The Ability of cadets to solve trigonometry routine and non-routine problems

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Abstract. This research is a qualitative research, which is describe the ability of cadets to solve routine and non-routine problems of trigonometry material in applied mathematics subject. Competence of learning achievement in applied mathematics course required cadets to be able to solve mathematical problems related to trigonometry. An analysis of this ability was needed as an illustration of lecturers in developing lesson plan which is more effective and efficient. The population of this study was cadets of the ship engineering study program academic year 2018/2019 and the sample of study was three cadets chosen by random. The technique of collecting the data by using the results test of the cadets. The results of the study shown that the ability of cadets to understand problem and apply the concepts to solve routine problem was good, although not all of the information was written in their answers. The cadets' ability to compile and carry out a plan of routine problems was quite good, even though they immediately wrote the formula to solve the problem. The ability of cadets to understand non-routine problem was not good, due to, cadets have not been able to know the additional information that must be extracted from the problem.

1. Introduction
Cadets are students registered at the Inland Water and Ferries Transport Polytechnic of Palembang to develop their potential through the learning process [1]. Learning is the process of student interaction with lecturers and learning resources in a learning environment [1]. The ability to solve problems is one of the abilities students must have after learning in class, and explicitly stated in the curriculum [2]. That ability must also be possessed by every cadet as a student of higher education level. This is stated in the appendix to the Ministry of Research and Technology regarding attitudes and general skills that each graduate must demonstrate and possess variety of character values and be able to solve work problems with the nature and context in accordance with his field of expertise [3].

The ability to solve problems is needed in order to prepare students to face global competition, so students will be better prepared to engage and participate in the world of work [4]. Mathematics is a way to encourage students to practice to solve the problem faced by humans [5]. Although not all problems are mathematical problems, but to solve those problems not a few require mathematical thinking [6].

In general, mathematical problems can be divided into two types, routine and non-routine problems. Routine problems are ordinary practice problems that can be solved by procedures learned in class. While non-routine problems are problems that need to be further thought to solve because the procedure is not as clear as the procedure learned in class [7, 8, 9]. Other research results recommend the teacher to be able to give non-routine problems to students because non-routine problems can trigger the emergence of happy characters such as honesty, hard work, creativity and especially the value of curiosity [10].
Trigonometry comes from Greek which means triangular measurement. Trigonometry initially discussed the relationship between the sides and angles of triangles, but is now used in the development of astronomy, navigation and surveys [11]. Trigonometry is one of the material in mathematics that is important to learn because it has broad application [12]. Students must have knowledge about trigonometry because trigonometry applications are often found in everyday life, such as determining distances that are difficult to reach and heights that cannot be measured directly [13].

Trigonometry was the most difficult to master by students. The average score of senior high school students in Indonesia on trigonometric material was only 40.90 [14]. Researchers have suspected that are lack of skepticism on mathematics problems, learning of school mathematics that has not led to critical thinking, ignorance of students about critical thinking, and motivation in solving mathematics problems [15]. Other research result conclude that the majority of students have difficulty understanding the trigonometric material [16]. There was the difficulty of students lies in solving trigonometric problems, namely, it is difficult for students to determine the sine and cosine values of angles that must be used to solve problems [12].

This study is a preliminary study what the researcher want to do before make another research study media assembled with trigonometry for cadets. Applied mathematics courses become one of the subjects that must be taught by cadets Inland Water and Ferries Transport Polytechnic of Palembang. One of the competencies in the achievement of learning in applied mathematics courses is cadets to be able to solve mathematical problems related to trigonometry. Based on the description above about the various abilities and skills that must be possessed by cadets, an analysis of these competencies is needed as an illustration of the lecturer in preparing learning designs and teaching materials that are more effective and efficient. Therefore, before compiling and designing more effective learning, it is necessary to analyze the ability of cadets in solving routine and non-routine math problems in trigonometry material.

2. Method
This research is a qualitative research that aims to describe the ability of cadets to solve routine and non-routine problems on trigonometry material. The population of this research is the first level cadets of the ship engineering engineering study program Inland Water and Ferries Transport Polytechnic of Palembang. The research subjects were three cadets who were randomly selected. The data collection technique used is a written test. The analysis technique used is to analyze the answer sheets of cadets. The steps of the analysis are as follows: (1) arrange the answer rubric by referring to the stages of problem-solving according to Polya [7,17]; (2) checking the cadet answer sheet; (3) describe the ability of cadets to solve routine and non-routine problems.

3. Result and Discussion
3.1. Routine and Non-Routine Problems
In this study the questions used consisted of routine and non-routine questions that were analyzed based on the results of the cadets' answers. The routine problem that is tried is a matter of applying the concept of trigonometry, namely regarding the sine and cosine rules. Non-routine questions that are tried are forms of questions that require more thinking and have never been tried out to cadets.

A student who has worked on non-routine problems and knows or memorizes the steps to solve them, then the problem cannot be used to test the student's problem solving ability and can only be used to test his memory [8]. Figure 1 shows the form of routine and non-routine questions given to cadets.
3.2. Analysis of answer sheets for cadets

In this study, the research subjects were three cadets chosen randomly. Then the results of the answers of the cadets were scanned and analyzed one by one. In question number one, the results of the three cadets' answers show that they can solve routine problems correctly. The final answer of the three cadets is not exactly same, but the solution is same. Figure 2 shows the cadets' answers of question number one.

Figure 2. Subject's answer to question number 1.

Figure 2 shows that for question number one, the way to solve all cadets is the same, it's just that someone wrote the length of BC in decimal numbers and in the form of root numbers. From the results of these answers it can be seen that the cadets do not write important information on the problem and immediately apply it to the cosine rule. Even so, the way it works is correct and the answers of all cadets are also correct. This shows that the ability of cadets to understand problems and apply concepts to solve routine problems is good. Furthermore, Figure 3 shows the answers of questions number two.
Figure 3. The answer of subject 1 problem number 2.

Figure 3 shows that in question number two, the result of cadet 1’s answer shows that he understood the meaning of the problem quite well. The cadet does not write down the important information in the problem so he might not know that there is additional information to look for first. The cadet immediately wrote down the method of solution which was to apply the cosine rule. However, the angle used is 60°, this shows that cadets can know that the angle of 30° must be added again with an angle of 90° so as to produce an angle of 120°. An error occurred in converting the angle of \(\cos 60°\), so the problem solving becomes less precise.

Figure 4. The answer of subject 2 problem number 2.

Figure 4 shows the results of the answer of subject 2 to problem number 2. The cadet did not write down the important information in the problem. However, from the picture it can be seen that the cadets know the information and succeed in converting the angle of \(\cos 120°\) whose value is equal to \(\sin 30°\). Cadet’s fault only occurs in counting operation, so the final result of completion becomes wrong.
Figure 5. The answer of subject 3 problem number 2.

Figure 5 shows the results of the third cadet's answer to question number 2. The third cadet writes important information in the form of a picture of the ship's journey from point A to point B, then continues his journey to point C at an angle $30^\circ$. From the picture the answer can be seen that the cadets know important information that the $30^\circ$ angle is not the right angle for solving the problem. How to solve the problem is right, but there was an error in the cadet in determining the intended angle so that the problem solving becomes less precise.

Problem number two is an example of a non-routine problem that should be solved by cadets properly. But in reality, cadets still make mistakes in determining the angle and cosine values of the right angle. Solution number two is discussed when a cadet has finished working on the problem.

Figure 6. The answer of problem number 2.

Figure 6 can show the form of questions that are transformed into the form of images that will make cadets more easily understand the purpose of the problem. The lecturer conducts discussions with the cadets so that the cadets understand the description of the questions and the right way to solve them. More specifically so they can imagine the angle and cosine value of the right angle.

For non-routine questions number 3, all cadets cannot answer the questions. This is known from their blank answer sheets. After conducting a question and answer session with them, it was discovered that they could not understand the purpose of the problem and how to solve it. They said
that they had never seen a question like question number 3 so they found it difficult to answer the question.

After analyzing the answers to cadets, the authors argue that it seems that the ability of problem solving in cadets is still not developing optimally. This is also evident from the results of previous studies which showed that the ability of problem solving in students in mathematics is still relatively low [4]. Other research results also revealed that the ability of students to understand the problem was good but not good in reviewing the settlement plan [9, 17]. Then the difficulty of students lies in solving trigonometric problems, namely, it is difficult for students to determine the sine and cosine values of angles that must be used to solve problems [12].

4. Conclusion

Based on the analysis of the answers of the cadets and a few interviews with them, the conclusion of this research showed that the ability of cadets to understand the problems and apply concepts to solve routine problems was good, even though they did not write important information about the questions. The cadets’ ability to compile and carry out a plan of routine problems is quite good, that is, the cadets know the concept of problem solving even though the cadets directly write the formula to solve the problem. The ability of cadets to understand non-routine problems was not good, due to, cadets have not been able to find out additional information that must be extracted from the problems. Researchers see the lack of knowledge and ability of cadets in solving non-routine problems, this indicates that cadets are still not familiar with non-routine problems. The results of this study can be used as a reference as initial research before making appropriate media or teaching materials.

5. References

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