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Mathematical Communication Skill In Solving Trigonometry Problems Of Student Grade-IX Assessed From Self-Directed Learning

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Abstract – This study aims to describe the mathematical communication skills of grade XI students in terms of self-directed learning and influencing factors. This research used a qualitative research method with a descriptive approach. The subjects in this study amounted to 6 students who were selected using a purposive sampling technique. Data sources were obtained through interviews based on student mathematical communication ability tests in working on trigonometry problems and self-directed learning questionnaires. Material expertes carried out data validation in this study. Data analysis techniques in this study included data reduction, data presentation, and conclusion drawing. The results of this study concluded that Students with high self-directed learning were able to fulfill all three indicators, students with moderate self-directed learning were able to meet one indicator and quite capable on the other two indicators, students with low self-directed learning were not able to fulfill all three indicators; Factors that influence students' mathematical communication skills in terms of self-directed learning are understanding of mathematical concepts, skills in practicing problems, and interest in learning mathematics.

Keywords – Mathematical Communication Skills; Medium Initial Ability; Self-Directed Learning; Trigonometry.

I. INTRODUCTION

The learning objectives emphasized in the National Council of Teachers of Mathematics (NCTM, 2000) are that communication is an important part of mathematics. The mathematics learning process plays a major role in developing students' mathematical communication skills. Mathematics learning is expected to improve students' mathematical communication skills in solving problems and achieving the best results (Ahmad & Nasution, 2018). Therefore, the role of mathematics in improving students' mathematical communication skills is very significant (Hodiyanto, 2017). This is in line with the opinion (Zulfah & Rianti, 2018) that the development of mathematical communication skills can hone ways of thinking so that the relationship between mathematical content, problem-solving skills, reasoning skills, critical thinking skills, and socializing with others, both in writing and conversation can increase. The results of the research (Nurhasanah et al., 2019) state that mathematical communication skills are still less than optimal because they are constrained by slow thinking patterns and often forget the steps of completion, in accordance with the research findings (Munthe & Karim, 2021) which show that lack of concentration is one of the factors that affect students' mathematical communication skills. Based on research conducted by (Susanti et al., 2018), mathematical communication skills are not as expected. In other words, students' mathematical communication to learn is still lacking. This is in line with the findings of research (Sarumaha et al., 2022) that interest in learning mathematics has a significant impact on students' mathematical communication skills.

The differences in students' mathematical communication skills in conveying their ideas are influenced by one of them, namely readiness to learn individually and believe in their abilities or, in other words, self-directed learning. In line with research (Pujianti et al., 2023) students' mathematical communication skills are in line with students' self-directed learning itself. The process of self-directed learning becomes a means of knowing one's initial abilities by providing opportunities to practice, experiment, and develop new skills independently. Improving and creating this initial ability is an essential step in helping students become effective learners. According to (Suparni, 2019), Students' initial abilities are skills possessed by students before engaging in the learning process. A person's initial ability is a foundation for harmonizing new and previous knowledge (Azizah et al., 2021). This is in line with research (Zakiyah & Naili, 2022) that students who have moderate initial abilities dominate. A study (Payung et al., 2016) entitled "The Effect of Initial Knowledge, Emotional Intelligence, and Learning Motivation on Science Learning Outcomes of Class VIII Students of SMP Negeri 3 Parigi" showed the results that there was an influence of initial knowledge, emotional intelligence, and learning motivation on learning outcomes.

Baharuddin et al. (2022) explain that self-directed learning is a learning model exploring readiness to learn independently. According to (Handayani, 2017) self-directed learning emphasizes the development of process skills and system understanding rather than focusing on receiving material content and test evaluation. In this case, self-directed learning can be a solid foundation to build students' intrinsic motivation towards learning mathematics. When students have control over their learning, they tend to feel more empowered, are able to increase self-confidence, and develop motivation that comes from within themselves. Pujianti et al. (2023) in their research entitled "Analysis of Mathematical Communication Ability of Quadrilateral Material Students in Review of Self-Directing Learning" showed the results that students' mathematical communication skills are in line with students' self-directing learning. This is in line with research (Şenyuva & Kaya, 2014) that students who have high self-directed learning are able to control themselves to be able to direct the expected learning style. Trigonometry is part of a mathematics subject that focuses on triangles, including side length, area, perimeter, and angle measure (Hidayat & Aripin, 2020). The challenges in learning trigonometry are often obstacles for students to learn and even understand (Sarac & Aslan-Tutak, 2017). Students who do not understand the basics of trigonometry well may have difficulties when teaching materials related to trigonometric concepts (Kepa, 2019).

Based on a pre-survey interview conducted with one of the math teachers, students are not accustomed to expressing ideas orally and in writing. This condition is also caused by the need for more active students communicating the difficulties experienced during learning.

The novelty of this research from previous research is the addition of initial ability variables. Initial ability becomes the benchmark for achieving mathematical communication skills through self-directed learning. Students with moderate initial ability tend to understand most of the material concepts without significant difficulty but also face obstacles in deeper understanding or applying more complex concepts.

II. RESEARCH METHODOLOGY

This type of research is qualitative with a descriptive approach. The data presented in this study is in the form of descriptions in sentence form to analyze students' mathematical communication skills according to the facts obtained. The data sources of this research were obtained from the results of the initial ability test, the results of the self-directed learning questionnaire, the results of the test of students' mathematical communication skills in solving trigonometry problems, and the results of interviews with research subjects. Sampling or research subjects were selected using a purposive sampling technique. The selection first looks at the completeness of the answers to student test questions, then the questionnaire scores that are far from the interval limit, and the consideration of researchers and teachers on the results of student answers on the mathematical communication skills test. In this study, the data validity technique was used by researchers through material experts' validity testing. Data analysis techniques through data reduction, data presentation, and conclusion drawing.

III. RESULT AND DISCUSSION

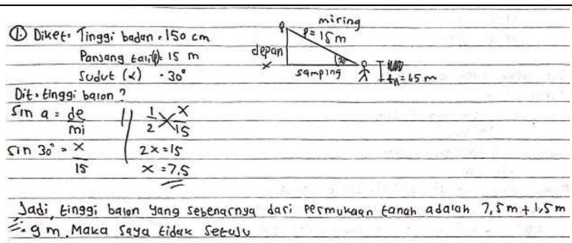
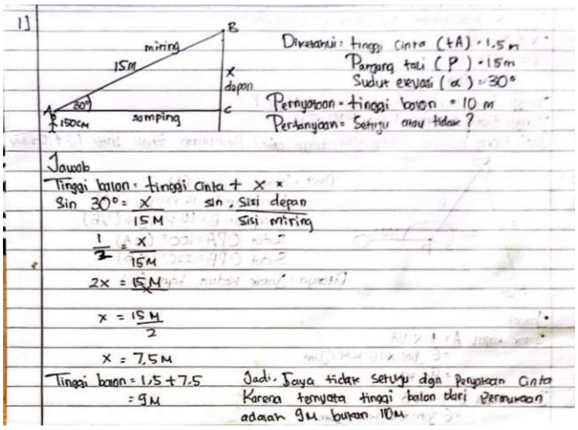
The researcher selected two students at each level of self-directed learning, so there were six students as research subjects. Students with high self-directed learning were given the initials T1 and T2. Students with moderate self-directed learning were given the initials S1 and S2. Students with low self-directed learning were given the initials R1 and R2.

Table 1. Students Self-Directed Learning Groups

Level of Self-Directed Learning	Amount of Student
High	6
Moderate	10
Low	7

The analysis was conducted on the test result data and task-based interview data to provide an overview of the mathematical communication ability of each self-directed learner. Then, the method of triangulation was carried out on both data to get valid data. The following is the data analysis of the subject's mathematical communication ability for each self-directed learning category:

Table 2. Mathematical Communication Ability Test Analysis Results

Category Self-Directed Learning	Mathematical Communication Ability Test	Analysis Results
High	 **Figure 1. Question 1 Subject T1**  **Figure 2. Question 1 Subject T2**	Subjects T1 and T2 were able to write mathematical ideas to find the balloon's height by calculating the length of the front side using the concept of sine and wrote conclusions with correct arguments on each problem.

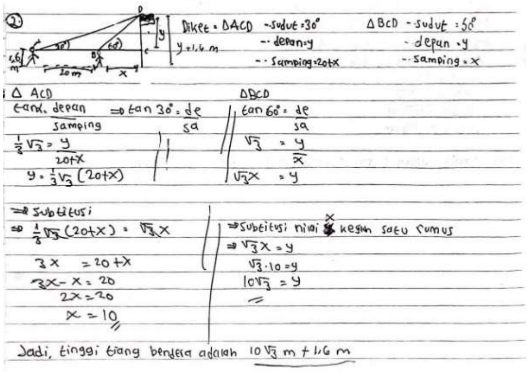
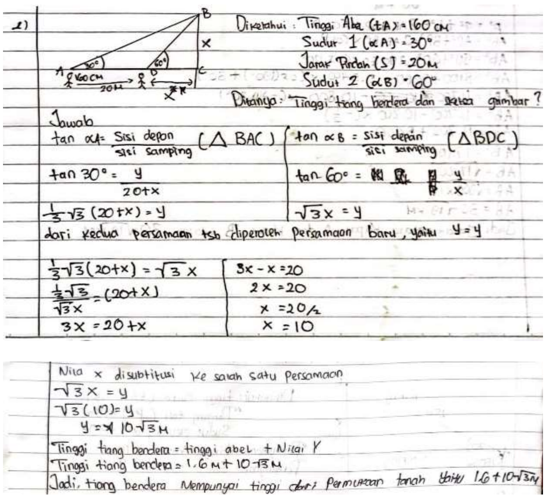


Figure 3. Question 2 Subject T1



Gambar 4. Soal 2 Subjek T2

Subjects T1 and T2 were able to present the problem in the form of a picture by analyzing the available information, finding information on the size of the image by using the concept of a tangent, observing the picture to find ideas related to the height of the flagpole by calculating the length of the front side to solve the problem.

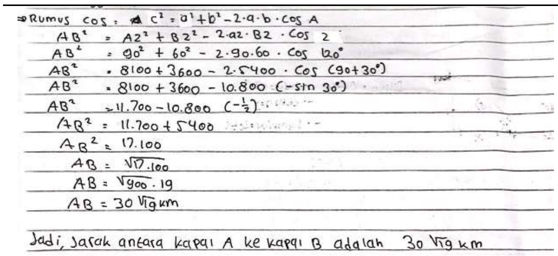


Figure 5. Question 3 Subject T1

Subjects T1 and T2 were able to express the distance of the two ships into a mathematical model by evaluating ideas using the cosine rule.

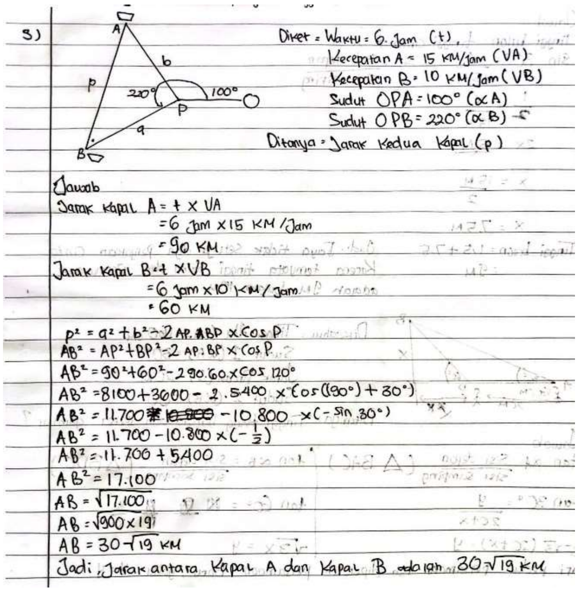


Figure 6. Question 3 Subject T2

Moderate

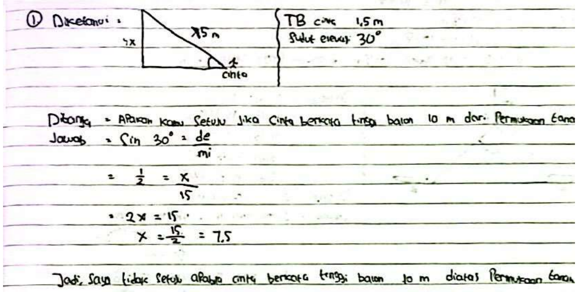


Figure 7. Question 1 Subject S1

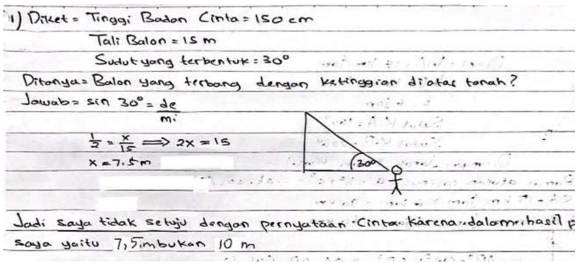


Figure 8. Question 1 Subject S2

Subjects S1 and S2 were quite capable of writing mathematical ideas to find the height of the balloon by calculating the length of the front side of the sine concept, so they wrote conclusions with inaccurate arguments in each problem.

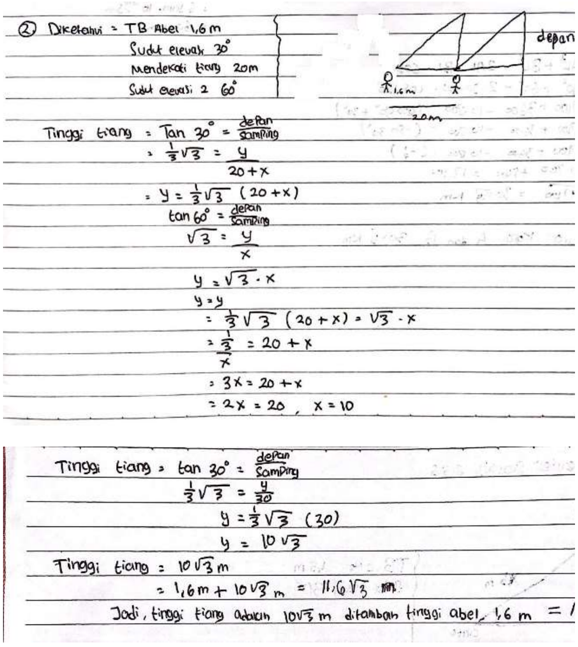


Figure 9. Question 2 Subject S1

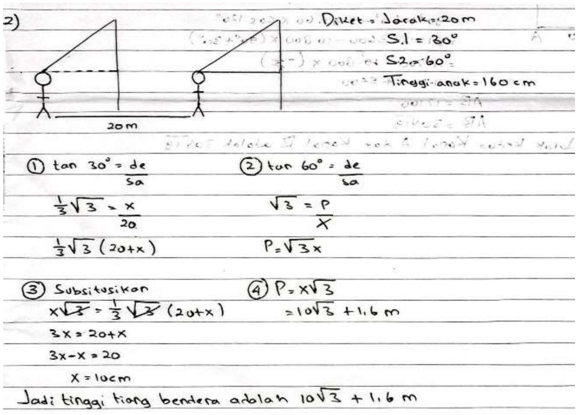


Figure 10. Question 2 Subject S2

Subjects S1 and S2 were able to present the problem in the form of a picture by analyzing the available information, were able to find information on the size of the image by using the concept of tangent, and were able to observe the image to find ideas related to the height of the flagpole so that they were able to solve the problem.

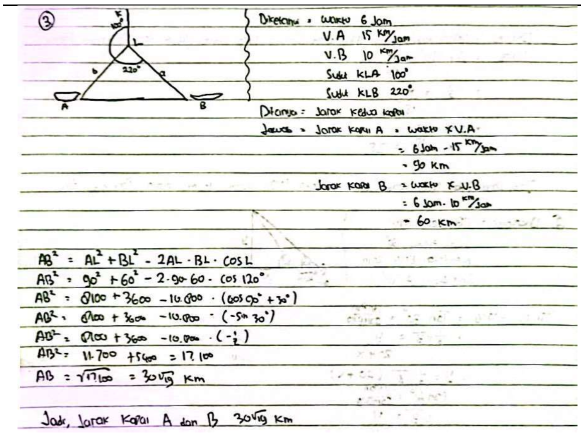


Figure 11. Question 3 Subject S1

Subjects S1 and S2 could express the distance of the two ships into a mathematical model by evaluating ideas using the cosine rule.

Figure 12. Question 3 Subjct S2

Low

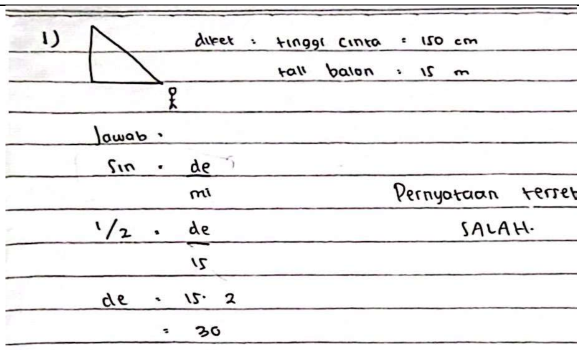


Figure 13. Question 1 Subject R1

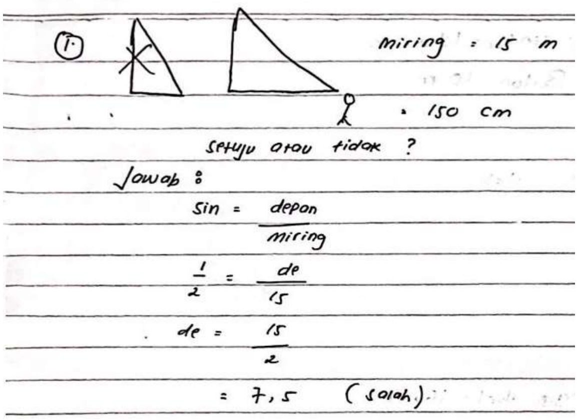


Figure 14. Question 1 Subject R2

Subjects R1 and R2 could not write down mathematical ideas to calculate the height of the flagpole and could not write conclusions with correct arguments.

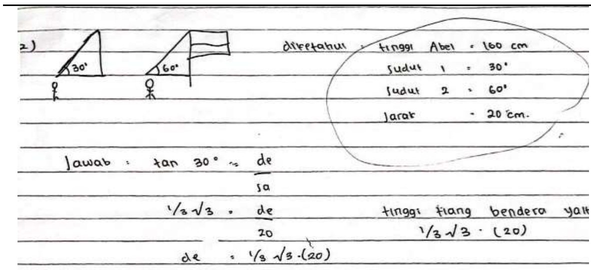


Figure 15. Question 2 Subject R1

Subject R1 was unable to present the problem in the form of a picture, unable to find information on the size of the image using the concept of tangent, and unable to observe the picture to find ideas related to the height of the flagpole so that he failed to solve the problem.

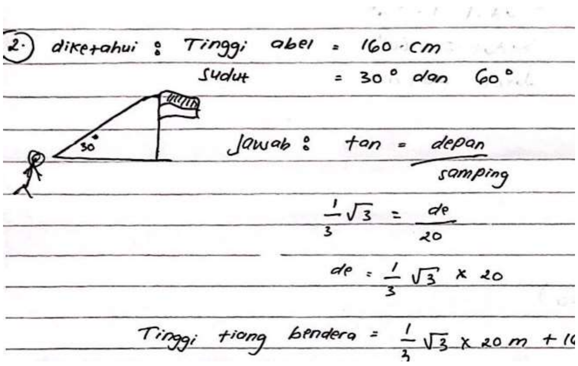


Figure 16. Question 2 Subject R2

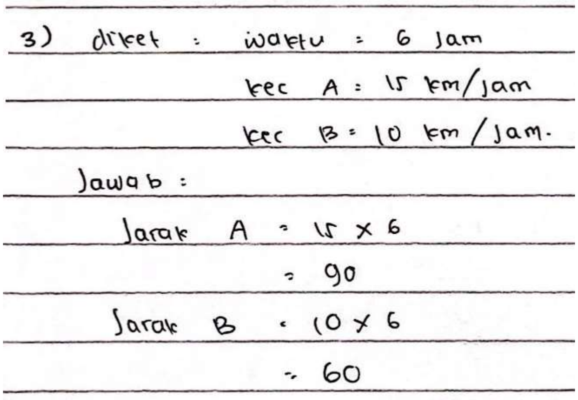


Figure 17. Question 3 Subject R1

Subject R1 could not express the distance of the two ships into a mathematical model through the process of evaluating ideas using the cosine rule.

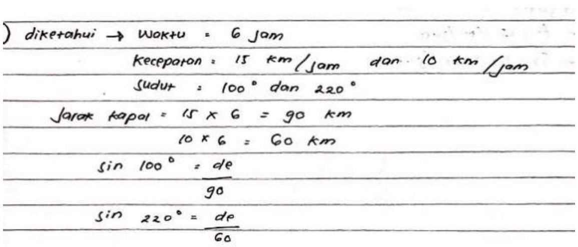


Figure 18. Question 3 Subject R2

The results of data analysis show that students with high self-directed learning tend to be able to explain mathematical ideas in their language in writing (written text). Students with high self-directed learning tend to be able to present mathematical ideas in visual form (Drawing). Students with high self-directed learning tend to be able to express ideas and picture situations in the language of mathematical symbols or formulas (Mathematical Expression).

Students with moderate self-directed learning tend to be able to explain mathematical ideas in their own language in written text. Still, they need to be more thorough so that it affects the conclusions written. Students with moderate self-directed learning tend to be less able to present mathematical ideas in visual form (Drawing). Students with moderate self-directed learning tend to be able to express ideas and picture situations in the language of mathematical symbols or formulas (Mathematical Expression).

Students with low self-directed learning tend to be unable to explain mathematical ideas in their own language in writing (written text). Students with low self-directed learning tend to be unable to present mathematical ideas in visual form (Drawing). Students with low self-directed learning tend to be unable to express ideas and picture situations in the language of mathematical symbols or formulas (Mathematical Expression).

Self-directed learning is one of the factors that can affect students' mathematical communication skills. Other factors can affect students' mathematical communication skills: 1) internal factors include students' understanding of mathematics, skills in practicing mathematics problems, and student's interest in learning mathematics; 2) external factors, namely the learning process.

IV. CONCLUSION

Based on the results and discussion, it can be concluded that students' mathematical communication skills in solving trigonometry problems and influencing factors in terms of self-directed learning align with students' self-directed learning. Factors that can affect students' mathematical communication skills in self-directed learning consist of 1) internal factors, namely students' understanding of mathematics, skills in practicing mathematics problems, and student's interest in learning mathematics; 2) external factors, namely the learning process.

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