A case study of analyzing 10th grade students using what-if-not strategy for mathematical problem posing in trigonometry topic

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Abstract. Mathematical problem posing is one of the important things that can help students to know how the developing higher order thinking skill. This study aims to present students’ mathematical problem posing using what-if-not strategy in trigonometry topic. This study was qualitative descriptive research with case study. The data were collected by using a written test, observation and an interview. The test was conducted to measure students’ mathematical problem posing and interview was conducted to determine the factors that influence mathematical problem posing. The research subjects were 10th grade students in Pangkalpinang. The result shows that the students’ mathematical problem posing was better than after using what-if-not strategy. The factors that influence students’ mathematical problem posing are the skill to understand the topic, the skill convergent thinking, the skill divergent thinking, creativity and strategies used by teachers in the learning process.

1. Introduction

Mathematical problem posing is one of the important points in developing higher-order thinking skills. Mathematical problem posing can develop skills in connecting mathematical concepts based on their own ideas so as to build thinking processes, understand the problem being worked on and improve students' understanding of concepts [1]. Mathematical problem posing is an important core in the discipline of mathematics and the nature of mathematical thinking [2]. Problem posing is an activity that emphasizes on students to help students in asking questions based on information or situations provided and to reformulate new problems from situations that have been given [3][4]. The quality of questions made by students illustrates their ability to solve problems [5]. Problems formed in problem posing can develop the level of difficulty from time to time. It depends on the role of a teacher who can have a positive influence, so that mathematical problem posing can build student understanding and not vice versa which become obstacles in the learning process. Some studies suggest that mathematical problem posing can improve the quality of student learning outcomes [6][7][8].

Giving assignments to students to make questions can improve their ability to solve problems and their attitude towards mathematics [9]. Bonotto looked at mathematical problem posing as a process based on the experience of mathematics, students give their views on the situation and formulate concrete faces become meaningful mathematical problems [10].

There are three problem posing activities related to the stages of problem solving such as Polya’s opinion [11] which gives direction from each stage of problem solving through questions, assignments,
or problem posing before, during, and after problem solving. This is in line with Silver also classifying three cognitive activities in problem posing as follows: (1) pre-solution posing, making questions based on the given situation, (2) within-solution posing, making or formulating the problem being solved, and (3) post-solution posing, students modify the conditions of the questions that have been solved to produce new questions that are more challenging [12]. Therefore, it can be explained that problem posing before problem solving is the process of making questions based on the situation or information provided. The situation given can be in the form of graphics, stories, pictures, statements and so on. Problem posing during problem solving is making problems that are more focused to simplify the problem in the form of sub-problems in the series of problem solving processes. In this case, general and complex problems can be done by making problems into specific problems as a form of simplification of the problem being solved. Problem posing after problem solving is developing new problems by modifying old problems in a certain way. The method chosen in modifying the problem can change the information from the original data, add information from the original data, change the information from the same situation and change the total situation.

In general, problem posing there are two stages in solving problems, namely accepting phase and challenging phase [13]. At the stage of accepting the questions given are clear and students only focus on solving problems. Activities like this are common in the process of learning mathematics in the classroom. Meanwhile, for the challenging stage, a process occurs where students contrast the conditions of the problem given so that students can analyze the problems and check the truth of their own resolution. One strategy that can be used in the challenging stage is a what-if-not strategy. This strategy is based on the idea that modifying or revising the conditions of questions that have been solved to produce new questions that are more challenging. Some mathematical studies also reveal that mathematical problem posing will be more increased if a what-if-not strategy is implemented [14][15][16]. What-if-not strategies are very useful for developing new tasks in learning [17].

From the various descriptions above, the writer uses a what-if-not strategy with the following steps: (1) changing the information or data in the original problem; (2) adding information or data to the original problem; (3) change the value of the data provided but still maintain the conditions or situation of the original problem, and (4) and change the situation or condition of the original problem but still maintain the data or information that is in the original problem.

2. Methods
This research is a descriptive qualitative with case study. The research subjects were 10th grade at Pangkalpinang City high school in the 2019/2020 which consisted of 6 students with high, medium and low initial abilities. This study aims to obtain a description of mathematical problem posing using what-if-not strategy.

In qualitative research, the main data collection techniques are observation and interview [18][19]. Data collection techniques in this study through observation, tests, and interviews. Observations conducted to determine the research environment and research subjects cognitive character and also an observation of mathematical problem posing. Then, the test instrument used in the form of a description consists of 3 questions that represent indicators of mathematical problem posing. Interviews are conducted by asking students questions about their experiences in solving problems so that what is found in observations and tests can be explained in more detail by students.

Because the case study is a qualitative research, the data analysis used qualitative analysis followed the procedure [20]. The strategies implemented to validate the findings in this study are data triangulation, time triangulation and member checking [21]. Checking the validity of the data using triangulation techniques. This technique is used so that the data obtained gets degrees and certainty.
3. Result and Discussion

Before giving a mathematical problem posing test to the research subject, the researcher first explains how the mechanism of what-if-not strategy in asking questions. At the beginning the researcher explained, students had a curiosity about what-if-not strategies and were enthusiastic about implementing these strategies in learning. In the learning process students learn in groups with heterogeneous abilities (high, medium, and low) seen from the student test scores on the previous material.

Based on observations obtained information that researchers have directed students to pay attention to problems on the worksheet. Some students are still confused about how to apply the what-if-not strategy of the given problem. Then, the researcher tells the students to ask questions about the problems faced by students, but from the number of 6 students who were used as research subjects only 2 people who dare to ask questions. Seeing the conditions that are still confused, researchers guide students to write information contained in the problem. Most students follow the directives of researchers, most of the others are still thinking about the information in question. Researchers approach and give instructions to students who do not understand the problem.

In creating a new question on the issue, researchers told the students proposed a strategy what-if-not by changing the information or data on the issue, add new information or data, change data values only with the same information, or to change the situation at issue with the data same. This strategy, of course, requires students to reason in formulating new questions. Not all students can apply what-if-not strategies because they are new to and not accustomed to using them. Although at the first time students work on mathematical problem posing with what-if-not strategies are unsatisfactory, researchers always guide students to be able to overcome the problems they face. However, the mathematical problem posing ability of students using what-if-not strategies made little progress after they got used to the activity.

In the following section, an analysis of items done by students in the mathematical problem posing activities that have the best answers is shown in Figure 1 below.

Figure 1 below shows the students' answers in completing question item number 3.a. It can be seen that students can make a question based on a given situation or problem. The question is rewritten as follows:

3.1. What is the distance between Bintang and Cia with a length of 2m each?

Based on questions that have been made by students, then students are instructed to work on questions that have been made. It can be seen that students understand the material concept of a given problem, so students can smoothly carry out mathematical problem posing activities. The answers written by the subject in the alternative answers write the steps to solve the problem coherently. The subject drew the design of the position between the Bintang, Cia and Dira in the form of a triangle. The subject wrote the steps to find the distance between Bintang and Cia by using the concept of sine rules on trigonometry. That is, when the student can concentrate his thoughts to find a certain solution to a problem, the subject is convergent thinking.
Based on interviews with students, obtained information that in doing mathematical problem posing, students have the ability to put forward some ideas in the form of a question from an editor of a given researcher. The subject can also complete the questions that have been made by students by describing the position between the Bintang, Cia, and Dira in the form of a triangle, making it easier for the subject to complete the question. The editorial provided by researchers is incomplete, but students are able to combine several rules in an equilateral triangle. Then if it is related to Guildfords theory in research on intelligence, it can be concluded that the subject has fulfilled the fluency aspect of divergent thinking ability [22]. This is because the subject is able to produce many ideas that are relevant to the problem.

Next, they were instructed to perform mathematical problem posing activity using strategies what-if-not that compose two different questions the meaning of the questions above by adding requirements / additional information. The following shows the students’ answers on item number 3.b.
Figure 2. Students answer working on problem 3.b

Figure 2 shows students' answers in completing item 3.b. The question with what-if-not strategy given in question number 3.b is better than the previous problem. Questions made by students are more varied and students can also make questions based on situations or conditions that are different from the previous questions. Furthermore, students are required to analyze and complete new questions that have been made by students.

Figure 3. The answers of students working on problems that have been made by students

Figure 3 displays the answer selected by the student after they have created a new question. On the matter of which have seen that this matter was made by the students in creating new questions related to strategy what-if-not that change the situation or condition of the first questions that have been raised previously. Questions the students selected students to be analyzed and worked on are as follows:

3.2. What if we change the length of each side of the triangle to 2, 3, 6? Does it affect the distance of Bintang and Cia?

This student question has to do with one of the conditions for compiling questions in a what-if-not strategy, namely changing the situation or condition of the original question that was created. That is, students' mathematical problem posing ability becomes better by using a what-if-not strategy. In this case students are also required to be responsible for the questions that have been made by students by answering these questions in accordance with mathematical concepts that have been mastered by students. That is, when students can produce questions with good quality these students have a good understanding of mathematical concepts and have high creativity.

Based on the results of the interview and seen from the questions made it appears that the subject is able to produce ideas in making questions by looking at it from another perspective. The question made by the subject explains that if the length of the rope is changed to 2, 3, and 6 cannot form a triangle, because as is known in the triangle inequality that the sum of the two sides of a triangle is greater than the third side. From the interview results it can be seen that the subject is able to generate answer ideas by looking at it from another perspective. Then if it is associated with Guildford's theory in research on
intelligence, it can be concluded that the subject has fulfilled the flexibility aspect of divergent thinking ability [22]. This is because the subject has the ability to generate new perspectives from various points of view. Divergent thinking ability opens up opportunities for students to think creatively. This is also caused, because in the learning process researchers apply what-if-not strategies so that students are accustomed to making more varied questions.

The main factors that influence mathematical problem posing are internal and external factors. Internal factors consist of the ability of pres rayate, convergent thinking ability, divergent thinking ability and creativity. Whereas external factors include the strategies used by the teacher in the learning process.

4. Conclusion

Each student has different initial abilities. The different mathematical initial abilities of students classified into low, medium, and high. This will affect different basic potentials. The basic potential can be in the form of interests, curiosity, encouragement to prove, investigate, and find your own.

This strategy can provide opportunities for students to expand the problem by structuring questions from existing questions. This strategy can also guide and train students who find it difficult to ask problems or questions. The form of questions asked by students can be varied, according to the breadth of mathematical knowledge relating to the material being taught. Questions asked by students require solutions from the students themselves, because if the questions asked by students do not have solutions then the questions asked are not correct. Then, the factors that can affect students’ mathematical problem posing are students must have good prerequisite abilities, divergent thinking skills, convergent thinking, creativity, cognitive style and learning strategies used by the teacher in the learning process.

5. References

[1] Ayllon M Gomez I and Ballesta-Claver J, 2016 Mathematical thinking and creativity through mathematical problem posing and solving Propósitos y Represent. 4, 1 p. 169–218.
[2] Silver E A Mamona-Downs J Leung S S and Kenney P A, 1996 Posing mathematical problems: An exploratory study J. Res. Math. Educ. 27, 3 p. 293–309.
[3] Cai J and Hwang S, 2019 Learning to teach through mathematical problem posing: Theoretical considerations, methodology, and directions for future research Int. J. Educ. Res. December 2018 p. 0–1.
[4] Kaba Y and Şengül S, 2016 Developing the Rubric for Evaluating Problem Posing (REPP) Int. Online J. Educ. Sci. 8, 1 p. 8–25.
[5] Kilpatrick J 1987 Problem Formulating: Where Do Good Problem Come From? In A. H. Schoenfeld (Hillsdale NJ: Lawrence Erlbaum Associates).
[6] Rahman A and Ahmar A S, 2017 Problem Posing of High School Mathematics Student’s Based on Their Cognitive Style Educ. Process. J. 6, 1 p. 7–23.
[7] Ghasempour Z Kashefi H and Miri S A, 2012 Higher - Order Thinking via Mathematical Problem Posing Tasks among Engineering Students I, 1 p. 41–47.
[8] Lavy I and Shriki A, 2007 Problem Posing ad a Means for Developing Mathematical Knowledge of Prospective 3 p. 129–136.
[9] Winograd K 1997 Ways of sharing student-authored story problems Teach. Child. Math. 4, 1 p. 40–49.
[10] Bonotto C 2013 Artifacts as sources for problem-posing activities Educ. Stud. Math. 83, 1 p. 37–55.
[11] Polya G 1985 How to Solve It: A New Aspect of Mathematics Methods (New Jersey: Princeton University Press).
[12] Silver E A 1997 Fostering creativity through instruction rich in mathematical problem solving and problem posing Int. J. Math. Educ. 29, 3 p. 75–80.
[13] Brown S I & Walter I 2005 The Art Problem Posing (3rd ed) (Mahwah, NJ: Lawrence Erlbaum Associates).
[14] Shriki A 2013 A Model for Assessing the Development of Students ‘ Creativity in the Context of
Problem Posing 4, 7 p. 430–439.

[15] Lavy I and Bershadsky I 2003 Problem posing via “what if not?” strategy in solid geometry — a case study 22 p. 369–387.

[16] Seo & Sook H 1998 An Important Component on Using the What-if-Not Strategy *Journal Math. Educ. Ser. D Res. Math. Educ.* 2(1):13-

[17] Lednicky L 2015 Problem Posing As A Means For Developing and Designing Task Acta Math. Nitriensia 1, 1 p. 92–94.

[18] Creswell J W 2009 *Research Design Qualitative, Quantitative and Mixed Methods Approaches* (California: SAGE).

[19] Marshal, Romney B & Steinbart P J, 2015 *Accounting Information System* (England: Perason Educational Limited).

[20] Christensen, Larry B ; Johnson, Burke R & Turner L A, 2011 *Research Methods, Design, and Analysis* (Boston: Pearson Education).

[21] Yusup, M; Romzi, S, N; Hardini M, 2019 Management of Utilizing Data Analysis and Hypothesis Testing in Improving the Quality of Research Reports *Aptisi Trans. Manag.* p. 9.

[22] Lee C S and Therriault D J, 2013 The cognitive underpinnings of creative thought: A latent variable analysis exploring the roles of intelligence and working memory in three creative thinking processes *Intelligence* 41, 5 p. 306–320.