47956 Turnitin

by Jurnal Kreano

Student's Verbal Mathematical Communication Skills when Presenting Vector Material

Sinta Rohmawati, Akhsanul In'am, Zukhrufurrohmah

Universitas Muhammadiyah Malang

Correspondence should be addressed to Zukhrufurrohmah: zukhrufurrohmah@umm.ac.id

Abstract

Students must master oral mathematical communication because it is often used to convey ideas during discussions or presentations. This research aims to describe students' verbal and mathematical communication skills on vector material. This research uses a qualitative approach with a descriptive research type. The subjects in this research were second-year students of the Mathematics Education study program. The instruments used were verbal and mathematical communication ability test sheets, and the data was validated through video recordings of student explanations and drafts collected by students. Data analysis techniques are carried out by presenting, condensing, and drawing conclusions. This research shows that students have good oral mathematical communication skills of 45%, meaning they can convey their ideas orally well. Most indicators are fulfilled in aspect (1) indicator (b), namely accuracy in conveying or demonstrating the use of concepts in problem examples. Good mathematical communication skills have a good and structured thought process so students can share ideas orally well.

Keywords: Mathematical communication skills; verbal communication; analysis of student ability.

Abstrak

Mahasiswa *perlu menguasi komunikasi matematis lisan karena sering digunakan dalam menyampaikan gagasan saat diskusi maupun presentasi. Penelitian ini bertujuan mendeskripsikan kemampuan komunikasi matematis lisan mahasiswa pada materi vektor. Penelitian ini menggunakan pendekatan kualitatif dengan jenis penelitian deskriptif. Subjek pada penelitian ini mahasiswa tahun kedua prodi Pendidikan Matematika. Instrumen yang digunakan yaitu lembar tes kemampuan komunikasi matematis lisan dan data divalidasi melalui video rekaman penjelasan mahasiswa dan draf yang dikumpulkan mahasiswa. Teknik analisis data dilakukan dengan cara penyajian data, kondensasi data, dan penarikan kesimpulan. Hasil penelitian ini menunjukkan bahwa mahasiswa memiliki kemampuan komunikasi matematis lisan berkategori baik sebanyak 45%, artinya mahasiswa dapat menyampaikan ide pemikirannya secara lisan dengan baik. Indikator paling banyak terpenuhi pada aspek (1) indikator (b) yaitu ketepatan menyampaikan atau mendemonstrasikan penggunaan konsep pada contoh permasalahan. Kemampuan komunikasi matematis yang baik memiliki proses berpikir yang baik dan terstruktur sehingga mahasiswa bisa menyampaikan ide secara lisan dengan baik.*

INTRODUCTION

Learning mathematics requires the ability to have optimal thought processes (Ismail et al., 2020; Toheri et al., 2019). Students can expand their knowledge through the thinking process (Buhaerah et al., 2022). Communication is one of the skills students need because it allows students to understand mathematics through thinking, discussing, and making decisions (Triana et al., 2019). There are four stages in the thinking process. Namely, when students think about mathematics, they will express, reveal, and share mathematical ideas by communicating the results of their thoughts orally and in writing (Chasanah et al., 2020; Naibaho et al., 2021; Sjunnesson, 2020).

At the stages of the mathematical thinking process, students can organize and connect their mathematical thinking through communication; they can express ideas and ideas from their thinking in mathematical language through symbols, visuals, and mathematical terms and can express this by communicating verbally or in writing, which they can then share the results of their thoughts by discussing with others (Nurhusain & Hasby, 2021; Rohid et al., 2019).

Mathematical communication is the ability to express mathematical ideas using mathematical language in solving mathematical problems (Kamid et al., 2020; Setiyani et al., 2020). Mathematical communication conveys ideas, understanding, thoughts, and reasoning in solving mathematical problems using clear and structured mathematical language (Murtafiah et al., 2021; Rachmawati et al., 2021; Sarlina & Alyani, 2021). Mathematical communication skills enable students to convey and explain ideas or concepts in solving mathematical problems (Putri et al., 2022; Zukhrufurrohmah et al., 2021). Mathematical communication is divided into two types, namely oral mathematical communication and written mathematical communication. Verbal mathematical communication delivers mathematical ideas through speech or sayings (Alin Putri Dianti et al., 2021; Mastuti et al., 2022; Rahmawati et al., 2023). Written mathematical communication is the delivery of mathematical ideas or thoughts in written form through pictures, graphs, and mathematical symbols (Marniati et al., 2021; Utami et al., 2023).

Mathematical communication is considered vital because it is one of the abilities that must be mastered in the 21st century. The importance of mathematical communication includes being a means of conveying mathematical ideas and thoughts, exchanging mathematical information and knowledge, and understanding related mathematical problems with the use of symbols, images, and words (Lubis et al., 2021; Sari & Pujiastuti, 2020). Communication skills are also crucial as the primary ability to analyse a mathematical problem, as a means for students to express their ideas or thoughts with a strategy and mathematical modelling, and to help students solve a mathematical problem using language they understand (Anderha & Maskar, 2020; Purnamasari & Afriansyah, 2021).

Indicators of mathematical communication skills used in this research are the ability to convey mathematical ideas orally, demonstrate and draw visually, the ability to use terms, mathematical symbols, and structures to communicate mathematical ideas and describe relationships with situational models, the ability to understand, interpret and evaluate mathematical concepts both verbally and in other visual forms (Efriyadi & Nurhanurawati, 2021).

The material that will be used in this research is vector material. Vector material is material that comes from the vector analysis course, which is a mandatory subject in the Mathematics Education study program. Apart from that, this material is related to mathematical communication skills. One of the achievements of the vector analysis course is conveying conceptual ideas related to vectors and solving problems related to vectors, dot products, cross products, or vector-valued functions.

Research on mathematical communication has been carried out in previous studies Aqilah & Kartini (2021) research regarding students' mathematical communication skills on prism and pyramid material shows that students need to correct their understanding of image meanings and inappropriate procedural errors. Research conducted by Wulandari & Astutiningtyas

(2020) regarding students' mathematical communication skills in learning recurrence relations shows that students who have high mathematical communication skills can interpret their ideas in written form and can describe solutions to problems using a chart, while students who have moderate and low mathematical communication skills experience difficulty in interpreting ideas, concepts, and solutions to problems. According to Faizah & Sugandi (2022), who analysed students' written communication skills in solving algebra story problems during online learning, it is known that students with high mathematical abilities have good written mathematical communication skills, students with moderate mathematical abilities have pretty good writing skills and students with low mathematical abilities have poor mathematical communication skills. Other research conducted by Agustina et al., (2022) regarding the analysis of mathematical communication skills in solving linear programming problems during the Covid-19 pandemic shows that students can express mathematical ideas orally and in writing, compose mathematical models orally and in writing, and write and explain the process of solving mathematical problems orally and in writing.

The difference between this research and previous research based on the explanation above is that this research will analyse students' verbal and mathematical communication skills on vector material. This research aims to describe students' oral mathematical communication skills on vector material. Apart from that, it is hoped that the results of this research will help lecturers find out students' verbal communication skills and can be used as a reference for other researchers who will conduct further research.

METHOD

This research uses a qualitative approach with a descriptive research type. This research uses descriptive qualitative method to describe students' oral mathematical communication skills on vector material. The study was conducted at the Muhammadiyah University of Malang, Malang City, East Java.

The subjects in this research were fourth-semester Mathematics Education students who had programmed vector analysis courses with 20 students. The topics to be researched were selected by one student, each with communication skills in presenting vector material well and not well based on aspects and indicators of oral mathematical communication. Before taking the oral exam, students participate in vector material learning activities for one semester. Learning activities are carried out using class discussion and group discussion methods. The observations on learning show that only around 20% of students actively provide responses or ideas in class discussions. However, students are active in group discussions.

The stages of descriptive qualitative research are presented in Figure 1.

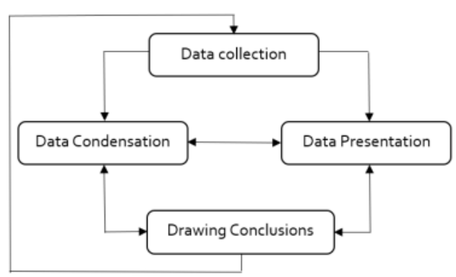

Figure 1. Stages of Descriptive Qualitative Research

Source: Qualitative Research Methods, Lexi J. Moleong (2015: 15)

communication indicators in Table 1.

After that, each student's data is

Table 1. Aspects and Indicators of Oral Mathematical Communication

No.	Aspects of Oral Mathematical Communication	Indicators of Oral Mathematical Communication
1.	Ability to use mathematical ideas or thoughts verbally and demonstrate and draw visually	a. Accuracy in conveying answers or statements related to concepts or vector material b. Accuracy in conveying or demonstrating the use of concepts in problem examples c. Present illustrations (pictures or diagrams) that match the explanation
2.	Ability to use mathematical terms or notation and structures to convey mathematical ideas and draw connections with situational models	a. Write the correct symbols when explaining (accurately presenting symbols) mathematics in the explanation b. The accuracy of presenting images as explanatory illustrations
3.	Ability to understand, interpret, and evaluate mathematical ideas both verbally and in other visual forms (drawing or writing illustrations)	a. Understand the clarity of the sentences conveyed (don't repeat the same sentence several times) b. The accuracy of the reasons or concepts used as answers or to provide answers to problems according to appropriate and correct theories or concepts c. The suitability of the response or answer given to the problem

Adapted from (Efriyadi & Nurhanurawati, 2021)

Data collection is obtained from one type of instrument, namely test instruments. The test instrument is an oral test sheet for mathematical communication skills. On the test sheet, students are asked to choose one topic in vector material and two problems with solutions related to the selected topic. To see oral abilities, students are requested to convey concepts or cases written coherently to explain the problems and solutions used. After the students present, a discussion or question and answer is held regarding the students' understanding.

The data analysis technique for the data presentation stage is carried out by looking at the results of student drafts, video recordings of student presentations, and student discussions. Then, the students' drafts and videos were checked individually and marked according to the fulfillment of the oral communication indicators in Table 1. After that, each student's data is categorized based on the criteria presented in Table 2 (Triana et al., 2019).

Table 2. Rating Scale

Compliance Indicator	Category
$0 \le x \le 2$	Low
$2 < x \le 4$	Currently
$4 < x \le 6$	High
$6 < x \le 8$	Very high

Information :

x = indicator fulfillment result

The conclusion-drawing stage is carried out by describing the analysis results based on the assessment indicators.

RESULTS AND DISCUSSION

Results

The results of the oral test of oral mathematical communication skills on vector material with research subjects of 20 people are as follows:

Table 3. Effects of Oral Mathematical Communication Ability

No.	Oral Mathematical Communication Ability Category	Total
1.	Very high	6
2.	High	9
3.	Currently	3
4.	Low	2
	Total	20

Based on Table 3, students' oral mathematical communication skills are in the high category because most students with verbal mathematical communication skills are in the high class, namely nine students. This means that students can communicate mathematically orally well.

The analysis results of oral mathematical communication abilities are seen based on the results of said tests, where the oral examinations are arranged based on indicators of verbal and mathematical communication abilities, which can be seen in Table 4.

Based on Table 4, it can be seen that the fulfilment of each indicator for each student varies. In aspect (1) Ability to use mathematical ideas or thoughts orally and demonstrate and draw visually, 17 students met, and three students still need to meet indicator (a) accuracy in conveying answers or statements related to concepts or vector material. Twenty students met indicator (b) Accuracy in giving or demonstrating the use of ideas in problem examples. Sixteen students met, and four still need to complete indicator (c) Present illustrations (pictures or diagrams) that match the explanation. In aspect (2) Ability to use mathematical terms or notation and structures to convey mathematical ideas and draw relationships with situational models, 15 students met, and five students did not meet the indicators (a) Write the correct symbols when explaining (accuracy of presenting symbols) mathematics in explanation. Fourteen students met, and six did not meet indicator (b) Accuracy in presenting images as explanatory illustrations. In aspect (3) Ability to understand, interpret, and evaluate mathematical ideas both verbally and in visual form (drawing or writing illustrations), Fourteen students met, and six students did not meet the indicators (a) Understanding the clarity of the sentences presented (not repeating the same sentence or several times and the language used in the explanation is easy to understand). Seven students met, and 13 students did not meet indicator (b) Accuracy of the reasons or concepts used as answers or to provide solutions to problems according to appropriate and correct theories or ideas. Eight students met, and 12 did not meet indicator (c) Appropriateness of the response or answer to the problem.

Therefore, given the diversity of the fulfilment of each indicator, the researcher took one subject as a representative of each criterion analysed for each hand. The following is the form of answers from student representatives, which are analysed based on each indicator.

Table 4. Achievement of Oral Mathematical Communication Ability Indicators

No	Subject Code	Oral Mathematical Communication Skills	Aspects of Oral Mathematical Communication							
			1			2		3		
			Indicators of Oral Mathematical Communication							
			a	b	c	a	b	a	b	c
1.	ZZ	Very high	F	F	F	F	F	NF	F	F
2.	FF	High	F	F	F	NF	F	F	NF	F
3.	AA	Currently	F	F	F	NF	NF	F	NF	NF
4.	SP	Very high	F	F	F	F	F	F	F	F
5.	AD	Currently	F	F	NF	NF	NF	F	NF	NF
6.	RM	Currently	NF	F	F	F	F	NF	NF	NF
7.	MI	Very high	F	F	F	F	F	F	F	F
8.	NH	High	F	F	F	F	F	F	NF	NF
9.	AL	Very high	F	F	F	F	F	F	F	F
10.	FN	High	F	F	F	F	F	F	NF	NF
11.	GA	High	F	F	NF	F	NF	F	F	F
12.	VA	High	F	F	F	F	F	F	NF	NF
13.	RF	Very high	F	F	F	F	F	F	NF	F
14.	MA	High	F	F	F	F	F	NF	NF	NF
15.	NP	High	F	F	F	F	F	NF	NF	NF
16.	DW	Very high	F	F	F	F	F	NF	F	F
17.	MB	Low	NF	F	NF	NF	NF	NF	NF	NF
18.	WP	High	F	F	F	F	NF	F	F	NF
19.	HA	Low	NF	F	NF	F	NF	NF	NF	NF
20.	IF	High	F	F	F	NF	F	F	NF	NF

Information :
F = Fulfilled
NF = Not Fulfilled

Subject ZZ, as a subject representative that fulfils aspect (1) of indicator (a), chooses two perpendicular vectors. ZZ could convey his answer verbally precisely regarding the concept of mutually perpendicular vectors. The ZZ subject said that two geometric objects are perpendicular or orthogonal if the two objects intersect or the two ends of the object meet and form a right angle. It is known that the angle formed by the two things is 90 degrees. RM, as a representative of subjects who do not fulfil aspect (1) of indicator (a), chooses vector dot multiplication material. RM does not meet indicator (a) because subject RM conveys answers regarding the concept of vector dot multiplication inaccurately and tends to convey it in writing rather than verbally; therefore, RM does not meet indicator (a) in aspect (1).

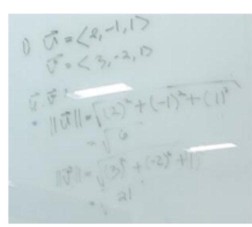

Figure 1. SP Subject Answers

In aspect (1) indicator (b), all subjects fulfil this indicator. As a subject representative, SP chooses vector dot product material. Based on this picture, it can be seen that SP can correctly convey or demonstrate the use of the concept of vector dot product (dot product of vectors) in the example problem in Figure 1.

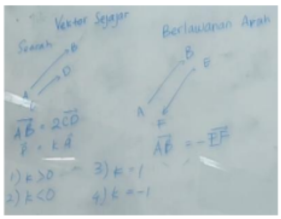

Figure 2. AL Subject Answers

As seen in Figure 2, DW represents a subject that fulfils aspect (1) of indicator (c) by selecting parallel vector material. Subject DW can correctly present illustrations in the form of similar vector images in the same and opposite directions. As a representative of a subject, GA does not fulfil aspect (1) of indicator (c) because GA does not present illustrations in the form of pictures or diagrams following the explanation regarding the parallel vector material it chose.

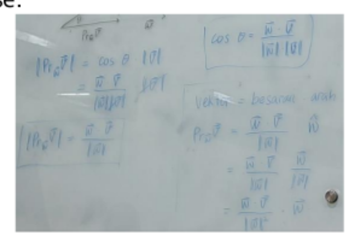

Figure 3. WP Subject Answers

WP chooses vector projection material as a subject representative that fulfils aspect (2) of indicator (a). WP subjects can present and explain the symbols and notations in the material correctly. In Figure 3, it can be seen that WP presents symbols by making examples of vector v and vector w, which are presented by writing the mathematical symbols, namely $\vec{v}$ and $\vec{w}$. WP can also provide mathematical notation, such as θ (theta), to express angle sizes.

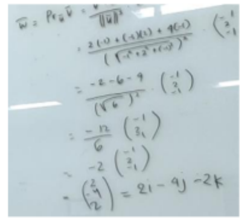

Figure 4. AA Subject Answers

AA, as a representative of subjects who do not fulfil aspect (2) of indicator (a), chooses vector projection material. Subject AA presents and explains the vector unit symbols in vector projection material incorrectly. This can be seen in Figure 3, and it can be seen that AA wrote the unit vector i-j-k incorrectly because the correct writing of the unit vector is $\hat{\imath} - \hat{\jmath} - \hat{k}$.

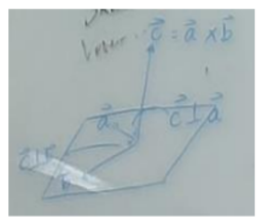

Figure 5. NH Subject Answers

NH, as a representative of subjects who fulfil aspect (2) of indicator (b), chooses vector cross product (cross product) material. NH subjects can present pictures as illustrative explanations of the cross-product concept precisely as in Figure 5.

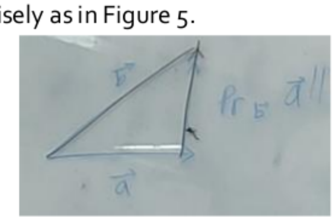

Figure 6. MB Subject Answers

MB, as a representative of subjects who did not fulfil aspect (2) of indicator (b), chose orthogonal vector projection material. MB presents the image as an illustrative explanation of the orthogonal vector projection material incorrectly, as in Figure 6. It should be that orthogonal projection $\vec{b}$ on $\vec{c}$ produces $\vec{a}$ where a line perpendicular bounds the end of $\vec{c}$ to $\vec{a}$ to $\vec{b}$.

FF, as a representative of subjects who fulfil aspect (3) of indicator (a), chooses vector cross-product material. Subject FF understood the clarity of the sentences conveyed by the researcher when conducting questions and answers regarding the material selected by the subject. This can be seen from researchers who give FF subjects questions without repeating the exact words or sentences several times. ZZ, as a representative of topics that do not fulfil aspect (3) of indicator (a), chooses mutually perpendicular vector material. Subject ZZ could not understand the clarity of the sentences asked by the researcher during the question-and-answer session. This can be seen from the researcher repeating the exact words or sentences several times and finally writing questions to subject ZZ.

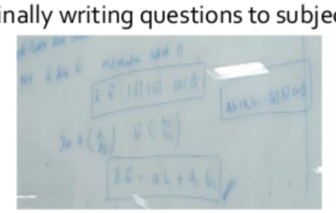

Figure 7. AL Subject Answers

AL, as a representative of a subject that fulfils aspect (3) of indicator (b), chooses the material of the scalar product of two vectors. The researcher asked subjects questions regarding the possibility of formula $\vec{a}.\vec{b} = |\vec{a}||\vec{b}|cos\theta$ and procedure $\vec{a}.\vec{b} = a_1.b_1 + a_2.b_2$ producing different or the same values. It can be seen from Figure 7 that subject AL explains that based on the proof of the two formulas, it is proven that the resulting value is the same, namely $a_1.b_1 + a_2.b_2 = |\vec{a}||\vec{b}|cos\theta$ so that you can use either formula.

RF, as a representative of subjects who do not fulfil aspect (3) of indicator (b), chooses cross-product material. The researcher asked the subject a question regarding finding $\vec{n} = \overrightarrow{PQ}.\overrightarrow{PR} = \vec{m} = \overrightarrow{PR}.\overrightarrow{PQ}$. Subject RF explained that he couldn't because $\vec{n} = \overrightarrow{PQ}.\overrightarrow{PR} \neq \vec{m} = \overrightarrow{PR}.\overrightarrow{PQ}$ because the result would be different, but RF could not provide an answer to the problem by the theory or concept that is correct and correct.

As a representative of subjects that fulfil aspect (3) of indicator (c), MI chooses the material for multiplying vectors with scalars. The researcher asked the issue regarding when two vectors are said to be the same vector. The subject answered that two vectors are said to be the same vector if they have the same direction and length, so it can be concluded that the MI subject can give an answer that suits the problem.

As a representative of subjects who do not fulfil aspect (3) of indicator (c), FN chooses cross-product material. The issue was asked a question by the researcher regarding the results of the cross product $\vec{a} \times \vec{b} = \vec{b} \times \vec{a}$. The subject answered that the development of the cross product $\vec{a} \times \vec{b} = \vec{b} \times \vec{a}$, this answer is not appropriate because $\vec{a} \times \vec{b} \neq \vec{b} \times \vec{a}$ because the commutative property does not apply, so it can be concluded that the FN subject gave the correct answer does not match the problem.

Discussion

Based on the data obtained in this research, most students' oral mathematical communication skills are in the high category, namely 45%, which means they can think mathematically by organizing and connecting their mathematical thoughts well and express ideas from their thinking into symbols and visuals, and mathematical terms correctly. They can tell the results of their thoughts by communicating verbally fluently. Then, they can share the results of their thoughts through discussion activities. As many as 10% of students' oral mathematical communication skills are in the low category, which means they cannot organize and connect their mathematical thoughts well. Still, they can correctly express ideas from their thoughts into symbols, visuals, and mathematical terms. They are less fluent in speaking their thoughts orally, so when sharing the results through discussion activities, they need clarification about how to explain them. Meanwhile, 30% of students' oral communication skills are in the very high category, meaning they can think mathematically by organizing and connecting their mathematical thoughts very well, can express ideas and ideas from their thinking into symbols, visuals, and mathematical terms in a coherent and precise manner, they can tell the results of their thoughts by communicating verbally very smoothly and then they can share the results of their thoughts through discussion activities well. 15% are in the medium category, meaning they can think mathematically by organizing and connecting their mathematical thoughts well. They need to be able to correctly express ideas from their thoughts into symbols, visuals, and mathematical terms, and they can accurately tell the results. They communicate verbally fluently, but in sharing the results of their thoughts through discussion activities, they could be better at conveying them. The results of this research are the same as the results of a study by Maryati et al., (2022), which shows that oral mathematical communication skills are mainly in the high category at 54.17% and 2.08% are in the low sort while 27.08% are in the very high category and 16.67% are in the low category. This means that students with high oral mathematical communication skills have good thought processes in understanding problems by using mathematical models, terms, and notation correctly (Septian et al., 2020).

Based on the analysis of oral mathematical communication skills, students with very high abilities can fulfil 7 to 8 indicators out of the eight indicators that have been determined, so these students have excellent oral mathematical communication skills. For students with good verbal and mathematical communication skills who can fulfil 5 to 6 indicators out of 8, the student has good oral mathematical communication skills. Students with moderate oral mathematical communication skills have relatively good oral communication skills because they only fulfil 3 to 4 indicators. Meanwhile, students with low oral mathematical communication skills can only fulfil 1 to 2 indicators out of 8 indicators, so these students are said to be unable to fulfil the verbal and mathematical communication indicators well. This means that students with fluent oral communication skills have an excellent theoretical thinking style because these students can understand problems with sequential and coherent oral mathematical communication based on indicators of verbal and mathematical communication (Maulyda et al., 2021).

The indicator that is easiest for students to fulfill is in aspect 1 of indicator b, namely accuracy in conveying or demonstrating the use of concepts in problem examples. However, when giving reasons, students have not been able to link the concept of the answer given with other concepts, so the indicator that is most difficult for students to fulfill is in aspect 3, indicator b, which is related to giving reasons or concepts used as answers or providing answers to problems according to theory or concept. which is correct and correct. It is possible that in aspect 1 indicator b, students can provide the concept of the example problem correctly because they have previously read or prepared what they want to convey, so that students have conveyed correctly what they have learned. However, when a problem or question arises that tests the concept, students are confused about finding the right reason. The results of this research are different from the results of research by Andini & Rina, 2021; Zaditania & Ruli (2022), where indicators regarding understanding of concepts in a problem in set material are classified as inadequate, causing students to experience errors in understanding concepts when delivering answers or statements related to concepts or set material.

As many as 65% of students need to improve in the indicators to provide appropriate reasons or arguments by the theory of being able to fulfil them. The results of this research align with the results of the analysis found by Elfareta & Murtiyasa (2022); Ismayanti & Sofyan (2021) where 21% of students who had low mathematical communication skills could not fulfil the assessment indicators well.

If you look at the results of this research, it shows that oral mathematical communication skills are in the high category because they fulfil 5 to 6 of the eight indicators, namely a) Accuracy in conveying answers or statements related to concepts or vector material; b) Accuracy in conveying or demonstrating the use of concepts in problem examples; c) Present illustrations (pictures or diagrams) that match the explanation; d) Write the correct symbols when explaining (accurately presenting symbols) mathematics in the explanation; e) Accuracy of presenting images as explanatory illustrations; f) Understand the clarity of the sentences conveyed (don't repeat the same sentence or several times. Students with good oral mathematical communication skills have good verbal and visual representations and coherent thinking processes (Mubarak et al., 2020). This differs from the results of research conducted by Febriana & Pujiastuti (2022), which shows that students' mathematical communication skills are in the medium category. This is because students only fulfil the first indicator, namely being able to explain their mathematical ideas, and do not fulfil the second indicator, namely providing a conclusion. problems that have been resolved.

The findings of Aqilah & Kartini, (2021); Septiani et al., (2020) which stated that students tend to be inaccurate in representing images, understanding the meaning of images, and procedural errors are not in line with the findings in this study. The results of this research show that students presenting illustrations (pictures or diagrams) that are by the explanation, accurately presenting images as explanatory illustrations, and writing the correct symbols when explaining (accurately presenting symbols) mathematics in explanations can be fulfilled well. Students with good verbal and mathematical communication skills can have good visual representation skills (Dihna & Sudihartinih, 2023; Fitrianingrum & Basir, 2020).

Implication of Research

The implications of this research are that it is hoped that further analysis can be directed at research on learning design that facilitates students to be able to argue using appropriate theories or concepts. Other research can be directed at research that focuses on examining students' abilities regarding the concepts or ideas they have studied.

Limitation

Limitations of this research include the research subject, which focuses on 4th-semester mathematics education students with a total of 20 students, namely 16 female students and 4 male students.

CONCLUSION

Based on the results of the research conducted, it can be said that the oral mathematical communication ability in vector material for Mathematics Education students at the University of Muhammadiyah Malang is in a good category, as much as 45%. This means that students can convey their ideas orally well.

This is related to the fulfilment of 6 indicators out of 8 indicators, namely in aspects (1) The ability to use mathematical ideas or ideas orally and demonstrate and draw visually fulfils the indicators, (a) accuracy of conveying answers or statements related to concepts or vector material; (b) Accurately conveying or demonstrating the use of concepts in problem examples, and (c) Presenting illustrations (pictures or diagrams) that are appropriate to the explanation. In aspect (2), The ability to use mathematical terms or notation and structures to convey mathematical ideas and draw relationships with situational models fulfils the indicators (a) Writing appropriate symbols when explaining (accuracy of presenting symbols) mathematics in explanations and (b) Accuracy of presenting images as explanatory illustration. In aspect (3), The ability to understand, interpret, and evaluate mathematical ideas both verbally and in other visual forms (illustrations, drawing, or writing), the majority only fulfil indicators (a) Understanding the clarity of the sentences conveyed (not repeating the same sentence or several times and the language used in the explanation is easy to understand).

47956 Turnitin

ORIGINALITY REPORT

18%	15%	15%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	journal.uin-alauddin.ac.id Internet Source	2%
2	journal.institutpendidikan.ac.id Internet Source	2%
3	www.journal.staihubbulwathan.id Internet Source	1%
4	www.owasso.k12.ok.us Internet Source	1%
5	doczz.net Internet Source	1%
6	e-journal.usd.ac.id Internet Source	1%
7	www.calvarydayschool.com Internet Source	1%
8	Zulhelmi, Anwar. "Mathematical communication skills in solving block and cube problems", Journal of Physics: Conference Series, 2021 Publication	1%

9	journal.unj.ac.id Internet Source	1 %
10	www.iiste.org Internet Source	1 %
11	Teguh Rafian, Yurnalis Yurnalis, Yosi Fenita, Rafi Iskandarsyah. "Polymorphism of Prolactin Gene (PRL/PstI) In Sikumbang Jonti Duck Using PCR-RFLP Methods", Jurnal Sain Peternakan Indonesia, 2022 Publication	1 %
12	www.pasoschools.org Internet Source	<1 %
13	journal.iaimnumetrolampung.ac.id Internet Source	<1 %
14	Harfin Lanya, Halimatus Zahroh, Moh Zayyadi, Devie Reztia Anjarani. "Mathematical logical intelligence of students with high mathematical communication skills in system of linear equations in three variable", Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah di Bidang Pendidikan Matematika, 2023 Publication	<1 %
15	U Ekaludini, D Darhim. "Mathematical communication ability analysis of high school	<1 %

students on trigonometry learning", Journal of Physics: Conference Series, 2020
Publication

16	Arjon Turnip, George Michael Tampubolon, Sami Fauzan Ramadhan, Adhi Viari Nugraha, Agus Trisanto, Dessy Novita. "Development of Medical Robot Covid-19 based 2D mapping LIDAR and IMU Sensors", 2021 IEEE International Conference on Health, Instrumentation & Measurement, and Natural Sciences (InHeNce), 2021 Publication	<1 %
17	Kristianus Viktor Pantaleon, Dwi Juniati, Agung Lukito. "Female Student Mathematical Communication Ability in the Proving Process: a Review Based on Math Anxiety", Bolema: Boletim de Educação Matemática, 2023 Publication	<1 %
18	eprints.ums.ac.id Internet Source	<1 %
19	Patrisius Nulle, Yohanis Ndapa Deda, Meiva Marthaulina Lestari Siahaan. "IDENTIFICATION OF STUDENT ABILITY IN SOLVING MODEL OF NATIONAL ASSESSMENT IN KEFAMENANU EAST OF NUSA TENGGARA", Alifmatika: Jurnal Pendidikan dan Pembelajaran Matematika, 2022 Publication	<1 %

20	ejournal.uin-suka.ac.id Internet Source	<1 %
21	ejournal.unkhair.ac.id Internet Source	<1 %
22	journal.unismuh.ac.id Internet Source	<1 %
23	Detiana, R Johar, Mailizar. "Students' mathematical communication in discovering the concept of graphs of trigonometric functions through instructional videos", Journal of Physics: Conference Series, 2020 Publication	<1 %
24	Elaine Beltaos, Terry Gannon. "The W N Minimal Model Classification", Communications in Mathematical Physics, 2012 Publication	<1 %
25	ilomata.org Internet Source	<1 %
26	"Traffic Flow Prediction with Genetic Network Programming (GNP)", Journal of Advanced Computational Intelligence and Intelligent Informatics, 2009 Publication	<1 %
27	Ristanti Diah Lestari, Susi Setiawani, Lioni Anka Monalisa. "Analysis of mathematical	<1 %

communication skills in problem solving linear programs on online learning reviewed from impulsive and reflective cognitive styles", AIP Publishing, 2022
Publication

28	ojs.fkip.ummetro.ac.id Internet Source	<1 %
29	A P Kusuma, Zaenuri, Wardono. "Implementation of TTW and TPS learning models to mathematics learning outcomes in terms of students' mathematical communication ability", Journal of Physics: Conference Series, 2021 Publication	<1 %
30	Khusnul Hotimah, Isnawati Lujeng Lestari. "High School Students' Mathematical Communication Skills Through Ethnomatematics-Based Realistic Mathematics Learning Approaches in Geometry Transformation Materials", Noumerico: Journal of Technology in Mathematics Education, 2023 Publication	<1 %
31	M A Maulyda, A M Annizar, V R Hidayati, M Mukhlis. "Analysis of students' verbal and written mathematical communication error in solving word problem", Journal of Physics: Conference Series, 2020	<1 %

Publication

32	N Noperta, A Armiati, D Permana, Y Yerizon. "The Validity of realistic mathematics education based mathematics learning materials for vocational high school students", Journal of Physics: Conference Series, 2020 Publication	<1 %
33	Nabila Muthia Ayu, Hamdani Hamdani, Rachmat Sahputra, Mohamad Rif'at, Dede Suratman. "KOMUNIKASI MATEMATIS LISAN, PEMAHAMAN KONSEPTUAL DAN MOTIVASI BELAJAR DALAM PEMBELAJARAN MATEMATIKA MENGGUNAKAN MEDIA QUIZIZZ", AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 2023 Publication	<1 %
34	alamalin.blogspot.com Internet Source	<1 %
35	ejournal.unesa.ac.id Internet Source	<1 %
36	jurnal.unimor.ac.id Internet Source	<1 %
37	www.coursehero.com Internet Source	<1 %
38	M K Ali, B A P Martadiputra. "Analysis of mathematical communication abilities of	<1 %

senior high school students in linear programming material", Journal of Physics: Conference Series, 2021
Publication

39	Syifa Kamilah, Subhan Ajiz Awalludin. "Analisis Kemampuan Komunikasi Matematis Siswa Autistik Berat dalam Menyelesaikan Soal Matematika", Jurnal Cendekia : Jurnal Pendidikan Matematika, 2021 Publication	<1 %
40	jppipa.unram.ac.id Internet Source	<1 %
41	DJORDJE ČUBRIĆ, PETER DYBJER, PHILIP SCOTT. "Normalization and the Yoneda embedding", Mathematical Structures in Computer Science, 1998 Publication	<1 %
42	Kamid Kamid, M. Rusdi, Olva Fitaloka, Fibrika Rahmat Basuki, Khairul Anwar. "Mathematical communication skills based on cognitive styles and gender", International Journal of Evaluation and Research in Education (IJERE), 2020 Publication	<1 %
43	Zeni Fadlila Agustina, Titin Masfingatin, Swasti Maharani. "Analysis of Mathematics Communication Capabilities in Linear Program Problem Solving during the Covid-19	<1 %

Pandemic", AL-ISHLAH: Jurnal Pendidikan, 2022
Publication

44	repository.upstegal.ac.id Internet Source	<1 %

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		