

The Application of Trigonometry on Problem Solving Strategy

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Abstract. This study aims to: (1) describe students' problem solving strategies to solve trigonometric problems using a clinometer media and (2) comparison of the strategies used against student analysis in processing the data obtained. This type of research uses qualitative research. The population of this study was all students of class X consisting of 7 classes, with 39 research subjects. Data collection is done by direct observation of the results of student work. The results showed that (1) students' problem solving strategies to solve trigonometric problems using a clinometer media were divided into two strategies: students pay attention to angular size rather than distance and students pay attention to distance than angular size to determine the height of an object and (2) the strategy used students paying attention to angles rather than distance show more accurate results when students use angles 45^0 than students pay attention to distances rather than angles to determine the height of an object.

Keywords: Clinometer, Problem Solving, Trigonometry

INTRODUCTION

Problem solving is one of the abilities that must be mastered by high school students in the 2013 Curriculum. Problem solving is also one of the mathematical abilities students must have in addition to communication skills, connection skills, reasoning abilities, and representation abilities. Problem solving is the ability of students to choose strategies to solve problems (Polya, 1985). Furthermore (Polya, 1985) states that there are four indicators students have the ability to solve problems, namely understanding the problem, making a solution to the plan, implementing a solution, and evaluating or reviewing the solution. In overcoming the problem-solving ability that is lacking, the teacher can provide questions of daily life stories that are solved by students. According to (Hadi, S. & Radiyatul, 2014) when students solve problems of daily life, students will use oral and reading skills in understanding problems, speaking skills in discussions, giving reasons and can convey every solution used, and represent problem solving in written form.

Problem solving can be categorized into two aspects, namely: 1) how problems are represented in languages such as sentences or non-languages using graphics and 2) how to find the structure of problems such as information, objectives, and plans to solve these mathematical problems (Tambychik, L.G. & Meerah, T.S.M, 2010). Problem-based learning can improve thinking skills and knowledge skills, in addition students can solve problems to make effective decisions (Snyder, L.G. dan Snyder, M.J. ,2008). Based on research (Tambychik, L.G. & Meerah, T.S.M, 2010) there are some difficulties that are often experienced by students

in solving problems, including classifying facts, information, and language.

Trigonometry is one of the materials that must be studied for high school students. Trigonometry is the science of measuring triangles such as the length of the sides, angles, and area of a triangle (Butler, S., 2003). Trigonometry is derived from the Greek trigono means triangle and metro which means size, so trigonometry means the study of sides and angles of triangles (Corral, M., 2009). Trigonometry is still considered material that is difficult for students to understand. That is because trigonometry material still looks abstract by students. Though mathematics will be more meaningful when represented in everyday life.

One of the media used in trigonometry material is clinometer. Clinometer is a device used to measure angles and calculate the estimated height of an object. But as long as based on the results of student work, the authors observe there are differences in student strategies in using the clinometer so that it is also different in processing measurement data. Based on this the authors analyze the problem solving strategies of student measurement results using a clinometer

MATERIALS AND METHODS

This type of research is qualitative research. Qualitative research methods are research methods used to examine natural conditions of objects where the data obtained are analyzed using descriptive qualitative. The subjects of this study were 225 students of class X Senior High School. The object examined in this study is the results of student projects. The procedure in this research is that students make trigonometry application projects in daily

life, after the project has been collected the researcher analyzes the student's work. Data is used to determine students' strategies in solving trigonometric problems using a clinometer.

RESULTS AND DISCUSSION

The research begins with the assignment of project assignments to students to apply the use of trigonometry in everyday life, the teacher frees students to choose material sub-chapters on the trigonometry. Each class consists of 20-37 students divided into groups and each group consists of a maximum of 6 group members. Based on the results of the grouping there were 39 groups and more than 61% chose the topic of using a clinometer to solve trigonometric problems in daily life. Therefore in this study the researcher will analyze the use of clinometers as a medium to solve trigonometric problems in everyday life. Following is a summary of the results of student selection for the selected assignment material, presented in table 1.

Table 1. Student Selection Record.

| No | Material selection | Amount | Presentase |
|----|---|--------|------------|
| 1 | The height of the object using a clinometer | 24 | 61,5% |
| 2 | Total area | 3 | 7,69% |
| 3 | Distance somewhere | 5 | 12,8% |
| 4 | Others | 7 | 17,9% |

The use of clinometers in measuring the height of an object is used for various types of objects, based on the observations of researchers, many groups choose the height of a tree, flagpole, tower, and electricity pole. The selection of the measured object is mostly done around the school. In measuring an object's height, the whole group of students uses a clinometer that they made themselves.

When students want to measure the height of an object, what is known is the distance of the student to the object and the angle of elevation or the angle from the horizontal line to the top, and the height of the observer (student). Based on the known thing, the distance of objects to students, object height, and students' visibility using elevation angles, will form a triangle shape and students can choose the trigonometric ratio on a right triangle. So that the right trigonometric ratio is to use tangent comparisons. Based on the results of the student's work, the researchers found that there were differences in the way students worked in solving problems of daily life into two strategies, namely students measuring the height of an object based on the angle reference and the distance reference:

Angle Reference

The students' strategy to solve the problem of determining the height of an object using this homemade

clinometer is with an angle reference, meaning that students choose to use special angles such as 30° , 45° , and 60° as a reference to the clinometer. This means that when the angle becomes a reference then in measuring the distance of objects with students using the angle chosen by students. The following is an example of the work of students who chose a special angle as a reference in measuring the height of an object. Furthermore, the results of the researchers' analysis showed that more students chose a 45° angle compared to other special angles. This is one of the students' strategies in solving problems, because when choosing an angle of 45° and the trigonometric comparison used is tangent then the value of the trigonometric ratio in the right triangle is 1.

$$\tan 45^\circ = \frac{\text{the height of the object being searched}}{\text{student distance from objects}} = 1$$

This is in accordance with the opinion (Rianto, V.M, Yusmin, E., & Nursangaji, A, 2017) that when students have a strategy in solving problems that have been thought about, the problem solving stage is easy to do such as preparing hypotheses (activities carried out in finding a solution), testing the selected hypothesis and choosing the best hypothesis. Furthermore (Garderen, D. & Montague, M., 2003) states that good problem solving generally builds a representation of the problem and facilitates understanding

Furthermore, the results of the analysis also indicate that the selection of strategies for using special angles has the following reasons:

1. Students are familiar and know the value of a triangle comparison on trigonometry at a special angle
2. Selection of an angle of 45° that produces a value of 1, makes it easy for students to calculate the high value of the object sought.

This is consistent with the opinion of (Hadi, S. & Radiyatul, 2014) if students are given the opportunity to solve problems, will find ways to overcome these problems through a process of thinking that is systematic and careful and makes students more creative and critical

Distance Reference

Other strategies for students in solving problems of daily life, can also be seen from the distance reference strategy, namely students choose a distance that is round or does not contain numbers behind the comma. Next students measure the elevation angle using a clinometer. According to the author, this strategy is also correct, but students must use a calculator to find the trigonometric angle comparison values. The following are examples of student work that uses angles other than special angles.

This is in accordance with the opinion (Indarwati, D., Wahyudi, Ratu, N., 2014) giving application problems can provide opportunities for students to solve problems using a variety of mathematical skills and procedures.

Furthermore Branca (Hadi, S. & Radiyatul, 2014) if students solve problems using methods, procedures, and strategies, students have used the basic skills of learning mathematics and achieve the general objectives of learning mathematics. Next (Lahinda, Y. & Jailani, 2015) the problem solving process is available in contexts where concepts, principles, and skills are learned. When students are given a mathematical problem, there are several strategies that students will do according to Souvieney (Lahinda, Y. & Jailani, 2015) as follows *Guess and Test*:

1. Substitute Simpler Values, a strategy by entering number values into the problem.
2. Devide Problem Into Subtask, a strategy by separating several components to be solved in turns.
3. Conduct an Investigation, a strategy by designing a picture using sketches, tables, and graphs of the problem situation.
4. Design a Model, a strategy by designing models of problems.
5. Draw Sketch, strategy by drawing a chart or diagram of the problem.
6. Make a systematic List, the strategy of making the possible outcomes of the problem.
7. Make a table, a strategy by simplifying data in tabular form.
8. Construct a Graph, a strategy by interpreting the relationship of information about using graphs.
9. Reduce to a Simpler Case, a strategy to find patterns to predict activities in the next process
10. Search for a pattern, find a number or geometric pattern as a clue to the relationship on the problem.
11. Construct a General Rule, a strategy by writing a formula that suits the problem situation.
12. Word Backward, a strategy by working backwards to determine steps to find the initial state.
13. Add Something to the Problem, a strategy by adding new elements in the problem to produce a solution

Next the researchers analyzed the comparison of students' strategies in solving these problems to the high precision of an object.

1. Corner Reference

When students use angular references as a strategy in solving problems measuring object heights, students can choose angular angles of 30° , 45° , and 60° , but the angles that produce numbers for are only 45° angles ie 1, because of one is an integer so that the measurement accuracy is more reliable. Meanwhile, if students choose the angle of 30° and 60° it will produce a number that is not round or there is a number behind the comma. This makes it less accurate because it depends on the rounding chosen by students.

2. Distance Reference

When students use the distance reference as a strategy in solving problems measuring the height of

objects, students are free to choose the angle and this allows students to get an angle that is not a special angle. This will cause the value of the angular comparison will not be round or there is a number behind the comma, so that it will cause inaccurate results because of the students' chosen rounding depends.

So when referring to the problem-solving strategy according to Souvieney (Lahinda, Y. & Jailani, 2015), students use the conduct an investigation strategy, design a model, draw sketch. This is evident in the results of student project work that uses strategies to design images using sketches, tables, and graphs, design models of problems, and draw charts or diagrams of problems.

CONCLUSION

Based on the results of the analysis conducted by the researcher, it can be concluded that: (1) students' problem solving strategies to solve trigonometric problems using a clinometer media are divided into two strategies namely students pay attention to angular size rather than distance and students pay attention to distance from angular size to determine height a building and (2) the strategy used by students by paying attention to the angle rather than distance shows better results than students paying attention to the distance than the angle size to determine the height of a building. Based on the results of research and findings during the study, the researcher has a number of suggestions that other researchers can apply mathematical projects in everyday life so that students better interpret mathematical applications in daily life and students are freed in solving problems to be solved.

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