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Analysis of Students Mathematical Communication Ability in Solving Trigonometry Problems Reviewed from Students Learning Interests

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Abstract: Mathematical communication ability have an important role for students in knowing their abilities when communicating their understanding. The purpose of this study is to analyse students' mathematical communication ability in solving trigonometry problems in terms of interest in learning. This research uses qualitative descriptive research. The instrument used in this study were the questionnaire interest in learning, the mathematical ability test, and interview. The results of this study is mathematical communication ability is different for every subject both orally or writing related with interest in learning. And the conclusion of the study is mathematical communication ability in writing, subject with high interest learning still better than the subject interested in learning is medium and the interest in learning is low. While the ability to communicate mathematically oral subject with medium and low interest learning still better than the subject interested in learning is high.

Keywords: mathematical communication ability, learning interest, trigonometry.

Abstrak: *Kemampuan komunikasi matematika berperan penting bagi siswa dalam mengetahui kemampuannya saat mengkomunikasikan pemahamannya. Tujuan penelitian ini adalah menganalisis kemampuan komunikasi matematis siswa dalam menyelesaikan soal trigonometri ditinjau dari minat belajar. Penelitian ini menggunakan penelitian kualitatif deskriptif. Hasil penelitian menunjukkan bahwa kemampuan komunikasi matematis berbeda-beda setiap subjek baik secara lisan maupun tulisan yang dihubungkan dengan minat belajar. Dan kesimpulan pada penelitian ini adalah kemampuan komunikasi matematis tulis, subjek dengan minat belajar tinggi lebih baik daripada subjek dengan minat belajar sedang dan minat belajar rendah. Sedangkan secara lisan, subjek pada minat belajar sedang dan rendah lebih baik daripada subjek minat belajar tinggi.*

Kata kunci: *kemampuan komunikasi matematis, minat belajar, trigonometri.*

▪ INTRODUCTION

Mathematics can be interpreted as a language, in the widely is a universal language (Kabael, 2012). Mathematics learning is one of the material required, because in addition to being neccessary in everyday life and future (Astuti, Azhar, & Faradillah, 2018; Uyen, Tong, & Tram, 2021; Viseu & Oliveira, 2012). In the mathematics learning, one of the important abilities must have for student is mathematical communication ability (Ismail, Arnawa, & Yerizon, 2020). Mathematical communication ability can be defined as exchange ideas and explain knowledge then communicate their ideas orally (Suratno, Tonra, & Ardiana, 2019). Mathematical communication ability can also be interpreted as a student ability to present opinion and idea, well as orally or written although other phase and can understand a opinion and other idea (Al Tamimi, 2017; Phuong & Tuyet, 2018; Ulya, Rahayu, & Riyono, 2019). In another sense, mathematical communication ability is expressing mathematical ideas pass oration, writing, demonstrate, and describing through visual (Puspa, Riyadi, &

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Subanti, 2019). Less of student knowledge in mathematics can make their communication mathematical ideas to be not effective because the limited knowledge of vocabulary for students. That needs a vocabulary in mathematical communication ability because is very important for the writing skills students (Tong, Uyen, & Quoc, 2021). Mathematical communication have a role important to expand mathematical question (Wiriyaudomsatean & Thinwiangthong, 2019).

One of individual success expand mathematical communication ability related in student learning interest (Armania, Eftafiyana, & Sugandi, 2018). Interest in learning is psychological condition for enganging or the desire for involved with a part of object class, events, or thought certain (Lo & Tierney, 2017; Tsai, Lin, Hong, & Tai, 2018). Interest in learning have a important role for guiding the selection of purpose for student in choose for chase or supporting students to chase this purpose (Liebendörfer & Hochmuth, 2013; Tsai et al., 2018). Students who given interest will be motivated for receive a correct and equipped on understanding about the concept, affair, or object which leads to meaningful learning (Lee et al., 2014).

Students interest in trigonometry is a determinant of performance while students present is not determinant of performance in trigonometry (Muhammad, Sumaila, & Yusuf, 2018). The material trigonometric important for studied because containing the basic competency of students who must be managed and control of trigonometric material related with level of thinking students (Bernard, Sumarna, Rolina, & Akbar, 2019). Many students still can not able to create substantiation between trigonometric formula in trigonometry lesson (Hadi & Faradillah, 2020; Luzano, 2020) .

Several studies have examined related mathematical communication ability and interest in learning such as; (Septiana, Kusmayati, & Fitriana, 2018), students mathematical communication ability own a introvert personality able to arrange notion, create a reason, and formalize general definition. (Anwar Rivai, Mardiyana, & Slamet, 2021), student mathematical communication ability actually good categorize but the students still less for explaining and creating mathematical problem learned. (Rohmanawati, Kusmayadi, & Fitriana, 2021), students who have assimilator characteristic capable to explaining the problem situation in the design of geometry and using mathematical solution in related to the analysis of other design. (Lomibao, Luna, & Namoco, 2016), the students with approach mathematical communication have a higher accomplishment, constructual understanding, and more for reduce anxiety compared to the DLP approach.

From several studies that have been mentioned, then the gap in this study is that there is still no research found related to mathematical communication ability in solving trigonometry problems in terms of interest in learning at the high school. From the studies that have been mentioned, the novelty from this research is researchers are interested in conducting research about analysis of mathematical communication ability in solving trigonometry problems in terms of interest in learning at the high school. And the research purpose is to analyze studets mathematical communication ability in solving trigonometry problems in terms of interest in learning.

▪ METHOD

This study uses qualitative descriptive methods. This study design seeks to find, understand, and describe experiences by staying close to the research subject.

Descriptive qualitative approach provides a clear description and experience that fits the novice researcher to explore the question (Power, Atkinson, & Noonan, 2022). This study aims to describe and analyze students' mathematical communication ability in solving trigonometry problems through interest in learning. This research was conducted at SMA 2 Tambun Selatan from May to June. The population in this study was all students of class X MIPA in Sma 2 Tambun Selatan for the 2021/2022 school year with sample subjects totalling two classes.

Research Instruments

Determination of subjects in this study using a questionnaire of learning interest that have been validated by experts, namely two lectures of mathematics education and one mathematics teachers. Based on the results of the questionnaire that has been reviewed and validated shows that the questionnaire that has been made by the researcher is suitable for use to conduct research. The learning interest questionnaire is used to classify categories of students who have a high, medium, and low interest in learning. Based on the result of questionnaire which the students has done, obtained the subject of study as many as three students, consisting of one subjects interested in high learning, one subjects interested in medium learning, and one subjects interested in low learning which refers to the subject taking guidelines for questionnaires and interviews divided into three categories. The mathematical communication ability tests (Tkkm) conducted using a description test totalled three trigonometric questions that had been made by researchers. The purpose of this test is to measure the mathematical communication ability of the subject of study. Each of the questions given has fill the indicators of mathematical communication ability based on the reference indicators, namely (1) drawing, is describe the picture or diagram into mathematical ideas; (2) expression, is states the situation into the language or mathematical symbols; (3) writing, is draw or explain the idea and the situation in writing (Surya, Syahputra, Panjaitan, & Tiffany, 2017). Indicators of the drawing question : this indicators explain about how to draw and decribe a picture according the statement was known. In this indicator, students can presenting situation, idea, or solution from the problem was known with a image or diagram.

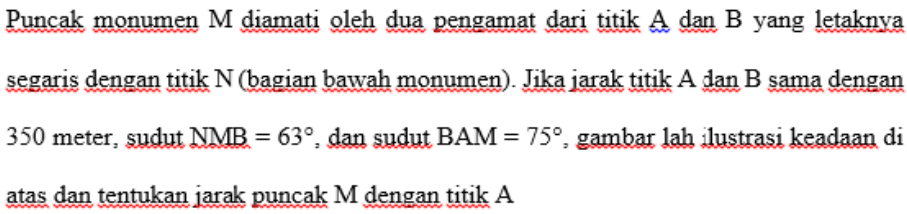

Puncak monumen M diamati oleh dua pengamat dari titik A dan B yang letaknya segaris dengan titik N (bagian bawah monumen). Jika jarak titik A dan B sama dengan 350 meter, sudut NMB = 63°, dan sudut BAM = 75°, gambar lah ilustrasi keadaan di atas dan tentukan jarak puncak M dengan titik A

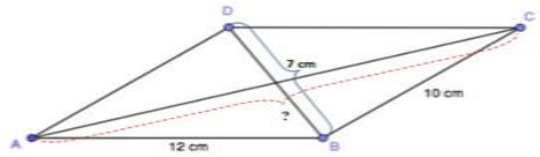
Figure 1. The question in aspect drawing

Indicators of the expressing question: these indicators explain about how to presenting mathematical concept to mathematical models or mathematical language. In this indicator, students can present idea or situation using a mathematical models and notation or symbol of mathematics.

Pada tanah lapang dipasangi 3 buah papan yaitu pada titik *D*, *E*, dan *F*, sehingga jarak papan dari E ke *D* adalah 60 meter, $<FDE = 60°$, dan $<DEF = 45°$. Kemudian Andi berjalan dari papan *D ke F* dan Bima berjalan juga dari papan *E* ke *F*. keduanya mulai bergerak pada saat bersamaan pula. Jika kecepatan Andi berjalan 5 meter/menit, buatlah model matematika serta tentukan kecepatan Bima berjalan

Figure 2. The question in aspect expression

Indicators of the writing question: these indicators namely explaining and identify was known from the problem with own sentence. In this indicators, students can identify was known and stated in the problem.



Berapa panjang Diagonal AC?

Figure 3. The question in aspect writing

Interview were conducted using semi structured techniques in this study. Semi-structured interviews techniques are able to obtain a variety of large amounts of data and detail quickly that guarantees accurancy about individual characteristics and events (O'Keeffe, Buytaert, Mijic, Brozovic, & Sinha, 2016). Semi-structure interview designed to establish subjective responses from subjects about the specific conditions they are facing using detailed interview guidelines which can be used when the subjects statement is felt to be lacking (McIntosh & Morse, 2015).

Data Analysis

Data collection media uses tests, questionnaires, and interviews. here are the indicators on the learning interest questionnaire.

Table 1. Indicators of questionnaire learning interest (abhi purwoko et al., 2021)

Variable	Indicators	Description	Amount	Statement Number
		Teacher openings learning mathematics		
		Ongoing learning mathematics		
		Teacher delivers the math learning in detail		
	Feeling of pleasure	I can answer the given question	4	1,2,3,4
		Material that the teacher is currectly teaching		

	Enthusiastic statement liking something	Teacher give questions to train mathematical comprehension skills	3	5,6,7
		If mathematics is taught daily		
	Growing sense of interest	Easy to understand mathematics lesson when using learning media	4	8,9,10,11
		Comfortable with interactive classroom atmosphere while learning mathematics		
		Enjoy the material that the teachers presents		
		Like the way the teacher brings when teaching		
	The growth of a sense of awareness in learning	Want to know a lot of knowledge about mathematics in learning	3	12,13,14
		Want to understand the material that the teacher teaches in class		
		Understand the importance of learning mathematics in classroom		
	Follow during learning activities	Follow directions from the teacher before doing math learning	3	15,16,17
		Trying to understand and practice the sample questions on the board that the teacher explain in class		
		Listening the evaluation that the teacher gives before ending the math learning		
	Ready to pay attention	Write math material that the teacher describes in class	3	18,19,20
		Willing to help the teacher if need my help while learning		
		Ready to help my friend if it is difficult when understanding the material		

The data analysis used was obtained from the learning interest questionnaire then classified into three categories where students were then given test of mathematical communication abilities whose results are presented in the form of a description. Furthermore, triangulation is carried out to check the validity of the data by comparing the results of the mathematical communication ability test with the results of interviews

▪ RESULT AND DISSCUSSION

Interest in learning questionnaires were given to 63 students of class X MIPA SMAN 2 Tambun Selatan which consisted of two classes through google form then researchers analysed the scores obtained from each student. Based on the questionnaire, it produced 19 students with high learning interest, 37 students with medium learning interest, and 7 students with low learning interest. Then the researchers chose one subjects with high interest in learning, one subjects with medium interest in learning, and one subjects with low interest in learning as research subject.

Table 2. Research subject categories

Number	Name	Subject Code	Gender	Score	Categories		
					High	Medium	Low
1.	NB	MNT-T	L	89	✓		
2.	NNY	MNT-S	P	64		✓	
3.	MB	MNT-R	P	41			✓

The selection based on the classification of learning interests and the scores obtained from the three subjects conformed to the criteria that qualified the required sample. Next, the researcher gave the test of mathematical communication ability (Tkkm) which amounted to 3 questions with each question referring to predetermined indicators. This test is given to students of class X MIPA at SMA 2 Tambun Selatan consist of two class by distributing questions directly in class.

Furthermore, students start working on Tkkm questions at number 1 with indicators of mathematical communication ability, namely describe the picture or diagram into mathematical ideas. The following are the result of working on Tkkm number 1 from MNT-T presented in figure 4.

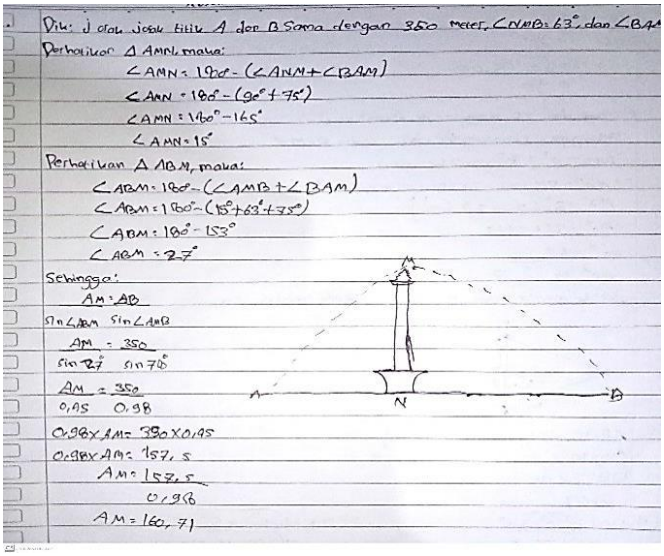


Figure 4. The results of tkkm mnt-t number 1

Next, the researchers conducted interviews with MNT-T. The following is the text of the interview with MNT-T.

MNT-T
R = are there any difficulties in answering question number 1?
MNT-T= possibly, I have a little trouble where during the illustration process i draw a triangle because I think because it is the peak of M that there are points a and b, so I combined MNB into one point then the MNB became the second point and the BAM one became the third point sir
R = in question number 1, you are asked to determine the distance between the peak and the starting point, what steps do you take first to solve this problem?
MNT-T= at first, I finished the calculation first and then drawn a triangle sir

Based on the presentation of the interview above and the test answer in figure 4, it can be seen that MNT-T can understand the content of the questions in figure 1 and knowing how to illustrate what is known from the question both in writing and orally with a little explanation even though the illustration of the picture is incomplete and not quite right and the process of calculating the problem is not correct, as in the research which states the subject can describe the mathematical situation in the problem but does not present the information in the image and is unable to solve the question on the problem (Rohmanawati et al., 2021). This shows that MNT-T is able to reflect real objects and drawing/diagrams into mathematical ideas even though they are incomplete. Furthermore, the results of working on Tkkm number 1 from MNT-S are presented in figure 5.

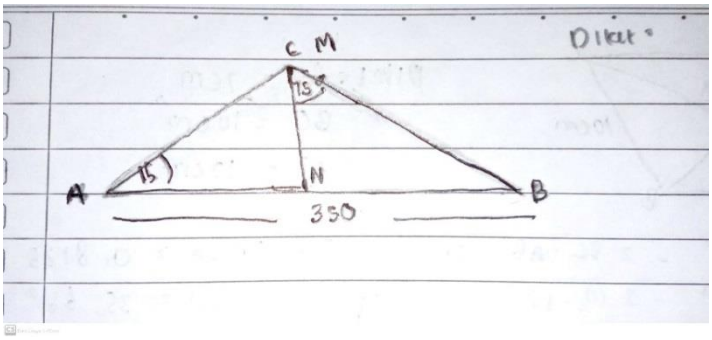


Figure 5. The results of tkkm mnt-s number 1

Next, the researchers conducted interviews with MNT-S. The following is the text of the interview with MNT-S.

MNT-S

R = from the question number 1, what information can you get in this question?
MNT-S = for number 1, I using the triangle area formula sir, Because I'm little confused by the question sir
R = anyway, for number 1 using cosinus rule. in the question number 1, it is asked to determine the distance of the peak with the starting point, how your illustrate the image?
MNT-S = for the illustration a little forgot, so I first made points a and b to point m which later the angle formed 63 degrees with the shape of triangle sir

Based on the presentation of the interview above and the test answer in figure 5, it can be seen that MNT-S a little confused in understanding related to the content of the question especially the calculation, but in describing what is known from the question both in writing and orally a little understanding of how to illustrate it with a little explanation during the interview even though the image made is incomplete, as in the research which states the student shall not suitably state the situation of mathematics in the form of picture (Pangaribuan, Martadiputra, Usdiyana, & Sihotang, 2020). This shows that MNT-S is able to reflect real objects and pictures/diagrams into mathematical ideas but the illustrations are incomplete. Furthermore, the results of working on Tkkm number 1 from MNT-R are presented in figure 6.

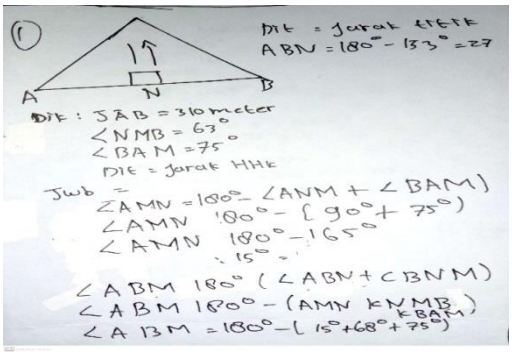


Figure 6. The results of tkkm mnt-r number 1

Next, the researchers conducted interviews with MNT-R. The following is the text of the interview with MNT-R.

MNT-R
R = in the question number 1, you answered this question with help or not?
MNT-R = for number 1, the process is done by yourself sir
R = in the question number 1, it is asked to determine the distance of the peak with the starting point, can you write the distance from point a to b which is known in the question
MNT-R = like this the result, sir

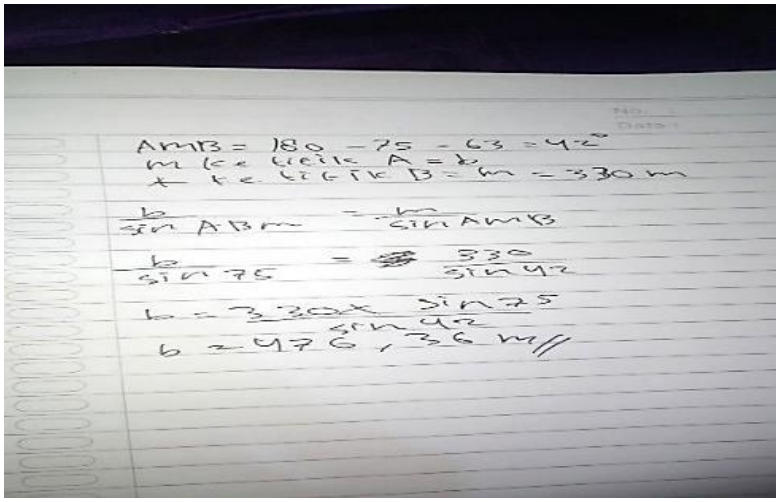


Figure 7. The distance of point A to B

Based on the presentation of the interview above and the test answer in figure 6, it can be seen that MNT-R can understand about the question by drawing what is known from the problem but the illustrated picture is incorrect and incomplete same with calculation and knows a little about point to point in the distance but the answer given orally is different from written result MNT-R on the answer sheet, as in the research which states the subject can declare his idea given by solving the problem with the way but was unable to declare his idea into graph (Septiana et al., 2018). This shows that MNT-R can reflect real objects and pictures/diagrams into mathematical ideas but the illustrations are incorrect and incomplete.

Furthermore, students start working on Tkkm questions at number 2 with indicators of mathematical communication ability, namely states the situation into the language or mathematical symbols. The following are the result of working on Tkkm number 2 from MNT-T presented in figure 8.

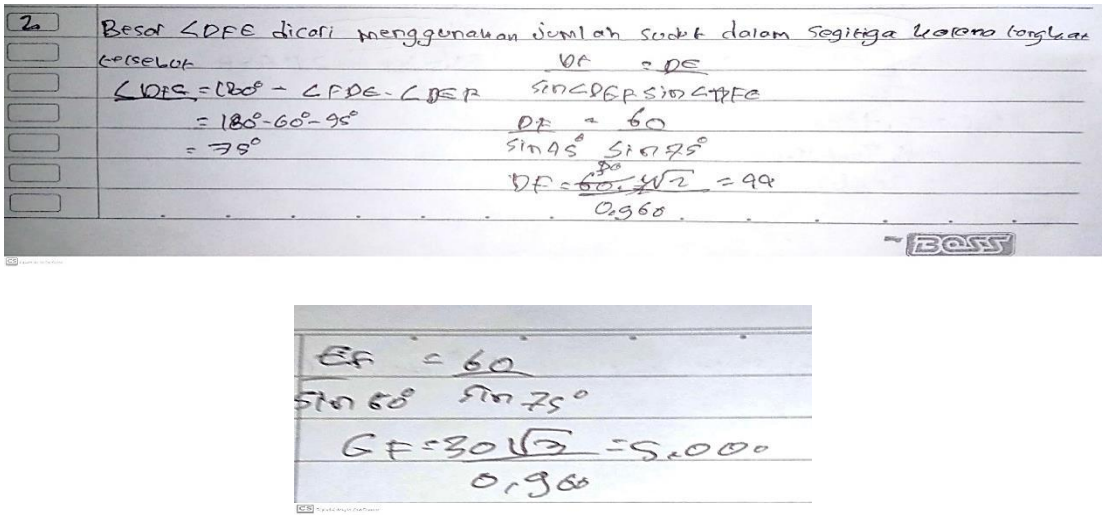


Figure 8. The results of tkkm mnt-t number 2

Next, the researchers conducted interviews with MNT-T. The following is the text of the interview with MNT-T.

MNT-T

R = are there any difficulties in answering question number 2?
MNT-T = I had a little trouble in the calculations for the DEF and FDE angle
R = in question number 2 you are asked to determine the mathematical model of the statement in the problem and determine the speed, what variable did you use first to solve this problem?
MNT-T = I am forgot fo writing a variable sir

Based on the presentation of the interview above and the test answer in figure 8, it can be seen that MNT-T unable to write mathematical symbols on the test sheet and not understand how to make mathematical models both in writing and orally during the interview and unable to complete the calculation of the problem, as in the research which states students can't make mathematical models correctly for solve problems according to the formula that was written (Utami, Pramudya, & Slamet, 2021). This shows that MNT-T hasn't been able to express mathematical concepts into mathematical language. Furthermore, the results of working on Tkkm number 2 from MNT-S are presented in figure 9.

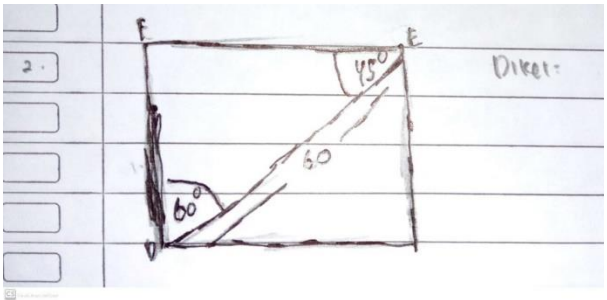


Figure 9. The results of tkkm mnt-s number 2

Next, the researchers conducted interviews with MNT-S. The following is the text of the interview with MNT-S.

MNT-S

R = from the question number 2, what information can you get in this question?
MNT-S = for the number 2, it is known that the distance of the board, the angle as well as the speed
R = in question number 2 you are asked to determine the mathematical model of the statement in the problem and determine the speed, what variable did you use first to solve this problem?
MNT-S = I'm still a little confused about this question sir

Based on the presentation of the interview above and the test answer in figure 9, it can be seen that MNT-S can't write down math symbols on the test sheets because they can only draw without mentioning the math symbols and confused in understanding the meaning of the question both in writing and orally during the interview, as in the research which states that have trouble when understand the language using in the senteces because the language in the problem needs to be declared in the form of variable and mathematical models (Sinaga, Sinaga, & Napitupulu, 2021). This shows that MNT-S hasn't been able to express mathematical concepts into mathematical language. Furthermore, the results of working on Tkkm number 2 from MNT-R are presented in figure 10.

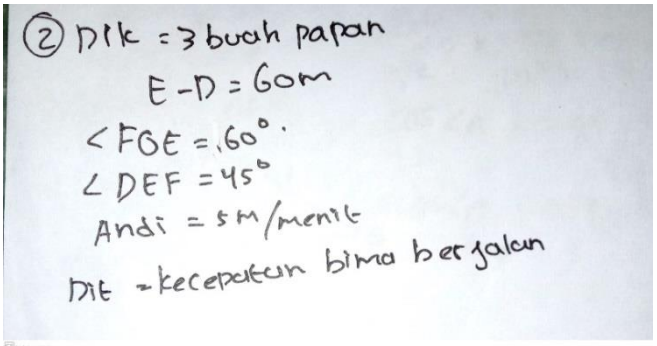


Figure 10. The results of tkkm mnt-r number 2

Next, the researchers conducted interviews with MNT-R. The following is the text of the interview with MNT-R.

MNT-R

R = in the question number 2, you answered this question with help or not?
MNT-R = for number 2, the process is done by yourself sir
R = how do you write mathematical symbols on what kind of problem?
MNT-R = I mentioned the know thing according to the order about sir

Based on the presentation of the interview above and the test answer in figure 10, it can be seen that MNT-R can write the mathematical symbols on the test sheet but not be detailed with the completion of the answer either in writing or orally during the interview, as in the research which states the subject can write down the element was known although that incomplete (Ratnaningsih, Hermanto, & Kurniati, 2019). This shows that MNT-R can reveal mathematical concepts into the language of mathematics but not yet detailed.

Furthermore, students start working on Tkkm questions at number 3 with indicators of mathematical communication ability, namely draw or explain the idea and the situation in writing. The following are the result of working on Tkkm number 3 from MNT-T presented in figure 11.

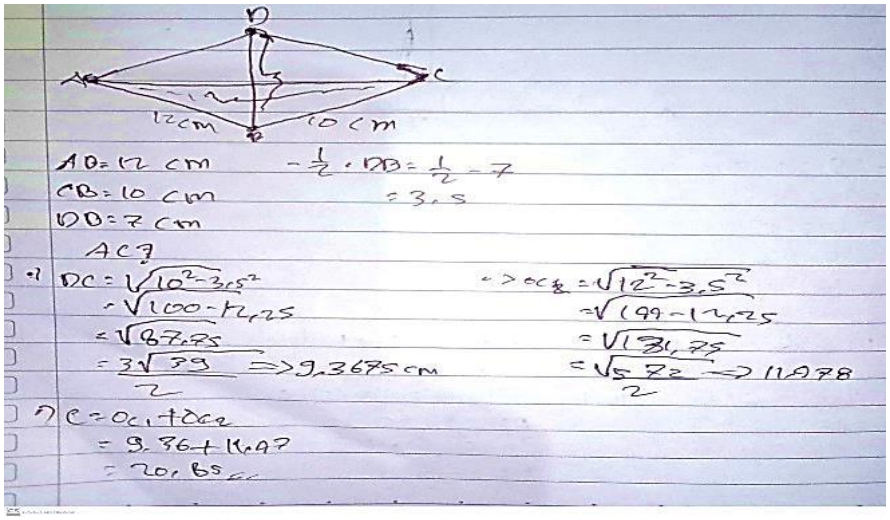


Figure 11. The results of tkkm mnt-t number 3

Next, the researchers conducted interviews with MNT-T. The following is the text of the interview with MNT-T.

MNT-T

R = are there any difficulties in answering question number 3?
MNT-T = I'm still confused and curious for calculate this problem sir
R = so the first, write down the known sides and create a triangle then we look for angle with cosine rule. In your mind, the distance is positive or negative?
MNT-T = distance value is positive sir

Based on the presentation of the interview above and the test answer in figure 11, it can be seen that MNT-T a little difficulty understanding the meaning of the question can be seen from the resuts of the written and oral answers during the interview and the from MNT-T written test can mention the known but cannot calculate the answers, as in te research which state that students still less knowing how to write according on mathematical concepts and to write was known from the problem (Puspa et al., 2019). This shows that MNT-T able to explain and identify what is known in the problem with

the own sentences even though it is not yet correct. Furthermore, the results of working on Tkkm number 3 from MNT-S are presented in figure 12.

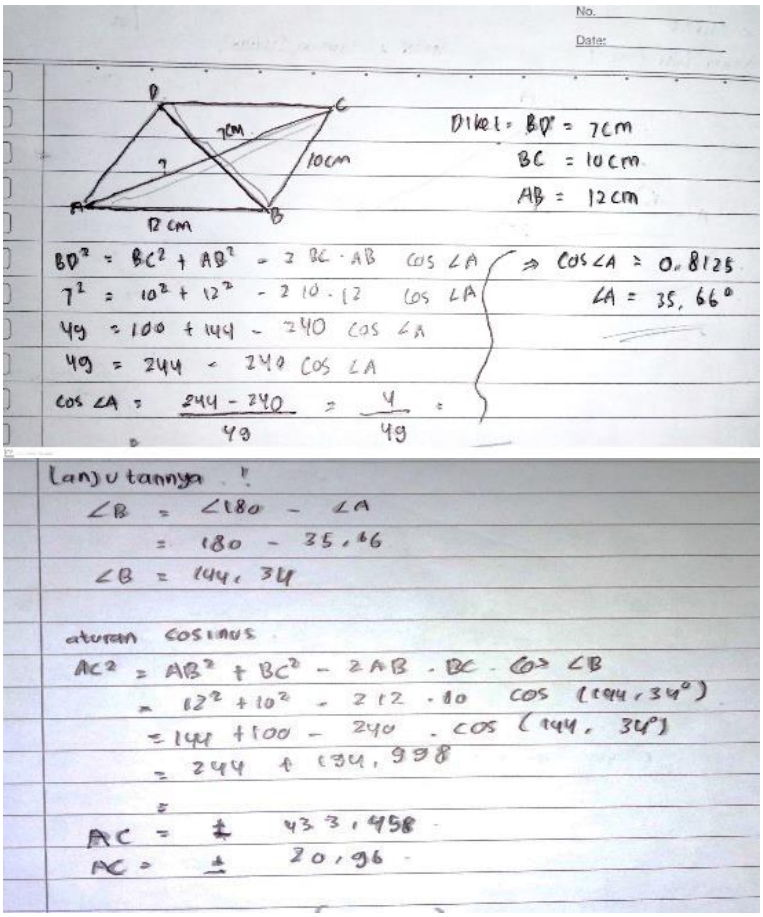


Figure 12. The results of tkkm mnt-s number 3

Next, the researchers conducted interviews with MNT-S. The following is the text of the interview with MNT-S.

MNT-S
R = from the question number 3, what information can you get in this question?
MNT-S = in my opinion, the length of DB side is already known then for the AC side, I am a little confused about how to calculate it
R = in the question number 3, are there no intersecting side?
MNT-S = have sir, in my opinion the DB side and the AC side intersect
R = it's not the answer, for intersecting lines are line AB and line BD

Based on the presentation of the interview above and the test answer in figure 12, it can be seen that MNT-S a little difficulty understanding how to calculate the AC side can be seen from the results of written answers and verbally during the interview and from the written tests MNT-S can writing answers in detailed, as in the research which state that student can solve the problem this section with proofs that students can

modelling this problem correctly (Ismail et al., 2020). This shows that MNT-S able to explain and identify what is known in the problem with the own sentences even though it is not yet correct. Furthermore, the results of working on Tkkm number 3 from MNT-R are presented in figure 13.

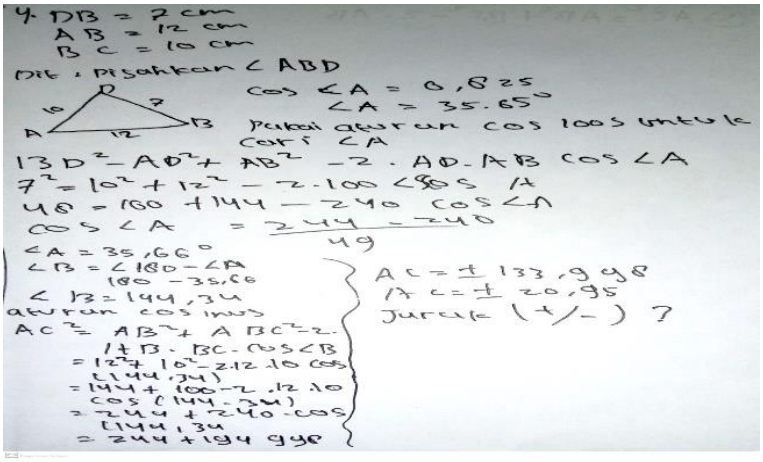


Figure 13. The results of tkkm mnt-r number 3

Next, the researchers conducted interviews with MNT-R. The following is the text of the interview with MNT-R.

MNT-R

R = in the question number 3, you answered this question with help or not?
MNT-R = for number 3, the process is done by yourself sir
R = in the question number 3 is asked to determine the diagonal length of the AC, can you try to write down the known side of this problem?
MNT-R = I don't know sir

Based on the presentation of the interview above and the test answer in figure 13, it can be seen that MNT-R can write down the calculation of the results in detail in writing but the MNT-R answer is different during the interview when asked about writing the known side of the question where the resuts of the written and oral tests are very different, as in the research which states that the subject have a difficulty when reveal a idea or mathematical sentence in own language (Septiana et al., 2018). This shows that MNT-R unable to write down the known thing from the question with the own sentence.

The results of description from 3 subject of research above, indicate that mathematical communication ability is differents for every subject both orally or writing related with interest in learning. This confirms that conveying mathematical ideas both orally and in writing is related to the interest in learning. Subject who have solid interest in learning will be matearialized in readiness to receive a read material then reads from self awareness. Basically, the teacher strive to have the ability to design and set many learning strategies that are felt to be in accordance with the interests and abilities of students (Murtiyasa & Hapsari, 2020).

▪ CONCLUSION

Based on the results of the data analysis described above, it can be concluded that mathematical communication ability in writing, subject with high interest learning still better than the subject interested in learning is medium and the interest in learning is low. While the ability to communicate mathematically oral subject with medium and low interest learning still better than the subject interested in learning is high.

The student in this research becomen more aware that there is relationship between their mathematical communication ability and their interest in learning as seen from research. There are several shortcomings in this study, including the lack of the research that examines the connection of this variable, still lack questionnaire material was using in this research namely learning interest questionnaire because it has not been studied too much by other researchers and this research can used as material for other researchers if they want to conduct research similar to this variable.

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