = GA = 8cm. If the area of the shape below is 238cm², calculate the area of shaded shape !

![Figure 1. The first problem of mathematical problem solving based on first indicator](image)

Most of students have difficulties because the average score of this indicator was 50%. This can be seen from the students' answers. Based on these answers, students can be grouped as follows. Figure 2
shows that, the students simply rewrite the question without answering questions. This caused by the students were not able to write down ideas or planning in solving the problem. So, we can conclude that the students’ mathematical problem solving ability are still low.

![Figure 2. Student’s answer](image)

Figure 2 shows that, the students only determine the area of trapzoid and parallelogram without determine the shaded area. Students are still having difficulties to understand the questions. But, the students already understand the procedure to get the correct answer. It is seen from the student’s answer that wrote the right formula to solve that problem.

![Figure 3. Student’s answer](image)

Figure 3 shows that, the student’s answer shows that, the students simply rewrite the question without answering questions. This caused by the students were not able to write down ideas or planning in solving the problem. So, we can conclude that the students’ mathematical problem solving ability are still low.

![Figure 4. Student’s answer](image)

Figure 4 shows that, students have difficulties to understand the picture in that problem so that the students wrong in choosing the correct formula to determine the area. The students have difficulties to remember the formula on segiempat because there are so many formula for each plane.

![Figure 5. Student’s answer](image)

Figure 5 shows that, it appears that most of students make miscalculations in operating numbers. Based on all the examples of students’ answer, we can conclude that there are some students can
answer with the correct answer and some students answer with the wrong answer. The most students’ error in this problem is operation error.

Figure 5. Student’s answer

The problem number 2 with indicators solving closed mathematical problems with contexts outside mathematics is: “The floor of living room shaped square with a length of side is 5 m. The living room will be fitted with tiles (sized 50 cm x 50 cm). Calculate how many tiles needed to cover the floor! If 1 box of tiles cost Rp 70,000.00 and contains 4 pieces of tile. Calculate the total price paid for the purchase of tiles!”

Most of students have difficulties to answer the problem number 2. It can be seen by the average score of this indicator was 24%. The average score in this indicator is the lowest than other average score. This can be seen from the students’ answers. Figure 6 shows that, it appears that students have difficulties in calculating the many tiles required. It seen from some students only calculate the area of floor and the area of tile, but not proceed to the next procedure. So that, the student does not know how many tiles are required and the total price is paid.

Figure 6. Student’s answer

Figure 7 shows that, the students are only guessing the problem solving. This was evident from the student’s answer that does not lead to the correct answer. The student does not determine the area of floor and the area of tile.

Figure 7. Student’s answer

Figure 8 shows that, it appears that most students make miscalculations in operating numbers. The student already answer by the correct procedure. The student already calculate the area of the floor and change the unit of area from m to cm to determine how many tiles are required by the correct procedure, eventhough the student still wrong in write the unit of area (do not write cm² or m²). But, the student make miscalculation in operating numbers. The student wrong in determine the total price is paid. The correct answer is Rp 1,750,000.00.
The problem number 3 with indicators solving open mathematical problems with contexts in mathematics is: “The area of rhombus ABCD is = 300cm². Calculate the length of diagonals!” Most students have difficulties because the average score of this indicator was 35%. This can be seen from the students' answers. Figure 9 shows that, it appears that students simply write down the formula without proceeding to the proper procedure to find the correct answer. Students do not understand that the given problem was a matter of open ended, so the students were confused about what the question asked. Most of the other students were able to answer correctly by guessing although not using the proper procedure.

The problem number 4 with indicators solving open mathematical problems with contexts outside mathematics is: ” A yard shaped rectangular with the area is 100 m². If around the yard will be placed flower pots with a distance between pots 1 m. How many flower pots are needed?” Most of students have difficulties because the average score of this indicator was 44%. This can be seen from the students' answers. Figure 10 shows that, it appears that the student just wrote the formula without continuing to the proper procedure to find the correct answer. Students do not understand that the given problem was a matter of open ended, so the students are confused about what the question asked. Most of the other students were able to answer correctly by guessing despite not using proper procedures.
Based on the analysis of student answers as a whole above, can be seen some mistakes made by students. The most common mistakes were concept errors and operation errors. The concept error that students know what was known and know what was being asked. Operation errors were about students who have accuracy in solving the problem, and true or not in operate. Based on the previous description shows that students’ mathematical problem solving ability have not been good, therefore it takes an effort to help the students in developing problem solving ability. Several efforts to improving mathematical problem solving ability are the teachers should not only pay attention to students who have high but also low ability, and should be able to design innovative learning that suits all the characteristics of students. Teachers need to guide students not to be easily discouraged in improving problem-solving ability by providing training and teaching routinely in solving problems that measure problem solving ability. Teachers should also ask to get back to check what has been done to minimize errors in the solution of the problem.

4. Conclusion
Based on the percentage achievement of each indicator, it can be concluded that the level of achievement of students' mathematical problem solving ability on geometry was still low with an average of the indicator was 38.25%. This is because students are not used to solving problems that measure mathematical problem solving ability, weaknesses remember previous knowledge, and lack of problem solving framework. So the students’ ability of mathematical problems solving need to be improved with implement appropriate learning strategy. So the ability of mathematical problem solving need to be improved. Alternative ways that can be done to develop the ability of mathematical problem solving was train the students by getting used to solving problems that measure the problem-solving’s ability and familiarize students to re-check the results of student’s task. Based on this research, the teacher can choose the correct strategy and plan the learning activity for learning mathematics that can improve ability of mathematical problem solving.

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