How to improve students mathematics problem solving by implementing indonesian realistics mathematics education (IRME) approach

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Abstract. This research aims to know How to improve Students Mathematics Problem Solving by implementing IRME. It is a quantitative research with experiments method and Randomized Control Group Posttest Design. Research samples are obtained randomly from XIth Grade in State Senior High School in Center Jakarta. This research has an independent variable and a dependent variables. The independent variable is a learning approach and the dependent variable is Students Mathematics Problem Solving ability. This study took 60 samples, which were 30 students from SMAN 7 Jakarta dan 30 students from SMAN 25 Jakarta, as samples. Both schools are taken because they are considered to represent the school population, especially in Indonesia. They also have many similarities, like they are located in the center of Jakarta, using Curriculum 2013 and being accredited A. Data was collected by test technique. Data has processed by using t-test in one way in significant level 0.05. The result is There is a significant direct influence of learning approaches toward Students Mathematics Problem Solving ability.

1. Introduction
Students will deal with math’s problem, and they need to find out the way to solve the problem. The ability of the student to explain the math’s problem is learned skill based on a rule of the sophisticated level. The intricate level needed after understanding the concept[1]. Problem Solving applied in Senior High School into Math’s curriculum with the aim of learning mathematics which understanding the problem, made mathematic model, solving and interpret the solution obtained[2].

However, Problem Solving ability of Students is still far from expected. The reality is students again confuse how to solve a problem when they deal with the slightly different problem after they understand the example from their teacher. The reason is they are not able to imagine problems. Therefore, the low ability of students ‘problem solving based on the low achievement of students' mathematics learning.

In learning activities, a teacher must be able to instill confidence in students that they are able to solve a problem. Students who have already claimed themselves that they are unable to solve a problem, will have difficulty in understanding mathematics. They will give up easily in finding
solution to the problems. Therefore, we need a way to attract students' interests and attention. One of them is by connecting of mathematics learning with students' lives.

By associating mathematics learning with real life, learning will be more simply assumed and imagined by students. It is trusted in making mathematics to be understood effortlessly. One of learning approaches that commence learning by connecting it with real life is Indonesian Realistic Mathematics Education (IRME) approach, which was adapted from Realistic Mathematics Education (RME). RME was introduced by Freudenthal Institute in Netherlands since 1971. The words of “Indonesian” is added to show that IRME has its own caharacteristic. Doorman stated that “RME influences textbooks in primary education. Full credit value of Netherlands students above scoop-item is 74%. This can not be fully associated with the implementation of RME, but this approach probably contributes to the quality of mathematics education.”[3] Therefore, we need we need to develop RME which are based on situation, context, and character Indonesians.

The idea of RME are began from the learning of mathematics should be true-to-life and set as a humane activity. Arsaythamby and Zubainur (2014 : 310) stated that “Learning Mathematics is best done by giving students actively solve contextual problems”.[4] The problems should be have relation with the real-life and obvious in students' mind. Tangible in students' mind means that the problem should be visible as applications or modeling. In IRME, learning process is more comprehensive and the concepts are more meaningful. Students are treated as alive participants in learning, so they can extend their mathematical notions. This is what distinguishes IRME from conventional approaches. The conventional approach focuses only on a small part of the subjects matter and students are given a regular procedure to complete issues.

In IRME, students are trained to create contextual problems to be mathematical form. This process is called horizontal matematization. Horizontal matematization is students with their knowledge (mathematical tools) can arrange and solve evident problems in habitual life. First, students will accomplish the questions informally (using their own methods). After students have been being familiar with similar solving processes (through simplification and formalization), they will apply more formal way, and at the end of process, students will acquire an algorithm. The process which learners through till they obtain an algorithm is called vertical mathematical. Vertical matematization is a process of reorganization in a mathematical system itself, for example finding a short way, finding a relationship between concepts and strategies, and then implementing those strategies. Vertical matematization refers to the process of reorganization within the mathematical system resulting in shortcuts by using connections between concepts and strategies.[5] Concisely, horizontal matematization related to changes in the real world into symbols in mathematics, while vertical matematization is the conversion of symbols to other mathematical symbols (moving within the world of symbols).

2. Methodology
This study is a quantitative study with experiments method and Randomized Control Group Posttest Design. It is done in even semester in the 2014/2015 school year at the State Senior High School in Jakarta. It took 60 students, which were 30 students from SMAN 7 Jakarta dan 30 students from SMAN 25 Jakarta, as samples. Both schools are taken because they are considered to represent the school population, especially in Indonesia. They also have many similarities, like they are located in the center of Jakarta, using Curriculum 2013 and being accredited A.

This study has two variables, which are Indonesian Realistics Mathematics Education (IRME) Approach as its independent variable and Students Mathematics Problem Solving ability as its dependent variable. In this study there are two validities. They are internal validity and external validity. Internal validity is related to the extent of influence of learning approach on students' mathematical problem-solving abilities. This validity are measured based on the accuracy of procedures and data collected and conclusions taken. External validity is related to whether the results of this study can generalized or not to other subjects who do not have the same conditions and traits. The influence of extra variables are minimized by the following manner:
a. The influence of historical variables is set by giving the same subject matter, in the same time term and by the same teacher.
b. The influence of masturation variables is managed by doing a treatment which lasts for not too long.
c. The effect of pretesting variable were overseen by not giving pre-test to the two sample classes
d. The effect of instrument variables were overseen by giving the same test to both of class.
e. The influence of mortality variable was overseen by giving the same treatment to other students who were not members of the sample. So that if there is mortality, it can be replaced immediately by other equal students.
f. Effect of variable interaction between subjects supervised by informing the participants that research is being carried out.
g. The influence of different variables in the selection of subjects controlled by selecting sample in the experimental class and the control class are proportional (homogeneous).

Then, the effort to supervise the external validity are:

a. The initial conditions in both classes are assumed to be the same.
b. Arranges participants reaction to this study were controlled in a way:
   1) The study atmosphere is not pretended so the subject does not feel being researched.
   2) Did not inform the subject that they were being studied.
   3) Treat equal to all students in the class, whether they were chosen as samples or not.
   4) There were no teacher exchange for the two sample classes, either before, during or after the study.

The elected sample is a representative sample. So, it can portray the traits of a population. The sampling technique is cluster sampling technique.

The source of the data in this study is the score or value obtained by students from the tests carried out by giving essay questions that measure students' mathematical problem solving skills. Test questions are arranged in such a way that they are able to represent various characteristics and cognitive aspects of application (C3), analysis (C4) and synthesis (C5). Mathematical questions which are tested to the students is subjects of 11th grade even semester

The data obtained in each class is processed by applying descriptive analysis techniques by computing the mean, median, mode, varian, and standard deviation. This descriptive analysis must be done for all types of research. Mean (\( \bar{x} \)) is a comparison between the sum of all data (\( x_i \)) with the number of data (n). In this case, the data is students' problem solving test scores in the classroom. Or it can be formulated

\[
\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}
\]

Median is the middle value from a sorted list of numbers. The median of even data is the average of two middle data. So, the median of 30 data is the average of 15th and 16th numbers. Mode is the value that occurs most often. Variance is the expectation of the squared standard deviation of a random variable from its mean (wikipedia). Standard deviation measures how spread out numbers from the normal (mean), or it can be formulated as

\[
s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}
\]

Furthermore, the data was analyzed using inferential techniques. This analysis is needed to support the results of study in order to remain in the scientific corridor. In a sense, if this study is carried out by anyone and anywhere, it will give the same results. This test verifies how the data are distributed, whether the distribution is normal or not and homogeneous or not. Then, the results that obtained can be utilized to decide what test will be applied to the hypothesis. If the data is normal and homogeneous, then we can apply one of the parametric tests. It is t-test
\[ t = \frac{\bar{x}_1 - \bar{x}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}; \]
\[ s_p^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}. \]

However, if the data are not homogeneous, we use one of non-parametric test. It is Mann Whitney test. The consequence of non-parametric tests is the conclusions cannot be generalized to the population.

3. Results and Discussion

Ability problem solving of 30 students with IRME learning approach can be presented in the form of a frequency distribution table.

| No. | Interval Class | Absolute Frequency | Percentage Frequency | Cumulative Frequency |
|-----|----------------|--------------------|----------------------|---------------------|
| 1   | 30-40          | 2                  | 0.066667             | 2                   |
| 2   | 41-51          | 2                  | 0.066667             | 4                   |
| 3   | 52-62          | 8                  | 0.266667             | 12                  |
| 4   | 63-73          | 9                  | 0.3                  | 21                  |
| 5   | 74-84          | 5                  | 0.166667             | 26                  |
| 6   | 85-95          | 4                  | 0.133333             | 30                  |

| Total | 30            |

Figure 1. Graph of Students Mathematical Problem Solving with IRME Learning Approach.

Based on the results of the analysis of mathematics students Problem Solving data, the data intervals in the experimental class are in the range of 30.00 - 95.00. The minimum value is 30, signifies the lowest problem solving ability of students is in the low category. The maximum number is 95, indicates the highest problem solving ability of students is in the high category. This interval shows a significant difference between the lowest ability and the highest ability.

The mean value of students' problem solving ability is 65.63. It repesents that the average mathematical problem solving ability of students in experiments class is in the medium category. Meanwhile, median and mode are 67.50 and 70.00. Focused on mean, median, and mode. They provide quite different values. This seems to make us speculate that the distribution of data in this class is quite diverse. This can be proven by the standard deviation of 15.815. Standard deviation delineates the distribution of data in the sample. Based on the results of the table and the histogram above, subjects who have scores below the average are 12 of 30 testees or 40%. Subjects who have scores above the average is 9 of 30 testees or 30%. Thus, the data which are obtained are classified in good level and quite diverse.

Then, ability problem solving of 30 students with conventional learning approach can be presented in the form of a frequency distribution table.
Table 2. Frequency Distribution of Problem Solving Skills with an Conventional Learning Approach

| No. | Interval Class | Absolute Frequency | Percentage Frequency | Cumulative Frequency |
|-----|----------------|--------------------|----------------------|---------------------|
| 1   | 30-38          | 5                  | 0.166667             | 5                   |
| 2   | 39-47          | 6                  | 0.2                  | 11                  |
| 3   | 48-56          | 6                  | 0.2                  | 17                  |
| 4   | 57-65          | 8                  | 0.266667             | 25                  |
| 5   | 66-74          | 2                  | 0.066667             | 27                  |
| 6   | 75-83          | 3                  | 0.1                  | 30                  |
|     | Total          | 30                 |                      |                     |

Figure 2. Graph of Students Mathematical Problem Solving Skills with Conventional Learning Approach.

As shown in figure 2, the data in the control class lies at intervals of 30.00 – 83.00. This range illustrates that the lowest value of students' problem solving abilities is 30, which means there are students who have low mathematical problem solving abilities. Meanwhile, a maximum score of 83.00 indicates that there are students who have high mathematical problem solving abilities.

Furthermore, the mean value is 52.73. This shows that students' mathematical problem solving abilities are included in the low category. Meanwhile, median and mode are each 52.00. Mean, median, and mode provide similar values. It speculate that the distribution of data in this class is not quite diverse, like in experiments class. Then, let us see standard deviation, which is 14,746. Standard deviation in control class is smaller than experiments class. Therefore, the problem solving ability data given by the IRME learning approach is more diverse than the problem solving abilities given by conventional learning approach. Based on the results of the table and the histogram above, subjects who have scores below the average are 11 dari 30 testee or 37%. Subjects who have scores around average are 6 dari 30 testee or 20%. Subjects who have scores above the average are 13 of 30 testee or around 43%. Thus, the data which are obtained are classified in good level and not quite diverse.

Based on the results the test results on statistical tests using t-test, obtained the value of t count = 3,268. The value of t-count is greater than t table (=2,002) with a one-way test and a significance level of 0.05. It implies that H₀ is rejected or H₁ is accepted. This means that there is a very significant influence on the learning approach to students' mathematical problem solving skills.

4. Conclusion

Learning approach gives significant effects on student’s problem solving skill at mathematics issue. The problem solving skill of experiment class is higher than the control class. IRME Learning approach using another topic that linked to the learning topic. It increases the student’s problem solving skill because they have many point of view to solve the problems. In math, there are more complex knowledge needed to be applicated, not only arithmetic, geometry and algebra, but also another knowledge is involved. Problem solving using IRME approach has various method and it could be different one to another. Everyone could find and use their own method to solve the
problems. It is increasing student’s activeness and creativity to find their own method to solve the problems and encourage them to speak their mind.

References
[1] Gagne R M Wager W W Golas K C Keller J M and Russell J D, Feb. 2005 Principles of instructional design, 5th edition Perform. Improv. 44, 2 p. 44–46.
[2] BADAN STANDAR NASIONAL PENDIDIKAN, 2007 Education Unit Level Curriculum for SMA-MA-SMK-MAK Unit (Semester I & II) Jakarta: Cipta Jaya.
[3] Doorman M, 2016 For Our Future Society? May p. 16–17.
[4] Arsaythamby V and Zubainur C M, 2014 How a Realistic Mathematics Educational Approach Affect Students’ Activities in Primary Schools? Procedia - Soc. Behav. Sci. 159 p. 309–313.
[5] Van den Heuvel-Panhuizen M and Drijvers P, 2014, Realistic Mathematics Education, in Encyclopedia of Mathematics Education, p. 521–525.