Mathematical Problem Solving Ability of Junior High School Students through Ang’s Framework for Mathematical Modelling Instruction

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Abstract. This research background of this research is the importance of student problem solving abilities. The purpose of this study is to find out whether there are differences in the ability to solve mathematical problems between students who have learned mathematics using Ang's Framework for Mathematical Modelling Instruction (AFFMMI) and students who have learned using scientific approach (SA). The method used in this research is a quasi-experimental method with pretest-posttest control group design. Data analysis of mathematical problem solving ability using Independent Sample Test. The results showed that there was a difference in the ability to solve mathematical problems between students who received learning with Ang's Framework for Mathematical Modelling Instruction and students who received learning with a scientific approach. AFFMMI focuses on mathematical modeling. This modeling allows students to solve problems. The use of AFFMMI is able to improve the solving ability.

1. Introduction
Mathematics is a science that has an important role in the development of science and technology. Mathematics serves to help examine the natural surroundings so that one can develop technology for human well-being. To study the natural surroundings requires critical thinking skills, systematic, logical, creative and innovative. These skills can be developed through math learning. It is in accordance with the function of mathematics as a tool, mindset and science. So that mathematics has a role in developing critical thinking skills, systematic, logical, creative and innovative.

Based on the above description, then the mathematics lesson needs to be given to the students starting from elementary school so that learners are able to develop critical thinking ability, systematic, logical, creative and innovative. The National Council of Teachers of Mathematics (NCTM) establishes five standards of mathematical ability that students must possess, namely problem solving, communication, connection, reasoning, and representation [1]. Thus, problem-solving ability is an important and must-have ability of students. Problem-solving abilities are one of the basic mathematical skills that students have to master [2]. In addition, problem-solving skills are an integral part of mathematics learning, so it should not be released from mathematics learning [1]

However, based on the results revealed the fact that the ability to solve mathematical problems is still low. Survey results from Trends International Mathematics and Science Study (TIMSS) in 2011, Indonesia ranked 38th out of 63 countries. One of the problems of mathematical problem solving on TIMSS in figure 1.
Figure 1. Problem solving mathematic TIMSS

Figure 1 is a matter of solving mathematical problems. On the question students are asked to count how many books of a certain size can be put into a box of a certain size. In this case, only 11% of Indonesian students are able to answer correctly, while Singaporeans are 60% able to answer this matter correctly. The average of the entire country is 25% [3].

Thus, students’ mathematical solving abilities are still low. Students tend to be difficult when given problems that are not routine. Students experience difficulties due to lack of knowledge of strategy and problem-solving skills [4]. In addition, teachers tend to teach learners to apply formulas and give routine problems done and not far from the example of the questions given teachers. This resulted in students being given less freedom to express their mathematical ideas and less active during the lesson.

In essence, mathematical material is developed based on natural and social phenomena. To that end OECD developed four categories of mathematical material in the development of PISA item tests in 2015, namely: (1) change and relationships, (2) space and shape, (3) quantity, and (4) uncertainty and data [5]. In essence the TIMSS and PISA studies lie in the power of mathematical reasoning and its ability to apply them in everyday life. For example for material change and relationships, change always happens every time. The change of an object or quantity is related to the change of another object. The shape of change may be discrete or continuous. To understand the relationship required an appropriate modeling. Similarly for space and shape material, quantity, uncertainty and data, mathematically requires modeling either in the form of corresponding equations, symbols, graphical representations, images, and so forth. This modeling serves to facilitate in solving problems. Mathematical modeling can be considered as simplification or abstraction from complex real-world problems to simpler mathematical models [6]. Mathematical modeling provides an opportunity to connect and use ideas in different areas, so the steps in Ang’s Framework for Mathematical Modeling Instruction allow students to solve mathematical problems.

Based on the description above, required an alternative learning that can improve the ability of problem solving mathematically. One of the alternative learning that can improve the problem solving ability of mathematics is by applying Ang’s Framework for Mathematical Modeling Instruction. This learning is a new framework for constructing mathematical modeling that can guide and facilitate teachers in mathematical modeling learning. Steps in Ang’s Framework for Mathematical Modeling Instruction as follows: (1) Decide on the learning level of mathematical modeling; (2) listing all the abilities and competencies (mathematical or modeling) targeted in the lesson; (3) to write down the concepts or formulas or mathematical equations that will be required in the lesson; (4) preparing and providing logical solutions to problems in learning; (5) list factors and outcomes that may explain why this lesson is considered successful [7]. In solve the problem, we often apply ideas or concepts in one area. Mathematical modeling provides an opportunity to connect and use ideas in different areas, so
the steps in Ang's Framework for Mathematical Modeling Instruction allow students to solve mathematical problems.

Based on the 2013 curriculum, the lessons used in each elementary and secondary education unit is a scientific approach. The scientific approach is a scientific approach applied in a learning process that involves process skills such as observing, questioning, gathering information, processing information and communicating. So the formulation of the problem in this research is whether there are differences in the ability to solve mathematical problems between students who received learning with Ang's Framework for Mathematical Modeling Instruction and students who received learning with a scientific approach.

2. Method
To answer the above problem is done quasi experimental research. This research was conducted in one of junior high school in Bandung. The population in this study is all 8th grade students in one junior high school in Bandung in the academic year 2016-2017. Sampling technique used is purposive sampling technique. The sample of this research are students of class 8A and 8B. Class 8A is a control class that gets learning with Ang's Framework For Mathematical Modeling Instruction (AFFMMI) approach, while class 8B is a control class that gets learning by scientific approach (SA). This research uses control class and experiment class, the test is done twice before the learning process, which is called pretest and after learning process called posttest so that the design used in this research is pretest-posttest-control group design. Instruments in this study only use the test instrument, which is a description test consisting of 4 items. The instruments are based on indicators of mathematical problem solving abilities.

3. Result and Discussion

| Table 1. Descriptive statistics of pretest, postests, and N-gain data |
|---------------------------------------------------------------|
|                  | SA                       | AFFMMI                   |
|                  | Pretest | Postest | N-Gain | Pretest | Postest | N-Gain |
| \( \bar{x} \)    | 4.30    | 10.54   | 0.54   | 4.33    | 12.83   | 0.75   |
| s                 | 2.36    | 3.21    | 0.24   | 2.52    | 3.11    | 0.21   |
| n                 | 37      | 36      |        |         |         |        |

Table 1. shows the average pretest grade scores that received learning with the SA and class approaches that received lessons with AFFMMI of 4.30 and 4.33 respectively. Difference in average pretest score of both classes is 0.03. The average post grade scores that received learning with the SA and class approaches that received learning with AFFMMI were 10.54 and 12.83, respectively. Difference in average postes score second class 2.29. This means that the average postes score for the two classes differs considerably. For the average N-gain classes that received learning with the SA and class approaches that received lessons with AFFMMI of 0.54 and 0.74. Classroom N-Gain learning with PS approach is in the moderate category, while the N-gain class that gets learning with AFFMMI is in the high category. Furthermore, to find out whether the enhanced classroom problem-solving capabilities that were studied with the SA and class approaches that received learning with AFFMMI were different, statistical tests were performed with the help of SPSS software. Test statistic that is done is independent sample test. Before performing t-test, normality test using Kolmogorov-Smirnov test and homogeneity test using Levene test.

| Table 2. Pretest data analysis result |
|-------------------------------------|
| Kolmogorov-Smirnov                  | Mann-Whitney |
| Sig.                                | Asymp.Sig.(2-tailed) |


Table 2 shows the sig (2-tailed) value of 0.947. The value of significance is greater than 0.05, so H₀ is rejected. This means the initial ability to solve mathematical problems of students who are learning with a PS approach and students who are taught with AFFMMI are the same.

Table 3. Postest data analysis result

| Kolmogorov-Smirnov | Mann-Whitney |
|-------------------|--------------|
| Sig.              | Asymp.Sig.(2-tailed) |
| SA                | 0.014         | 0.002          |
| AFFMMI            | 0.008         |                |

Table 3 shows the sig (2-tailed) value of 0.002. The value of significance is smaller than 0.05, so H₀ is rejected. This means that there is a difference in the achievement of mathematical problem solving of the students between the class that gets the learning with the SA approach and the class that gets the learning with AFFMMI.

Table 4. Analysis Result of N-Gain Data

| Kolmogorov-Smirnov | Levene | Uji t |
|--------------------|--------|-------|
| Sig.               | Asymp.Sig.(2-tailed) | Sig   |
| SA                 | 0.200  | 0.643 | 0.000 |
| AFFMMI             | 0.084  |       |      |

Table 4 shows that the significance value is 0.000. The value is smaller than 0.05, so H₀ is rejected. Thus there is a difference in the improvement of mathematical problem-solving ability between classes that have been studied with SA and class approaches that have been taught with AFFMMI.

The difference in the ability to solve mathematical problems between students who received learning with the approach of PS and students who received learning with AFFMMI in this study is believed as a result of different treatment given. In AFFMMI learning, students are given problems related to real life, then, students make a mathematical modeling of the given problem. In making the modeling, students utilize the ability, competence they have. Then the modeling is used to solve the problem. In mathematical modeling, the emphasis is on solving problems [6]. This means that when students do mathematical modeling, students actually learn to solve math problems. Mathematical modeling can be considered as simplification or abstraction from complex real-world problems to simpler mathematical models [6]. With this modeling will help students in solving problems. In addition, in learning AFFMMI there are 3 levels that become learning objectives. These levels are related to the ability, competence that students will achieve in learning, such as the ability to create images, graphics, and make assumptions. These skills and competencies required students to solve problems. By knowing all the skills, competencies and concepts needed for learning can facilitate teachers and students in solving problems.

4. Conclusion
Based on the results of research and discussion in this study, it can be concluded that there are differences in the ability to solve mathematical problems between students who obtained learning with Ang’s Framework for Mathematical Modeling Instruction and students who received learning with a scientific approach.
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