How does HOTS based problem posing model improve students’ attitudes toward mathematics?

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Abstract. Attitude toward mathematics is one of the challenges encountered by students while learning mathematics. The learning outcomes of the student prior to employ the learning model are still low. Based on the 2013 curriculum, it is a must for the learning at school to use the model and include Higher Order Thinking Skill (HOTS) in learning. 2013 Curriculum is expected to facilitate the students ‘attitudes toward math. One of the models expected to improve student ‘attitude toward mathematics is HOTS based Problem Posing learning model. The purpose of this study is to determine the effectiveness of HOTS-based Problem Posing model in facilitating the attitude toward mathematics compared to conventional teaching. The research method used is Two-Ways ANAVA, with the subjects of 124 students of the 7th grade from two different schools. The findings of this study indicate that the model of learning posing problem is able to facilitate student ‘attitude toward mathematics in learning it.

1.Introduction
It is acknowledged that the positive attitude in learning is not given a big part of attention by the teacher. The same thing applies to mathematics learning. Mathematics learning is more often related to student achievement, what makes them less interested in learning it and have a negative attitude toward it. However, some argue that positive attitudes toward mathematics need to be possessed by students, due to the fact that students with positive attitude tend to be more successful at learning mathematics than those with negative attitudes [1][2]. Attitude toward mathematics is a crucial variable that can direct students’ behavior in learning math and figure out the way they contribute in motivating themselves. Attitude toward mathematics can also be considered as the determinant of personal emotions [3]. One of the factors of student learning success rate is also influenced by students’ attitude toward mathematics [4], [5]. Based on the results of the mathematical logical intelligence test of students using HOTS problem, the results obtained are shown in Table 1 below.

| Table 1. Mathematics Logical Intelligence test Results |
|-------------------------------------------------------|
| **Result**                                           | **The Average Score** |
| Mathematics Logical Intelligence                      | 57,795                |

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The results of the mathematics logical intelligence test shown in the table 1 above are considered as low category as listed in Table 2 below. Based on the results from Table 2, it can be divided into three categories: high, medium, low [6].

| Interval                  | Category |
|---------------------------|----------|
| $x_i > 94,5$              | High     |
| $\bar{x} \leq 85,85 \leq x_i \leq 94,5$ | Medium   |
| $x_i < 85,85$             | Low      |

$x_i =$ score of students ‘attitude toward mathematics

This can become one of the forms of students ‘negative attitude toward mathematics. Initial tests of students' attitude toward mathematics can be seen in Table 3 below.

| Result                                      | Experimental Class | Control Class |
|---------------------------------------------|--------------------|---------------|
| Attitude toward mathematics                 | 60,13              | 55,46         |

Based on these results, it is clear that students in both experimental and control classes have a low category attitude toward mathematics as shown in table 4.

| Interval                  | Category |
|---------------------------|----------|
| $x_i > 94,5$              | High     |
| $91,93 \leq x_i \leq 94,5$ | Medium   |
| $x_i < 91,93$             | Low      |

$x_i =$ score of students ‘attitude toward mathematics

Based on observations made by researchers in learning mathematics, there is a tendency of passive students during learning. This is the reference of researchers to provide a model of learning problem posing. Thobroni and Mustofa [7] state that learning through problem posing was firstly introduced by Lyn D. English in 1997 and firstly applied to mathematics subjects. The problem posing model is a learning model with a thinking-based and problem-based approach that includes researching, expressing opinions, applying prior knowledge, generating ideas, making decisions, organizing ideas, making connections, connecting areas of interaction, and appreciating the culture [8]. Akay and Boz [9] define problem posing as a process of thinking when students are solving a problem or formulating a new problem or question. El Sayed [10] classifies PP into three types, namely free problem posing, semi-structured problem posing, and structured PP. The selection of the types can be based on mathematical material, student ability, student learning achievement, or student's level of thinking. The following is the description of each type.

a. Students in free problem posing are assigned to formulate a problem/question freely based on daily life situation.

b. Students in semi-structured problem posing are given a free or open situation and asked to explore it using the knowledge, skills or concepts they already possess. The form of questions that can be given is an open-ended problem involving mathematical investigation activities, making a problem based on a given problem, making a problem with the same context as a given problem, making a problem related to a particular theorem, or making a problem based on given images.

c. Students in structured PP are asked to make a problem based on a known problem by altering the data or information that is known.
To add, it is highly suggested in the Curriculum 2013 that teachers use the Higher Order Thinking Skill type questions during math learning. Anderson and Krathwohl [11] revise the use of Bloom's Taxonomy as a conceptual framework for the Higher Order Thinking Skills study. The revision of Higher Order Thinking Skills based on Bloom's Taxonomy according to Krathwohl [11] in Bloom’s Taxonomy revision “an overview - Theory Into Practice” states that indicators and descriptors for measuring high-order thinking include:

a. Analyzing, divided into three parts, (1) analyzing incoming information and structuring information into smaller sections to recognize patterns or their relationship, (2) recognizing and distinguishing causing and effecting factors from a complex scenario, and (3) identifying / formulating questions.

b. Evaluating, divided into three parts, (1) generalizing an idea or perspective toward something, (2) designing a way to solve the problem, and (3) accepting or rejecting a statement based on predetermined criteria.

c. Creating, divided into three parts, (1) generalizing an idea or worldview, (2) designing a way to solve problems, and (3) organizing the elements or parts into new structures that have never existed previously.

The use of HOTS-based Problem Posing model is expected to improve the students ‘attitude toward math. Hence, it is necessary to know its effectiveness when used in the class.

2. Research Methodology

The methodology used in the current research is quantitative research with Two Ways Anova. It used the Mathematics Logical Intelligence test, learning model, and attitude toward mathematics pre-test and post-test. When determining control class and experiment class, it is better to test normality and homogeneity first.

a. The subjects were 124 seventh grade students at two schools in Yogyakarta. The schools were selected based on the results of the National Examination in 2017. They were categorized into 3 categories as high, medium, and low. The population taken was students of the low category. After categorizing the schools, the mathematics logical intelligence test is administered to the students, where 124 students of grade 7 are still in the low category. The influence of the students’ attitude towards mathematics was emphasized. The research was carried in two schools, SMP 1 Ngaglik which is a school of medium category, and SMP 2 Cangkringan of low category.

b. The instrument used was a questionnaire to know students’ attitudes toward mathematics well before using the learning model, and after using it. The instrument of mathematics logical intelligence is used to discover whether there is a relationship between the students ‘mathematics logical intelligence and their attitude toward mathematics.

3. Findings

3.1. Normality test

Normality test was done by liliefors method to gain that the data was normal. Table 5 shows the results of the normality test based on the student ‘initial attitude towards mathematics.

| Model               | Lobservation | L0.05  | Decision        | Conclusion |
|---------------------|--------------|--------|-----------------|------------|
| Problem Posing HOTS | 0.112342     | 0.112522 | H0 is not rejected | Normal |
| Conventional        | 0.110967     | 0.222522 | H0 is not rejected | Normal |

Based on the normality test presented in Table 5 above, it can be concluded that the sample is obtained from a population with a normal distribution.
3.2. Homogeneity Test

Homogeneity test is used to find out whether the variances of a population are equal or not. It is called homogeneity test of population variance.

| Model                        | $\chi^2_{observation}$ | $\chi^2_{0.05}$ | Decision | Conclusion |
|------------------------------|-------------------------|------------------|----------|------------|
| Problem Posing, Conventional | 0.486232                | 0.651756         | $H_0$ is not rejected | Homogeneous |

Based on the homogeneity test results shown in Table 6 above, it can be concluded that the variances of the two populations are the same (homogeneous).

3.3. Two ways ANAVA with balance cell

The analysis of two-way variance with the same cell aimed to test the interaction significance of the two independent variables towards the dependent variable. The following are the results of a two-way analysis test with the same cell in Table 7 below.

| Source        | SS           | df | MS      | F           | P-value | F crit | Decision          |
|---------------|--------------|----|---------|-------------|---------|--------|-------------------|
| Sample        | 15855.15     | 61 | 259.92  | 2.8752      | 3.28E-07| 1.4232 | $H_{0A}$ is rejected |
| Columns       | 6150,101     | 1  | 6150,1  | 68,0327     | 1.98E-13| 3.9175 | $H_{0B}$ is rejected |
| Interaction   | 13027,15     | 61 | 213,5   | 2.3624      | 2.69E-05| 1.4232 | $H_{0AB}$ is rejected |
| Within        | 11209,5      | 124| 90,3    |             |         |        |                   |
| Total         | 46241.9      | 247|         |             |         |        |                   |

Based on the results shown in Table 7 above, the findings of the students’ attitudes toward mathematics have different results. It is not true that both models of learning give the same effect on the students’ attitudes toward mathematics. There is an interaction between the initial and final results of the students’ attitudes toward mathematics and learning models. Finally, after students used HOTS-based problem posing, most of 70% students’ attitude toward mathematics increase to be better than before. It shows in Table 8.

| Interval | Students (%) | Category |
|----------|--------------|----------|
| $x_i > 113,1$ | 72%         | High     |
| $95,90 \leq x_i \leq 113,1$ | 20%         | Medium   |
| $x_i < 95,90$ | 8%          | Low      |

Previously, the results of the students’ attitudes toward mathematics were of the low category, based on the results after using HOTS-based problem posing model, the results of the students’ attitudes toward mathematics entered the medium category, this means there was a given effect resulting on the occurrence of interaction.

4. Discussion

Based on the finding, there are three aspects that can be discussed to know that the effective model of HOTS-based problem posing gives effect to the student ‘attitude toward mathematics. Firstly, based on the results questionnaires given to the students, it is found that the results of the students ‘attitudes toward mathema-tics had different results. This is because the emotions of students are also different.
Based on the differences of students’ questionnaires results, it is necessary to consider the learning model that is able to improve the students’ attitudes toward mathematics to the positive direction. Secondly, the learning model used gives different effects on the students’ attitudes toward math.

After knowing these 3 things, there are several ways in the HOTS-based problem posing learning model that can help students in improving their attitude towards mathematics in a positive direction. This process is supported by real problems faced by students and able to be solved with mathematics, this is supported by HOTS, namely at the stage of analysis, evaluation, and create. Every problem given to HOTS-based problem posing always has links to the real world, and 3 stages to HOTS. Posing problems that are carried out by students also need to be given instructions to lead to 3 stages of HOTS. It also needs guidance from the teacher, to help students post problems with HOTS. The teacher changes students’ attitudes toward mathematics when students are instructed with interesting problems that students often face every day. According to These are perceived parental influences [12], teacher’s affective support [13][14] and classroom instruction [15][16]. One that is used by teachers is classroom instructional and teachers’ affective support. Teachers’ support is also necessary to encourage positive attitudes towards mathematics [17][13]. Teachers’ strong influence on students’ beliefs in their mathematical competency suggests the teacher’s role in mathematics which leads to improvement in students’ mathematics performance ([18][19][20]. Instructional Classroom is a broad range that covers instructional strategies [16] and materials and equipment used in the classroom during the teaching and learning process. In the use of problem posing, teacher affective support is very necessary, so this hots-based problem posing is able to facilitate students in learning. This makes learning in the classroom also not boring. Combining methods from teacher affective support and instructional classroom is what supports hot-based problem posing successfully applied in the classroom. In addition, mathematical problems in the real world are given to students to attract students’ attention that mathematics can be related to students’ lives. This can refer to the Realistic Mathematics Education Approach that has been applied in the problem posing learning model long ago, so it does not need to combine with the RME approach. If implemented, the basic philosophy of RME brings about a fundamental change in the process of teaching-learning mathematics in the classroom [21]. The provision of questions based on real-world problems that HOTS designed in the range of cognitive skills, includes high-order thinking skills analyzing (C4), evaluating (C5), and creating (C6) [22] for given to students and helps improve HOTS and also to students' attitudes toward mathematics.

5. Conclusion
The effectiveness of the HOTS-based problem posing model can be seen from the two-way anova test. The improvement of the students ‘attitudes toward mathematics that was in the low category to be in a medium category, it can be argued that HOTS-based problem posing model is effective for improving the students’ attitudes toward mathematics. In the two-way Anova test, there were three outcomes, the difference of each students ‘attitude toward mathematics when subject model of HOTS-based problem posing, the difference of effect given between the problem posing model with conventional learning, where it can be seen that learning mathematics which the integration of problem posing model was more effective in improving the students ‘attitudes toward mathematics which initially also caused students; mathematics logical intelligence to be low. Meaning that, HOTS-based problem posing learning model was effective for improving the students ‘attitudes toward mathematics. So, the problem posing method helps students to improve with teacher affective support and instructional classrooms. Both of these are included in the problem posing model so that it helps students in learning mathematics in the classroom. Giving mathematics problems to students is always related to everyday life and interesting to be done by students. In addition, these problems are also related to student life or often experienced by students. This further encourages students to improve attitudes towards mathematics. Therefore, it is highly suggested for teachers and learning material/curriculum developers to integrate the HOTS based Problem posing model in their classes/learning material due to
its effectiveness in improving the students’ attitude toward mathematics as proven by the current research findings.

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