Enhancing students’ mathematical problem posing skill through writing in performance tasks strategy

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Abstract. Many researchers have studied the Writing in Performance Task (WiPT) strategy in learning, but only a few paid attention on its relation to the problem-posing skill in mathematics. The problem-posing skill in mathematics covers problem reformulation, reconstruction, and imitation. The purpose of the present study was to examine the effect of WiPT strategy on students’ mathematical problem-posing skill. The research was conducted at a Public Junior Secondary School in Tangerang Selatan. It used a quasi-experimental method with randomized control group post-test. The samples were 64 students consists of 32 students of the experiment group and 32 students of the control. A cluster random sampling technique was used for sampling. The research data were obtained by testing. The research shows that the problem-posing skill of students taught by WiPT strategy is higher than students taught by a conventional strategy. The research concludes that the WiPT strategy is more effective in enhancing the students’ mathematical problem-posing skill compared to the conventional strategy.

1. Introduction

In the Indonesian context, problem-posing plays an important role in the development of Kurikulum-2013. The standard process of Kurikulum-2013 emphasized a scientific approach to the implementation of learning method consists of five skills, namely observing, asking, reasoning, experimenting, and communicating in a consistent and persistent manner [1]. One aspect of the skills in Kurikulum-2013 is asking. In mathematics, asking or pose a problem is so-called problem-posing. The National Council of Teachers of Mathematics (NCTM, 1989) on the Curriculum and Evaluation Standards for School Mathematics explicitly states that students should “have some experience in recognizing and formulating their own problems, an activity that is at the heart of doing mathematics. Silver & Cai (1996) stated that the professional standards for teaching in mathematics underline the importance of teachers to provide opportunities for the students to pose their own problems. “Students should be given the opportunities to formulate problems in a given situation and create new problems by modifying the conditions of a given problem [2]. Problem-posing skill in mathematics can be defined as the skill to pose problems based on the tasks given by the teachers [3].

The problem-posing in mathematics learning has been widely recognized as an effective learning approach to train learners in problem-posing independently. Many researchers have studied the understanding of the students in problem-posing.[4, 5, 6, 7, 8]. However, only a few studies that specifically pay attention to the effect of learning strategy to measure the problem-posing skill in Indonesia.
As the fifth phase of the Polya’s problem solving, problem-posing can be considered as an indicator of the relation between problem-posing and problem-solving [9]. The problem-posing skill could be enhanced in phases of Polya’s problem-solving. The indicators of the problem-posing skills were developed based on classification by Stoyanova, namely reformulating the problem, reconstructing the problem, and imitating the problem. Reformulating the problem is conducted by restructuring the elements of the similar or identical problems using different sentences. Reconstructing problem is carried out by modifying or changing the properties of the problem in some ways with different contents. While imitating the problem is implemented by adding and expanding the purpose, as well as connecting other materials to the initial problems [10].

In general, the achievement in mathematics, which is related to the problem solving is low. The TIMSS (Trends in International Mathematics and Science Study) 2011, shows that achievement in mathematics of the Indonesian student’s 8th Grade was ranked at 38th out of 42 countries with a score of 386. The results were grouped in 3 categories: score 400 or less (low), 401-475 (medium), 476-550 (high), and 551-625 (advance). Using these criteria, Indonesian students’ achievement was in the lower category, focuses on memory rather than comprehensive understanding. Furthermore, the result of PISA study (Programme for International Student Assessment) 2015, shows that only about 10% of Indonesian students that able to answer the test at level 4, 5, and 6. In particular, level 5 contains problems that require the students to work in the complex situations, identifying constraint, selecting, comparing, and evaluating the suitable problem-solving strategies, using extensive reasoning, reflecting, formulating as well as stating the interpretation and reasoning [12]. Furthermore, the initial results of the study at the 7th-grade students of Junior Secondary School revealed that only 19.4% students achieved the average of problem-solving skill of 56.94 and achieve mastery level. In general, the level of problem-solving skills of the students is low. It is an indication of the low problem-posing skill among the students of Junior Secondary School in Indonesia.

One alternative to the learning strategies that can support the development of students’ mathematical problem-posing skill is the WiPT strategy or the Writing in Performance Task. According to Junaidi, WiPT is a learning strategy that asks the students to demonstrate and communicate the mathematical understanding of the tasks. WiPT has two main stages, namely, writing and performing the task. The writing stage contains the activities of writing in accordance with the Bloom’s taxonomy, namely: writing of knowledge, writing of comprehension, writing of application, writing of analysis, writing of synthesis, and writing of evaluation[13]. The performing stage contains a completion of the mathematical task, such as problem-solving, drawing an image and graph, developing tables, and preparing a summary. WiPT strategies can improve the mathematical disposition, confidence in problem-solving, delivering ideas, provide reasons, find mathematical ideas, find something new, reflecting the minds, appreciating the use of mathematics, and appreciate the role of mathematics in culture and language [14].

Based on the above problems, the purpose of this research is to examine the effect of WiPT strategy on the students’ mathematical problem-posing skill. The improvement of the problem-posing skill is studied through an experiment.

2. Methods
This research used a quasi-experiment with Randomized Control Group Posttest Only design. The experimental group was treated with the WiPT Strategy, while the control group was treated with the Conventional Strategy. The population in this research is all students of the 8th Grade of the MTs Khazanah Kebajikan, an Islamic Public Junior Secondary School in Tangerang Selatan. The number of sample in this research is 64 students. The sample was taken through cluster random sampling technique. One class with 32 students was randomly selected from the experimental groups and another with 32 students was also randomly selected as a control group. The problem-posing skill data were collected using 7 essay test items. Content validity of problem-posing skills test was determined based on expert evaluation using Lawshe method [15]. The reliability of the test was 0.82 and the validity of the test ranged from 0.45 to 0.89. Meanwhile, the level of difficulty of test items ranged from 0.24 to 0.75, and discriminating index test items ranged from 0.21 to 0.46. The test measures the indicators: the skill to carry out reformulation, reconstruction, and imitation of the problems.
Reformulation of the problem contains rearranging the elements in the structure of the initial problems to draw points and lines as well as determining the slope of the various forms. The reconstruction contains modifying the properties of a straight-line equation taken from a daily life. The imitation contains the addition and expansion of the purposes and determination of the slope based on the properties of the slope. The research uses an Algebra materials, which consist: 1) slope; 2) equation of a straight line; and 3) the graphs of straight lines. Data analysis was performed using test-t with SPSS program.

3. Results and Discussion
The students’ mathematical problem-posing skill both for the experiment and control groups is provided in Table 1.

| Statistics                        | Group          |
|----------------------------------|----------------|
| The number of students (n)       | Experiment 32  |
| Average (\(\bar{x}\))            | 60.68          |
| Standard Deviation (s)           | 12.70          |
|                                  | Control 32     |
| Average (\(\bar{x}\))            | 53.26          |
| Standard Deviation (s)           | 14.77          |

The indicators of the mathematical problem-posing skill in this research covering: problem formulating, problem constructing, and problem imitating. Base on the indicators, the percentage of both experimental and control group is provided in Table 2.

| Indicators  | Max score | Experiment | Control |
|-------------|-----------|------------|---------|
| Reformulation | 4         | 3.91       | 3.68    |
| Reconstruction | 8         | 5.81       | 5.47    |
| Imitation   | 12        | 4.81       | 3.62    |
|              | \(\bar{x}\) | 97.66      | 68.36   |
|              | %         | 92.19      | 30.21   |

Analysis results in Table 2 show that the indicator of problem-posing skill in mathematics for the reformulation is very high. On the reconstruction, the score for both of experimental and control group is moderately high. In contrast, the imitation scores low. The results of this analysis also show that the students treated by WiPT strategy have higher achievement in all indicators of reformulation, reconstruction, and imitation compared to the control group.

Based on the hypothesis testing, using program SPSS independent samples t-Test, shows that \(t_{abs} = 2.156\); p-value = 0.035/2 = 0.018. Thus, \(H_0\) rejected, in other words, the average of students’ mathematical problem-posing skill for the experimental group is higher than the control group. The results of the t-test are provided in Table 3.

| t-test for Equality of Means | df | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|-----------------------------|----|----------------|-----------------------|----------------------------------------|
| t                           | 62 | 7.422          | 3.442                 | .540 to 14.304                          |

Analysis results in Table 3 show that the students’ mathematical problem-posing skill with WiFT learning strategy is higher than of the one treated using the conventional strategy.

In general, the research findings indicate that the average of students’ mathematical problem-posing skill for experimental group is significantly higher than the control group. This shows that the
WiPT strategy is more effective in improving the skill of students’ problem-posing compared to the conventional strategy. This finding is consistent with all indicators including reformulation, reconstruction, and imitation, where students taught using the WiPT strategy tend to be higher than students who were taught with the conventional strategy. The findings of this study are similar to research by Suryana, which found that the average score of the capabilities for students with Problem-Based Learning is higher than the students with the conventional learning [16]. This research finding is slightly different from Esra and Unal, who found that the problem-posing skill is affected by the experience of the mathematics groups and learning motivation provided by the teacher [17].

The WiPT strategy emphasizing the group discussion, equipped with the student’s activity sheet (LKS) that contains two stages, namely: task writing and task performing. The writing stage includes writing of knowledge, writing of comprehension, writing of the application, writing of analysis, writing of synthesis, and writing of evaluation. In the writing of knowledge activity, the students were asked to write down their knowledge, such as summarizing a theory or algorithm using their own language and formulating the concept that has been understood. On the writing of comprehension, the students were asked to re-explain the definition or summarize a paragraph using their own sentences. In the writing of the application, the students were given a task to write and explain how to solve the problem by applying mathematical concepts related to everyday life. In the writing of analysis, the students were asked to identify the parts and the relationship between parts, and apply the organizing principles in resolving the problem. Similarly, in the writing of synthesis, the student identify the relationships among problems systematically to get a pattern or certain formula. In the last activity, the writing of evaluation, the students solve the problems given by the teacher. In the next stage, task-performing, students were guided to create a mathematical statement to develop the earlier problems.

One of the writing the equation of a straight line created by the students in the Experimental Group is shown in Figure 1.

Figure 1. Determining the equation of a straight line in the writing stage

Figure 1 shows the problems presented in students’ worksheet treated with a WiPT which are deliberately presented for exercise in order to assess the students’ writing mathematical in the equation of a straight line chapter. In the experimental group, the majority of students both in individual lessons or group are able to answer the practice questions within students’ worksheet WiPT. However, there are some questions that simply cannot be solved by all students and ultimately be discussed together with the teacher. In the control group, there are problems that can be done easily, but most cannot be solved by the students. This is because they are not taught the writing strategies, so they were not able
to understand the concepts that have been taught. Consequently, most of the mathematical writing problems were not able to be completed and finally discussed together with the teacher. The answer of the students in the posttest as a tool to measure the skill of mathematical problem posing. Students are given a question to measure the skill to a reformulation of the problem as follows:

**Question:** "the following graph is the velocity a car,

a. Write down the information that you should know based on the chart on the side!

b. Make at least 2 questions related the graph beside by adding other information!"

![Image of a graph showing velocity over time]

**Figure 2. Answers’s Problem Reformulation of Experimental and Control Group**

Based on Figure 2, shows that most of the students in the two groups were able to answer the question properly, but there is a difference in answers to the problem are given. Experimental group students could answer in more detail, so the students ask questions which related to the image fits the material equations of straight lines. Meanwhile, students’ answer is as well as true of the control group students, but students ask questions not related to the material equations of the straight line. The learning process in the group stage of the experimental group with writing training. The students writing down information through understanding the graphs. While in the stage of performance tasks, students doing the presentation in front of the group. This stage train the students for expressing his opinion either in the form of a math question so that develop the problem-posing skill with reformulate problem is given.

Furthermore, the capabilities of problem posing on indicator reconstruction of the problem, students are given a question to measure the skill to as follows:

**Question:** "Point A (5-4), B (2,-8) and C (k-12) are in the same straight line. (a) Draw the problem in the form of charts!, and (b) Make at least 2 questions, then finish your question that you create!"

![Image showing a graph with points A, B, and C]

**Figure 3. Answers’s Problem Recontruction of Experimental and Control Group**

Based on Figure 3(a), Experimental group, students are able to solve the problem that has been made by themselves. Even though the students do not modify the early problem by finding the k-value in the graph. The experimental group is more trained in writing the information which associated situations in the graph given. A similar situation occurred in the group control (Figure 3 (b)), but in the control group, students haven't been able to resolve the problem they create.

Furthermore, the capabilities of problem posing on indicator imitation of the problem, students are given a question to measure the skill to as follows:

**Question:** "Three straight line l1, l2, and l3 have slope 3, 4, and 5. The three lines through Y-axis in the same point. If the amount of abscissa point through each line with the X-axis is 47/60”. (1) Make the problem in form of charts!, (2) Make at least 2 question related the issue by changing the objective problem!, (3) Finish your question that you create by using more than one resolution procedure."
4. Conclusion
Based on the results and discussion, it can be drawn conclusion that the students’ mathematical problem posing skill who taught by WiPT learning strategy is good enough. Meanwhile, students who are taught strategy conventional still at less category. The gain of students’ mathematical problem posing skills, including indicators of reformulating, reconstruction, and imitation of the problem. Students’ mathematical problem posing skill on indicators of reformulating a problem, both for conventional and WiPT the learning strategy was already classified as very good in comparison with indicators of reconstruction and imitation of the problem. The high percentage of indicators of reformulating the problem because it is supported by the preparation of sentence that is identical to the earlier problem. Meanwhile, the low percentage in indicator of imitation the problems are caused by the students’ difficulties in expanding, enriching, and associating with other materials with early problems.

In general, students’ problem posing skill who were taught by WiPT learning strategy is higher than the students who are taught by conventional strategy. The intervention stage of writing in the learning process through the activities of the: writing of knowledge, writing of comprehension, writing of application, writing of analysis, writing of synthesis, and writing of evaluation is the main factor to enhancing the students’ mathematical problem posing skill. Referring to the conclusion, it can be suggested that the teachers should have well-understood and could apply the stages of WiPT learning strategy. For further researchers are expected to develop research instruments which are most appropriate to measure imitation problem indicator.

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