ME – 25

STUDENTS' PROBLEM SOLVING ABILITY IN MATHEMATICS: BASIC MATHEMATICS COMPETENCY, SCHOOL LEVEL, AND GENDER

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Abstract

This research is motivated by the importance of problem solving ability in mathematics. There are three indicators of problem solving ability in mathematics: (1) Identify elements that are known and asked, also adequacy of the required elements; (2) Select and apply problem solving strategies; and (3) Examine and explain the truth of the answers according to mathematical problems in question. Students' problem solving ability in mathematics be reviewed of three aspects: basic mathematics competency (BMC), school level, and gender. This research involved 232 junior high school students which in Serang City, Banten Province. The research subject consisted of 108 male and 124 female from three different school levels: high, medium, and low level. There are two instruments here: basic mathematics competency test and problem solving ability test. The findings of the research are: (1) Overall, the mean scores of students' problem solving ability in mathematics is 57,18% which classified as medium category; (2) Student with high, medium, and low BMC successively obtained the mean score of problem solving ability 85,66% (high category), 56,34% (medium category), and 29,55% (low category); (3) Student in high, medium, and low school level successively obtained the mean score of problem solving ability 60,84% (medium category), 58,13% (medium category), and 52,55% (low category); (4) Male and female student successively obtained the mean score of problem solving ability 50,76% (medium category) and 63,61% (medium category).

Keywords: problem solving, basic mathematics competency, school level, gender

INTRODUCTION

Problem solving is important ability to mastered by students. It is argued that students who are skillfull in solving problems will also be skillfull in identifying a problem, selecting relevant information, composing, analyzing, evaluating, and reflecting on the results. According to Nasution (2000), those skills will lead to students' intellectual satisfaction, enhance their intellectual potential, and encourage them to investigate throughly a discovery activity.

National Council of Teachers of Mathematics (NCTM, 2003) stated that problem solving has been an integral part of all mathematics learning so that it should not be an isolated part of mathematics program. Anderson (2009) also asserted that problem solving is recognised as an important life skill involving a range of processes including analysing, interpreting, reasoning, predicting, evaluating and reflecting. It is either an overarching goal or a fundamental component of the school mathematics curriculum in many countries.

As the main goal in mathematics learning, the aspects of problem solving ability in mathematics (PSAM) need to be developed in the learning process in the classroom. As stated in the NCTM that instructional programs should enable students to: (1) build new mathematical knowledge through problem solving; (2) solving problems that arise in mathematics and in other context;

(3) implement and customize a variety of appropriate strategies to solve problems; and (4) monitor and reflect on the process of mathematical problem solving.

Seeing the importance of problem solving ability, it needs to be studied more in depth how the achievement of students' PSAM. This study will be described more detail the achievement mean obtained by student on each PSAM indicator. There are three indicators of PSAM in this research: (1) Identify elements that are known and asked, also adequacy of the required elements; (2) Select and apply problem solving strategies; and (3) Examine and explain the truth of the answers according to mathematical problems in question.

Students' PSAM be reviewed from three aspects: basic mathematics competency (BMC), school level, and gender. This is done to inform the teacher in preparing lesson plans to train the aspects of PSAM in the learning process. In addition, teachers can make an appropriate teaching materials to accommodate students' characteristics and learning difficulties experienced by students.

METHOD
The main purpose of this study is to describe students' PSAM. This study used a descriptive method. In this study, a number of students were asked to answer a set of MPSA tests that have been validated by expert. The results were then analyzed based on student work in each MPSA indicator measured. This is to know in detail which indicators are the lowest and highest scores. Calculated the percentage of test scores on each PSAM indicators from the ideal maximum score (MIS).

Subjects Research
Subjects research in this research is eighth grade students from three different school levels: high, medium, and low level which in Serang City, Banten Province, Indonesia. There are 232 students involved in this research consisting of 108 male and 124 female.

Instruments
One of the research instrument used is PSAM test. PSAM tests are given to students after the learning activity. MPSA test used in this study is analytical test that is intended to find out the students' ways of thinking in solving problem in order to make it more clearly defined. This is in accordance to the opinion of Ruseffendi (1991) saying that one of the advantages of analytical test is that we can see clearly the thinking process of the students through their answers of the given problem.

PSAM test consists of 6 test items with a maximal ideal score 38. The material of MPSA test was adjusted to the subject matter of Mathematics in the second semester which refers to the curriculum. The preparation of the test begins with a first lattice covering subject matter which measured the ability aspects, indicators of PSAM, and the number of test items. Then, continued by preparing the PSAM test in accordance to their respective indicators to measure along with the answer key and the scoring guidelines.

The achievement of students' PSAM is obtained by scores of PSAM test. Criteria for achievement of students' PSAM can be seen in Table 1.

Table 1. Category of achievement

Test score (X)	Category
X ≥ 70%	High
30% ≤ X < 70%	Medium
X < 30%	Low

Other research instruments used are basic BCM test, observation sheets, and interview form. BCM test consists of 25 test items with multiple choices type. The observation sheets were used during the learning takes place. These observations were carried out to see the learning process that teachers do in the classroom. Observations made during several meetings to ensure the learning process is usually done in the classroom teacher. Meanwhile, interviews were conducted to confirm the results (answer) of some students on the PSAM test. In addition, interviews are also conducted to confirm the truth of some teachers to the results of observations made by the researcher.

RESULTS
Students' PSAM on Each Indicator
The mean scores of students' PSAM is obtained based on the test. Recapitulation of students' PSAM test result can be seen in Table 2.

Table 2. Recapitulation of students' PSAM on Each Indicator

Indicator	MIS	Mean Score	Precentage	Category
1	9	31,43	82,71%	High
2	20	11,17	29,39%	Low
3	9	22,58	59,42%	Medium
Total	38	21,73	57,18%	Medium

From Table 2 above it is known that the achievement mean score of students' PSAM is only 21,73, while the maximal ideal score is 38. The achievement of students' PSAM for the first and third indicator respectively is 31,43 and 22,58, while the maximal ideal score is 9. The achievement for the second indicator is 11,17 with maximal ideal score 20.

The achievement percentage of students' PSAM can be determined based on PSAM test scores. From the table above it can be seen that the achievement percentage of overall students' PSAM is in medium category. It can be seen from the achievement percentage obtained by student 57,18%. The achievement percentage of students' PSAM on each indicator respectively is 82,71%, 29,39%, and 59,42%. The highest percentage achieved on the first indicator 82,71% and the lowest 29,39% in the second indicator.

PSAM based on BCM
There are three categories of BCM: high, medium, and low category. Recapitulation of students' PSAM be reviewed from the BCM can be seen in the table below.

Table 3. Recapitulation of students' PSAM based on BCM

BCM	N	Mean Score	Precentage	Category
High	54	32,55	85,66%	High
Medium	105	21,41	56,34%	Medium
Low	73	11,23	29,55%	Low
Total	232	21,73	57,18%	Medium

From the table above is known that student with high, medium, and low BCM has different PSAM achievement mean score. The achievement mean score of the high BCM students is 32,55 or about 85,66% from maximal ideal score which classified as high category. Students with medium BCM revealed the PSAM achievement mean score 21,41 or around about 56,34% from maximal ideal score which classified as medium category. In additional, students with low BCM got the PSAM achievement mean score 11,23 or about 29,55% from maximal ideal score which classified as low category.

PSAM based on School Level

Table 4. Recapitulation of students' PSAM based on School Level

School Level	N	Mean Score	Precentage	Category
High	74	23,12	60,84%	Medium
Medium	78	22,09	58,13%	Medium
Low	80	19,97	52,55%	Medium
Total	232	21,73	57,18%	Medium

The achievement mean score of students' PSAM on each school level is almost the same. Students in the high, medium, and low school level respectively got the achievemement precentage mean score 60,84%, 58,13%, dan 52,55%. All the achievement are classified as medium category.

PSAM based on Gender

Table 5. Recapitulation of students' PSAM based on Gender

Gender	N	Mean Score	Precentage	Category
M	108	19,29	50,76%	Medium
F	124	24,17	63,61%	Medium
Total	232	21,73	57,18%	Medium

Female student obtain the achievement mean score PSAM higher than male student. However, all the percentage of achievement mean score still belong to the same category, that is medium category. The PSAM achievement mean score of male students 19,29 or about 50,76% from maximal ideal score and the PSAM achievement mean score for the female students is 24,17 or about 63,61% from maximal ideal score.

DISCUSSION

Students' PSAM in this research be reviewed from three indicators, namely: 1) Identify elements that are known and asked, also adequacy of the required elements; (2) Select and apply problem solving strategies; and (3) Examine and explain the truth of the answers according to mathematical problems in question. In each PSAM indicator measured, known that the achievement mean of students is classified in medium category. That is, the errors in completing the PSAM test is performed by students on each item tests representing each indicator is still quite a lot. Here is described the achievement of student' MPSA on each indicator.

Students' PSAM based on Each Indicator

Identify elements that are known and asked, also adequacy of the required elements

The first indicator of PSAM measured through three test items. From the results of tests known the achievement mean score obtained by student is 31,43 or about 85,66% of the maximum ideal score. The achievement mean score obtained by the students is classified as high category. In general, students in solving the problem able to transcribe the completeness of data in a matter and provide an explanation about the adequacy of the data needed to answer the problem in question. These results indicate that the students have been adequately trained to solve the problems that they are demanding in terms of the ability to identify. Results of interview with some of students are generally students has been explaining the elements are known to be

sufficient in the matter or try to answer the problem in question. Some students simply answered "not enough" or "enough" without giving the detail explanation.

Select and apply problem solving strategies

The second indicator of PSAM measured by five items test. The achievement mean obtained by student in this indicator is 11,17 or 29,39% of the maximum ideal score which is classified as low category. In general, many students make mistakes in choosing to use problem-solving strategies. Some students are already choosing and implementing the right strategy, but generally a lot of errors in the calculation (computing), so do not get the final result as expected. This fact made possible because based on the observation, students in the learning process less familiarized with the varied questions and challenging, so students do not have much experience in selecting and determining the strategies used in solving the problem. Students are not familiarized with the demands to solve complex problems. In completing the exercises, students tend to use coping strategies that are relatively similar to those used by teachers. Students can answer the questions correctly because they memorize the strategy used by teacher, but they don't understand the concept. As a result, when students are given problems slightly different context, students have no other choice-solving strategies, and the end student can not answer the problem correctly.

Examine and explain the truth of the answers according to mathematical problems in question

For the third indicators measured through three items test. The achievement mean obtained by student in this indicator is 22,58 or 59,42% of the maximum ideal score which is classified as medium category. From the achievement percentage can be seen that the students quite have been able to provide an explanation regarding the correctness of the result or answer a question. The results of interviews with some of students obtained the information that the students are not familiar with the form of the given problem. This is why they are confused about how to answer (how to explain the answers as instructed in the matter). From 18 students interviewed, some of them said that they only answer "that is the correct answer" or "that is not the correct answer", while the description of the answer is simply written on paper graffiti. Then they were asked to answer again five test items that measure this indicator in accordance with the specified time and a half of them can be answered the questions completely and correctly. Upon further confirmed, it is known that the students are not familiar with these forms test. In the learning process, students are trained in solving routine problems that can be solved with regular formula given by the teacher.

According to the results of observations class and interviews, in general the learning process consisted of a series: apperception, an explanation of material (mathematical concepts), completion of the demonstration example problems, exercises routin problems, and concludes with reflection. The series of learning activities are dominated by teacher. Although in each set of learning students are given the opportunity to be actively involved, but in general students were busy just described and recorded what the teacher wrote on the board. Then, the teacher gives students exercises. The questions given in the exercises were relatively similar to what the teacher demonstrated on the example problems, both the difficulty level or context. By the time the teacher gives the student the opportunity to be active (to ask and giving opinion), in general,

students were only be good listener, only one until two students who responded or asked. In the learning process, students are role as receivers of information rather than as a subject learners.

The results of the studies described above illustrate that in general mathematics learning process so far only develop the ability to think in such a low level which is very procedural in nature. In other words, the learning processes that occur have not been able to develop students' mathematical thinking skills to a higher level. The emphasis of teaching mathematics today is emphasized more on math formulas, sample questions, and regular exercises. In this case, students only do exercises directly by using formulas and algorithms that have been given. Through this way, the students are only trained to memorize things they have learned before. As a result, the learning process creates mostly passive students with limited knowledge to what is transferred by teachers.

These conditions lead to students' inability to solve various problems in which they are only able to resolve the problem in accordance to the examples given by teachers. Schoenfeld (Even & Tirosh, 2003) in his study revealed that students who have all the knowledge needed to solve a problem are often not able to use that knowledge to solve problems that are not familiar to them. These findings indicate that the students have not been able to apply important concepts in solving the problems being faced.

Students' PSAM based on BCM, School Level, and Gender
Based on the data obtained from the PSAM test against 232 junior high school students in the Serang City that the PSAM achievement mean scores of overall students is 21.73 or about 57.18% which classified as medium category. This result is certainly a little bit different from the results of a preliminary study conducted Pujiastuti (2014a) which revealed that the mean score of students problem solving ability in Serang City only reach the low category. This proves that the amean score students' problem solving ability in mathematics has experienced a change for the better. For more details, problem solving ability in mathematics of students in this study be reviewed of three aspects, namely the BCM, school level, and gender.

From the aspects of BCM students can be seen that the students' problem solving ability in mathematics directly proportional to the BCM students. Successively students with high, medium, and low BCM got the PSAM achievement mean score in high, medium, and low category. Its mean that the higher BCM students, students' ability to solve problems is also higher. This is consistent with the results of the study revealed by Pujiastuti (2014b) that BCM has significant effect on students' problem solving abilities in mathematics.

The similar results were shown also by the school level aspects. The results showed that the school level is also directly proportional to the ability of students' problem solving in mathematics. It can be seen that the students at the high level school obtain the PSAM achievement mean score higher than students in the medium and low level. Students at the medium level school are having the PSAM achievement mean score higher than students in low level school. Although the acquisition mean achievement scores slightly different, but the percentage all of the PSAM achievement mean score all three school levels are in the same category, namely the medium category.

In terms of gender (male and female) are known that problem solving abilities in mathematics of female students is higher than male students. It is shown from the achievement mean scores obtained. Female students obtain the PSAM achievement mean score of approximately 63.61% of the maximum score ideal, whereas male students only acquire 50.76% of the maximum score ideal. However, they still belong to the same category, that is medium category.

CONCLUSION

Based on the analysis of test results, observations, and interviews can be concluded that students' problem solving ability in mathematics is still in medium category. Still have to improve this ability to students through the learning process. Based on observation known that the learning process still less facilitate for students in training and developing the capability aspects of mathematical problem solving. The learning process that takes place more emphasis on memorizing formulas and textbook oriented. The problems are trained to students confined to routine problems. The exercises given to the students is almost similar to the teacher. In addition to developing students who lack the ability, the experience of students in the face of variations in the problems become very less. As a result, when students are asked to solve problems that are relatively different context of the problems it receives regular exercise, students became the shock and in the end the students assume that the problems can not be solved.

RECOMMENDATIONS

To develop students' problem solving ability in mathematics required a serious effort from the teacher. *First*, learning process should be more emphasis on the discovery of mathematical concepts, this means that students understand mathematical concepts instead just results of memorizing, but the result of deep thought students through the process of discovery. Student should be actively involved in constructing the concept being studied in the learning process, so that the concept is understood meaningful for students. The learning process is more geared to make students as thinkers. *Second*, the aspects of problem solving abilities in mathematics should be trained in the learning process in the classroom. In this case, teachers can train students with questions that measure problem solving ability. *Third*, the problems given to students in a classroom exercises should be more diverse. That is, students are not only trained in the routine problems that similar levels of difficulty and context, but they should give problems with different difficulty levels, from easy, medium, until the difficult and complex problems. Similarly, the context of the problems that should be given more diverse.

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