Indonesian Journal of Teaching and Learning

e-ISSN 2964-1446, p-ISSN 2962-0570
https://journals.eduped.org/index.php/intel

Analysis of Mathematical Communication Skills of High School Students on Matrix Material

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Article Info

Revised June 12, 2024
Accepted December 10, 2024

Abstract

This research aims to describe students' mathematical communication skills in solving problems, especially matrix material in class XI 2 students at SMA Negeri 2 Tambang. The type of research used is a descriptive method with a qualitative approach. Data collection techniques were carried out using observation, tests, interviews and documentation methods. The test instrument used is 3 essay questions about students' communication skills which have been validated. The subjects of this research were 28 students in class XI 2 SMA Negeri 2 Tambang. Then 4 students were selected as representatives of the research subjects based on the category of mathematical communication skills used. The results of this research show that students' mathematical communication skills in solving questions on matrix material average 65,89 in the high category. Where there are 6 students (21,43%) in this very high category, there are 9 students (32,14%) in the high category, and there are no students in the low category.

Keywords: Analysis, Mathematical communication skills, Matrix.

How to Cite: Ashari, F. N., Mayda, N. K., Nurhakiki, D. I., Angraini, L. M. (2025). Analysis of Mathematical Communication Skills of High School Students on Matrix Material. *Indonesian Journal of Teaching and Learning, 4*(1) 1-15. doi: https://doi.org/10.56855/intel.v4i1.1030

1. Introduction

Mathematics is a cornerstone of scientific and technological advancement, serving as both a foundational discipline and a practical tool across diverse fields. Its applications span physics, economics, biology, computer science, and beyond, enabling innovations such as artificial intelligence algorithms and medical research simulations (Siagian, 2016). Carl Friedrich Gauss aptly described mathematics as "the queen and servant of the sciences," highlighting its dual role as an independent discipline and a supportive framework for other scientific domains (Wahyudi, Suyitno, & Waluya, 2018). This duality underscores the importance of mathematics not only as a tool for solving practical problems but also as a conceptual framework for understanding complex phenomena. For instance, in information technology, mathematics underpins programming algorithms, while in economics, it facilitates financial modeling and market analysis. These examples illustrate the indispensable role of mathematics in driving innovation and scientific progress.

In Indonesia, the significance of mathematics is enshrined in the National Education System Law No. 20 of 2003, which mandates its inclusion in primary and secondary education curricula (Afsari et al., 2021). However, despite its critical role, Indonesian students continue to face challenges in mastering mathematical concepts, particularly in applying them to real-world problems. This is evident in their performance on international assessments such as TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment). In the 2015 TIMSS, Indonesian students ranked 45th out of 50 countries, with an average score of 397, significantly below the international average of 500 (PUSPENDIK, 2016). Similarly, in the 2015 PISA, Indonesia ranked 63rd out of 70 countries, with an average score of 386 compared to the international average of 494 (Kemdikbud, 2016). These results highlight a persistent gap in mathematical literacy and problem-solving skills among Indonesian students, particularly in areas requiring higher-order thinking and communication.

Mathematical communication skills (MCS) are a critical yet often overlooked component of mathematics education. MCS refers to the ability to express mathematical ideas clearly and coherently, both orally and in writing, and to interpret and evaluate mathematical arguments (Hodiyanto, 2017). These skills are essential for fostering deep conceptual understanding, facilitating collaborative learning, and enabling students to articulate their reasoning effectively. Research by Dewanti and Muna (2023) emphasizes that MCS enhances students' ability to derive meaning from mathematical reasoning, enabling them to express ideas more clearly and engage in meaningful discussions. Furthermore, MCS serves as a bridge between conceptual understanding and practical application, allowing students to connect abstract mathematical concepts to real-world contexts (Turrosifah & Hakim, 2019). Despite its importance, Indonesian students' MCS remains underdeveloped, as evidenced by their low performance on tasks requiring explanation and interpretation of mathematical ideas (Johar et al., 2017).

Matrix concepts, a fundamental topic in high school mathematics, provide an ideal context for exploring and enhancing MCS. Matrices are structured data representations

consisting of rows and columns, with applications in fields such as computer graphics, economics, and engineering (Siregar & Mardiati, 2020). Mastery of matrix concepts requires not only computational proficiency but also the ability to interpret, analyze, and communicate mathematical ideas effectively. For instance, students must be able to explain the steps involved in matrix operations, such as addition, multiplication, and inversion, and apply these operations to solve real-world problems. However, studies indicate that students often struggle with matrix-related tasks, particularly those requiring higher-order thinking and communication (Soleha & Ferdianto, 2022). This underscores the need for targeted interventions to strengthen MCS in the context of matrix learning.

The relationship between MCS and overall mathematical achievement is well-documented. Research by Astuti & Leonard (2015) found a strong positive correlation between MCS and mathematics performance, suggesting that students with stronger communication skills tend to achieve better learning outcomes. Similarly, Hendriana & Kadarisma (2019) identified self-efficacy as a key factor influencing MCS, with students exhibiting higher self-efficacy demonstrating superior communication skills. These findings highlight the importance of fostering both MCS and self-efficacy to enhance students' mathematical competence.

This study aims to address the gap in MCS among Indonesian high school students by focusing on matrix concepts. Unlike previous research, which primarily examined the relationship between MCS and learning outcomes or self-efficacy, this study delves into the specific mechanisms through which MCS influences students' understanding and problem-solving abilities in matrix-related tasks. By analyzing students' ability to interpret, explain, and apply matrix concepts, this research seeks to provide actionable insights for educators to design effective instructional strategies that enhance MCS. The findings will contribute to the broader discourse on mathematics education, offering evidence-based recommendations for improving students' mathematical literacy and communication skills.

Mathematics education plays a pivotal role in equipping students with the skills necessary for scientific and technological innovation. However, the persistent challenges faced by Indonesian students in mathematical literacy and communication highlight the need for targeted interventions. By focusing on matrix concepts and their applications, this study aims to enhance students' MCS, thereby improving their overall mathematical competence. The findings will provide valuable insights for educators and policymakers, contributing to the development of a more robust and effective mathematics education system in Indonesia.

2. Methods

This research is a descriptive study utilizing a qualitative approach. The data obtained are not presented in numerical form but rather as explanations derived from the research subjects. In line with Arikunto's explanation, when research collects data and interprets the results without using numbers, it is referred to as qualitative research.

The research was conducted on May 7, 2024, at State Junior High School 2 Tambang. The subjects of this study consisted of 28 students from Class XI-2 at State

Junior High School 2 Tambang. Data collection techniques employed in this research included observation, tests, and interviews. Prior to conducting interviews, the researcher administered a mathematical communication skills test in the form of essay questions to the students. Based on the test results, students with similar abilities were identified, and 4 students were selected as representatives for the research subjects. These representatives were categorized into four levels: very high, high, medium, and low. The selected students were examined in-depth to analyze their mathematical communication skills based on the given indicators.

Additionally, the analysis technique used in this research followed the qualitative analysis model proposed by Miles and Huberman, which consists of data reduction, data processing, data presentation, and conclusion drawing. Data reduction involves simplifying raw data into meaningful information, ultimately leading to substantial conclusions. The raw data in this study comprised the students' answers to the given questions. Data presentation refers to organizing information in a manner that facilitates the drawing of conclusions. The final stage in data analysis is concluding by comparing and contrasting the arranged data to derive meaningful insights.

After the data on students' mathematical communication skills is collected, the data is classified based on references in the form of criteria for the level of students' mathematical communication skills. The following criteria for the level of mathematical communication skills of students refer to Arikunto's opinion (Saputri, 2017) as follows:

Table 1. Criteria for Mathematical Communication Skills

No.	Percentage (%)	Criteria
1.	$81 \leq P \leq 100$	Very High
2.	$61 \leq P < 81$	High
3.	$41 \leq P < 61$	Medium
4.	$21 \leq P < 41$	Low

In developing essay test questions, indicators are required to identify the various difficulties students experience in matrix material based on their communication skills. Before formulating the indicators to be used, the researcher referred to expert opinions regarding the indicators of mathematical communication skills. According to Baroody, mathematics learning should assist students in communicating mathematical ideas through five aspects of communication: representation (representing), listening, reading, discussion, and writing.

The indicators used in this study to measure mathematical communication skills are as follows: Expressing mathematical ideas or problems through writing. Representing mathematical ideas or problems visually in the form of graphs, diagrams, or tables. Using mathematical terms, notations, and symbols to present mathematical ideas. Interpreting mathematical ideas or problems in their own words. Concluding mathematical statements (Sari, 2017).

Based on the expert opinions above, the researcher formulated the following indicators to understand the difficulties faced by students in the matrix material based

on their communication skills: Expressing mathematical ideas in other forms. Interpreting and evaluating mathematical ideas into other forms. Presenting information in the form of a matrix.

3. Results and Discussion

3.1. Results

The normality test in this study was used to determine the distribution of data on the results of the instrument between the experimental class and the control class both before and after treatment, whether the data was normally distributed or not. This test was carried out using SPSS Software. The normality test of the student post-test data used Shapiro-Wilk, the following are the results of the data obtained:

Table 2 - Normality Test

		Sig.
Shapiro-Wilk	df	23
	Experiment Posttest	0.353
	Control Posttest	0.013

Based on the output above, it is known that the significance value (Sig) for all post-test learning outcomes of the experimental class is 0.200, and the post-test of the control class is 0.024 in the Shapiro-Wilk test> 0.05, so it can be concluded that the data of the experimental and control classes are normally distributed.

The homogeneity test aims to determine whether a variant (diversity) of data from two or more is homogeneous (the same) or heterogeneous (not the same). The results of the homogeneity test are as follows:

Table 3 - Homogeneity Test Results

Levene Statistic	df1	df2	Sig.
0. 146	1	44	0.704

The following is the data on the results of the mathematical communication ability test for students in class XI of SMA Negeri 2 Tambang which is presented in the following table 2.

Table 4 - Description of Students' Mathematical Communication Ability Data

No.	Statistics	MCA	Information
1.	Maximum	85,00	Very High
2.	Minimum	45,00	Medium
3.	Mean	65,89	High

MCA = Mathematical Communication Ability

The research began by giving questions to students in class XI 2 to collect data on students' mathematical communication skills. From the test, an average score of 65.89 was obtained with a minimum score of 45.00 and a maximum score of 85.00. Meanwhile, the category data for each indicator of mathematical communication ability is presented in its entirety in Table 3 below.

Table 5 - Qualification of Students' Mathematical Communication Skills

No.	Interval	Frequency	Percentage (%)	Criteria
1.	$81 \leq P \leq 100$	6	21,43	Very High
2.	$61 \leq P < 81$	9	32,14	High
3.	$41 \leq P < 61$	13	46,43	Medium
4.	$21 \leq P < 41$	0	0,00	Low

Table 3 above shows the data on the results of students' answers to the test instrument on mathematical communication skills. Where there were 6 students (21.43%) in the very high category, 9 students (32.14%) in the high category, 13 students (46.43%) in the medium category, and no students in the low category. Next, 1 student was selected based on each category of ability to be analyzed, interviewed, triangulated and discussed as an overview of the achievement of mathematical communication skills of grade XI students of SMA Negeri 2 Tambang on matrix material. The results of the discussion will be described by category, to measure the achievement of students' mathematical communication ability indicators.

3.2. Discussions

3.2.1 Research Subject with Very High Ability Category

The results of the study showed that there were 6 students (21.43%) with a very high category in solving problems in matrix material. This achievement shows that the learning of matrix material carried out by mathematics teachers can be well understood by students so it succeeded in bringing 6 students to achieve indicators of mathematical communication skills. To further explore the abilities of very high-ability students, the researcher selected a representative of one student to be interviewed and analysed the results of the answers to the given questions. The following is an analysis of students' answers when working on questions on matrix material with their mathematical communication skills:

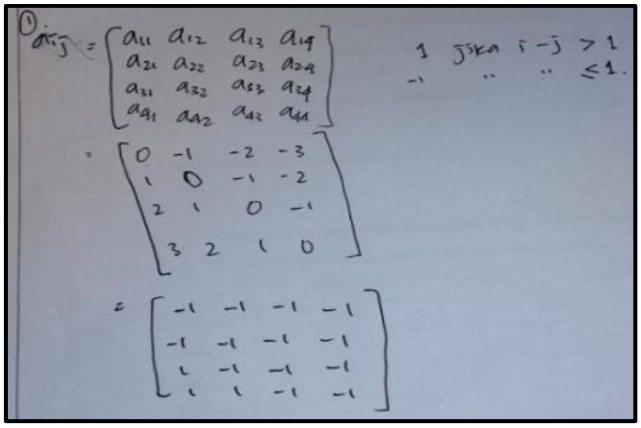

Figure 1 Students' Answers with Very High Ability in Question No. 1

Based on the student's responses shown in Figure 1, it can be seen that the students were able to understand the intent of the given question. The task required determining the form of a 4×4 matrix based on the provided rules. From the results of the interview, the students explained that to simplify the process of determining the matrix form, they first created the matrix element in the *i*-th row and *j*-th column. Then, they subtracted the row value from the column value to form a matrix with the numbers shown in Figure 1.

From the students' responses in Figure 1, it is evident that they could comprehend the intent of the given question. The question required the students to determine the form of a 4×4 matrix according to the given rules. The mathematical communication skills required to solve this problem include the ability to Interpret the Question: The students needed to understand the intent of the question and identify the provided information, such as the rule for creating matrix elements based on the row (i) and column (j). This understanding reflects the ability to read and interpret mathematical information, a key component of mathematical communication skills. Ability to Systematically Convey Ideas: During the interview, the students explained that to determine the matrix form, they created the matrix element *a* in the *i*-th row and *j*-th column, then subtracted the row value (i) from the column value (j). This explanation demonstrates their ability to orally communicate their thought process clearly and logically. Ability to Present Information in Mathematical Representations: The students needed to translate the rules provided in the question into an appropriate matrix form. This involved presenting mathematical information visually through a matrix with calculated elements. This task required mathematical communication skills in representing data mathematically. Ability to Explain Problem-Solving Steps: During the interview, the students were able to explain the steps they took, such as creating matrix elements and applying the rule by subtracting rows and columns. This demonstrates their ability to communicate their solution logically and systematically, both orally and in writing.

Each step in solving this question required integrated mathematical communication skills, including understanding the problem's information, developing and communicating a solution strategy, and presenting results in an appropriate representation. Thus, learning that emphasizes mathematical communication can help students solve problems like this more effectively. In the final step, the students applied the given rule: if the matrix result i−j is greater than one, the result will be written as 1. If the matrix result i−j is less than or equal to one, it will be written as −1. Based on the explanation above, it can be concluded that the student demonstrated a good understanding of the first indicator of mathematical communication skills.

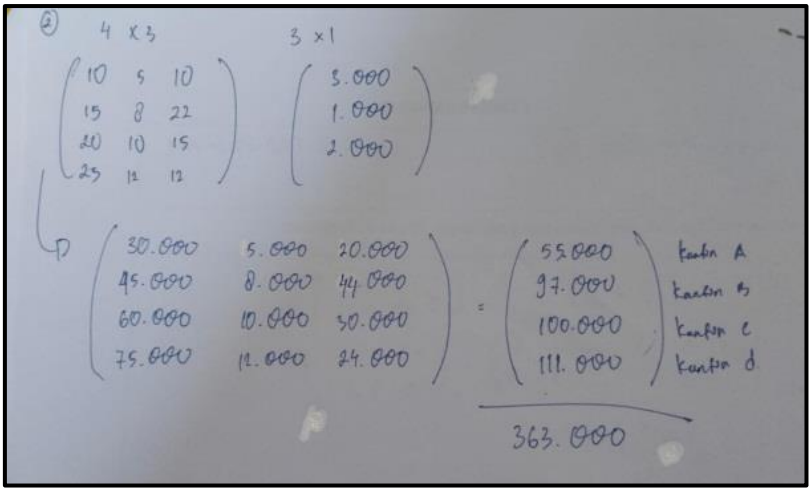

Figure 2 Students' Answers with Very High Ability in Question No. 2

From the results of the student's answers in Figure 2, it can be seen that the students can solve the story questions well and under the instructions given. Students can change the given story questions into the form of the matrix they want to be asked. From the results of the interviews that have been carried out, students explain the steps taken. First, the student explained that he first understood the meaning of the question table given. Then, he changed the table of the number of goods that Mr Joko deposited to the 4 school canteens every day into a matrix of order 4×3 and made the price of each item into a matrix form of order 3×1.

Furthermore, to find out the income of each canteen per day, he added the result of the multiplication that had been obtained. Daily income was obtained for Canteen A of Rp.55,000.00, Canteen B of Rp.97,000.00, Canteen C of Rp.100,000.00, and Canteen D of Rp.111,000.00. Then to find out Mr. Joko's total income from the four canteens, he added the income from canteens A, B, C. and D so that Mr. Joko's daily income was Rp. 363,000.00. So, based on the results of the answers and the results of the interviews that have been conducted, it can be concluded that the student can understand the second indicator of mathematical communication ability correctly.

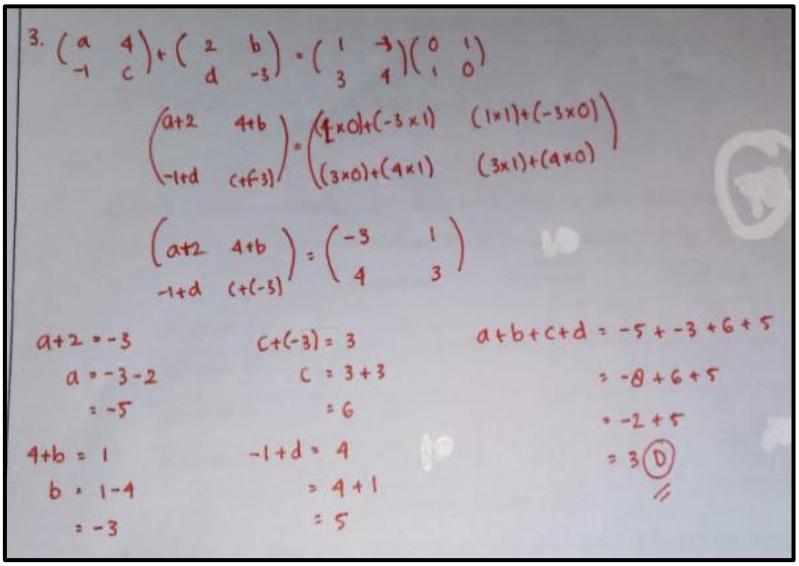

Figure 3 Students' Answers with Very High Ability in Question No. 3

From the results of the student's answers in Figure 3, it can be seen that the students can state the information presented in the form of a matrix so that the value of $a+b+c+d$ is obtained correctly and by the right steps. After the interview, the researcher concluded the results of the interview. The student explained that he had worked on a problem similar to the question. He explained that to get the value of $a+b+c+d$, he must first complete the given matrix operation. In the first step, to be left in the grid, he adds the first and second matrices so that the result is obtained as shown. To be on the right field, he multiplies the shape of the matrix by the matrix multiplication rules so that the result is obtained. $\begin{pmatrix} -3 & 1 \\ 4 & 3 \end{pmatrix}$.

After obtaining the results in the right and left fields, he will then look for the values a, b, c, and d, respectively, by making equations as shown in Figure 3. So that the values of a=-5, b=-3, c=6, and d=5 are obtained. The last step is to add the values a, b, c, and d so that the final value is 3. So, it can be concluded from the explanation above that the student can understand the third indicator of mathematical communication ability, namely stating the information presented in the form of a matrix correctly and appropriately.

The subject's abilities, as listed above, are in line with the opinion of Sugiman (2008) if students can understand how to connect mathematical ideas so that their understanding of mathematical concepts is well constructed. This is because students can see the relationship between topics in mathematics, in addition to mathematics, and daily life experiences. Based on the need for test instruments, this finding is relevant to the results of research by Daiyan, Nani, & Bani (2020), which states that students with very high abilities can master well the three indicators of mathematical communication skills, including expressing mathematical ideas into other forms, interpreting and evaluating mathematical ideas into other forms, and stating the information presented in the form of matrices.

3.2.2 Research Subject with High Ability Catalog

The results of the study showed that there were nine students (32.14%) who achieved mathematical communication sustainability with a high category in solving problems in matrix material. To further explore the abilities of high-ability students, the researcher selected a representative of one student to be interviewed and analysed the results of the answers to the given questions. The following is an analysis of students' answers when working on questions on matrix material with their mathematical communication skills:

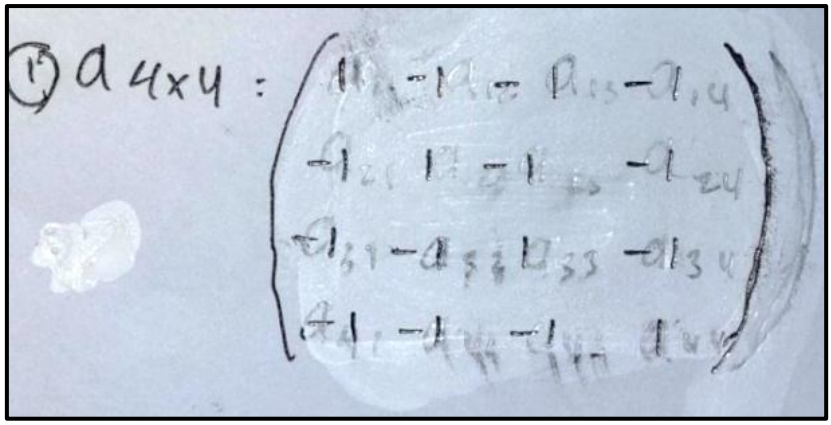

Figure 4 Answers of Students with High Ability in Question No. 1

Based on the results of the students' work in Figure 4, it can be seen that the students are not able to understand the meaning of the given questions to determine the form of the matrix of order 4×4 with the rules that have been given. From the interviews that have been carried out, students explained that they first made matrix elements in the ith row and jth column. However, the student explained that he was confused about whether to include the matrix elements he had made or not because some of his friends did not list the matrix elements.

After that, he changed the matrix directly using the conditions that had been listed in the question. Where if the result of the matrix i-j is greater than one, the result will be 1. And if the matrix i-j produces a number less than equal to 1, then it will be written with the number -1. But there are some results of the subtraction that make him confused and misdetermine between 1 and -1. So, it can be concluded from the explanation above the students still lack an understanding the concept of the matrix and have not been able to meet the first indicator of mathematical communication skills well.

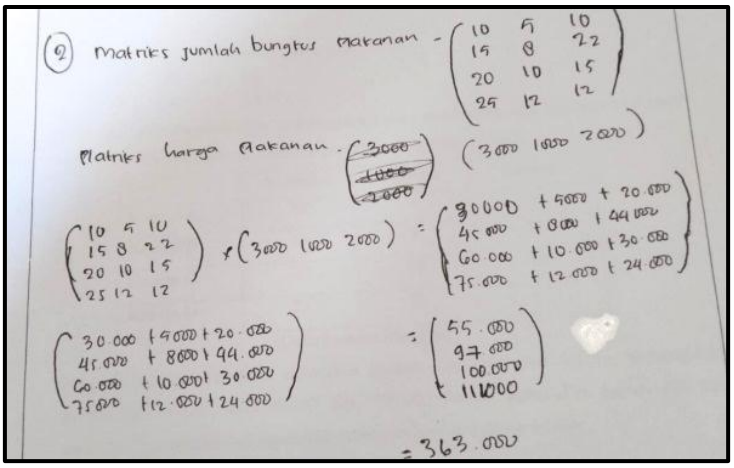

Figure 5 Answers of Students with High Ability in Question No. 2

Based on the results of the answers in Figure 5, it can be seen that the students have not been able to understand the forms of the matrix and the operation of matrix multiplication. Students can change the given story problems into the form of the matrix they want to be asked but do not understand the concept of matrix multiplication. From the results of the interviews that have been carried out, students explain the steps taken.

First, the student explained that he first understood the meaning of the question table given. Then, he changed the table of the number of food packages that Mr Joko deposited to the four school canteens every day into a matrix of order 4×3 and made the price of each item into a matrix form of order 1×3. Then, he performs multiplication operations on both matrices, where matrices of order 4×3 cannot be multiplied by matrices of order 1×3.

The meaning of matrix multiplication itself is the process of multiplying each row element in the first matrix by the column elements in the second matrix, which have the same number. If this fails to be met, then matrix multiplication cannot be used. The final result of the student's answer was correct, but he was confused about determining the form of the matrix in the concept of matrix multiplication. So, based on the results of the answers and interviews that have been conducted, it can be concluded that the student has not been able to understand the second indicator of mathematical communication skills properly.

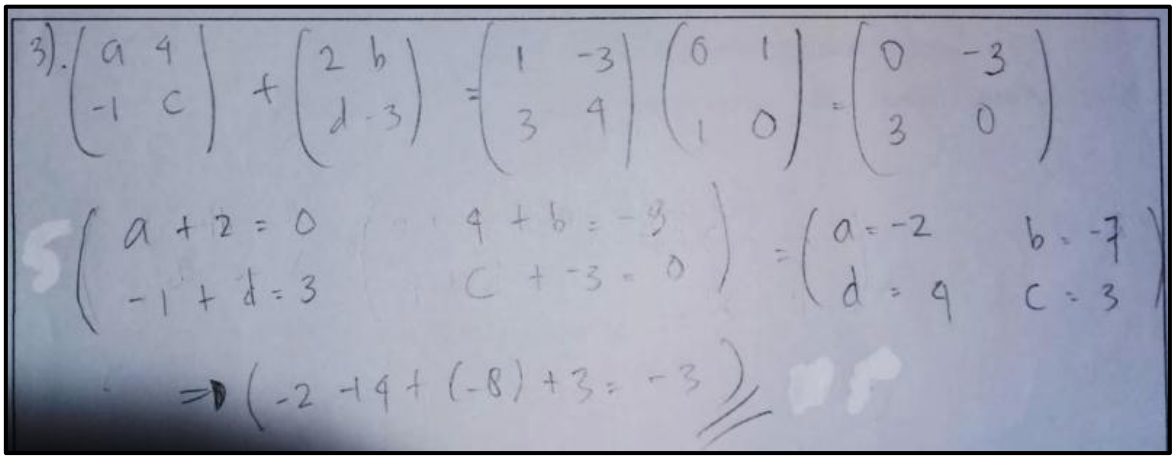

Figure 6 Answers of Students with High Ability in Question No. 3

Based on the results of the students' work in Figure 6, it can be seen that the students have not been able to state the information presented in the form of a matrix, so they do not get the score of a+b+c+d correctly. After the interview, the researcher concluded the results of the interviews that had been carried out. The student explained that to get a score of a+b+c+d, he must first complete the given matrix operation. In the first step, to be left in the grid, he adds the first and second matrices so that the result is obtained as shown. For the right segment, he multiplies the shape of the matrix, but it is not by the rules of matrix multiplication, and he is not thorough in working on the multiplication so that the result is obtained. $\begin{pmatrix} 0 & -3 \\ 3 & 0 \end{pmatrix}$. What makes the result of the student's answer incorrect is that it is wrong in understanding the concept of matrix multiplication.

Even though the student understands how to state the information presented in the form of a matrix, it can be concluded from the explanation that has been given the student has not been able to understand the third indicator of mathematical communication ability correctly and appropriately. Based on the results of the student's work in the explanation above, the subject still has obstacles in expressing mathematical ideas to describe the problem situation into a mathematical model in question 1. In

question number 2, students can interpret and evaluate mathematical ideas, where students are focused on interpreting problems in the form of matrices correctly, and there are still some students who experience obstacles in determining the shape of the matrix and do not understand the concept of matrix multiplication. Then, based on the results in question number 3, the average subject can state the information presented in the form of a matrix quite well, although it is good that it needs to be accurate enough so that the results are more massive.

3.2.3 Research Subject with Moderate Ability Category

The results of the study showed that there were 13 students (46.43%) who had mathematical communication skills with a moderate category in working on problems on matrix material. To further explore the abilities of high-ability students, the researcher selected a representative of one student to be interviewed and analysed the results of the answers to the given questions. The following is an analysis of students' answers when working on questions on matrix material with their mathematical communication skills:

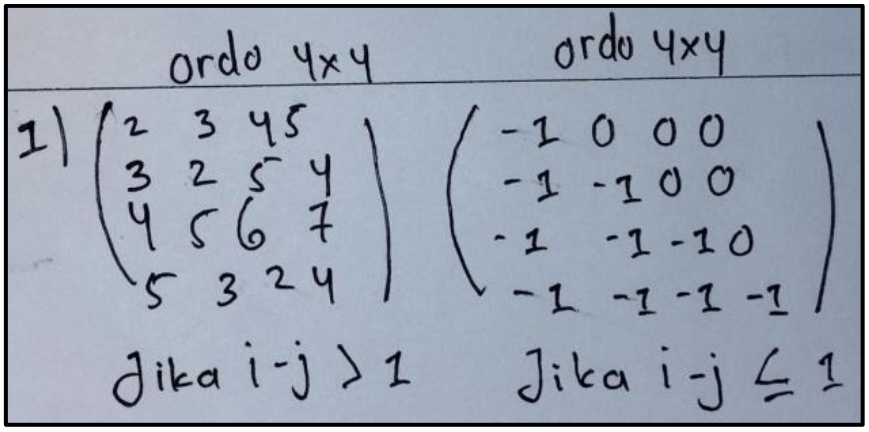

Figure 7 Answers of Students with Moderate Ability in Question No. 1

Based on the results of the students' work in Figure 7, it can be seen that the students do not understand the solutions requested in the questions. Students have been able to form a matrix of orders 4×4 but have not been able to adjust the answers based on the conditions listed in the question. Based on the results of the interview, students know the concept of the 4x4 order matrix but do not understand the application of the answers requested from the conditions in question. Where the student should form a matrix with elements of the ith row and the jth column, he should reduce the rows by the column. So, the matrix will form a number with the condition that it is asked to be questioned, and if the result of the matrix i-j is greater than one, the result will be 1. Then, if the matrix i-j produces a number less than equal to 1, it will be written with the number -1. This makes the answers given inappropriate.

In question number 2, students are less able to interpret and evaluate mathematical ideas to interpret problems in the form of matrices. Based on the interviews that were conducted, students explained that they do not understand how to express mathematical information from the problem in the form of matrices. Students understand how to multiply and solve matrix forms, but they do not use matrix forms and matrix multiplication rules for the solution process. In question number 3, students

can interpret the information in question number 3 in the form of a matrix. However, students are not careful in the process of working on the questions. Based on the results of the interview, students explained that they were confused about the matrix $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$. Which is the first step before being able to solve the problem. Students are not able to interpret the questions and do not multiply the matrix $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$ In advance, when the answer is added, the results become inaccurate. In solving these problems, students are less thorough and do not understand the concept of multiplication matrices.

Based on the results of the students' work, there is an explanation above: the subject does not understand the solution requested in question number 1. Based on problem number 2, the subject is unable to interpret and evaluate mathematical ideas to interpret the problem in the form of a matrix correctly. In question number 3, the subject can write a matrix that is known based on the problem, but the student is not careful in the process of working on the question.

This achievement shows that the learning of matrix mathematics taught by teachers to 13 students (46.43%) has not met the indicators of mathematical communication according to mathematical communication between lessons and mathematical communication to daily life, According to NCTM, subjects with moderate category abilities have not met the indicators of mathematical connection Subject with this category still has a lack of understanding of the concept of matrices and how to connect the concept of matrices to other subject matter. This is relevant to research by Daiyan (2020), where subjects with medium categories have not met the indicators.

3.2.4 Research Subject with Low Ability Category

The results of the study show that there are no students (0.0%) who achieve mathematical communication skills with a low category in working on problems on matrix materials. From these achievements, it can be concluded that the teacher is successful in carrying out the learning process, but there must be several students who need to be given a deeper understanding of the material.

To prove the truth of the existence or absence of the influence of the discovery learning model on students' mathematics learning outcomes in the data presentation material, a hypothesis test was carried out. However, before the hypothesis test was carried out, a prerequisite test was carried out, namely the normality test and the homogeneity test.

Based on the prerequisite test that has been carried out, the experimental class and control class data come from normally distributed samples, and both groups come from homogeneous variances, so a hypothesis test is carried out using the Independent Sample t-test, which shows that the discovery learning model influences students' mathematical communication skills. This is evidenced by the acquisition of a value of 0.04 where the significance value of 0.04 is smaller than 0.05 thus, it can be stated that the hypothesis is accepted, so the conclusion is that there is an influence of the use of the discovery learning model on students' mathematical communication skills. In addition, the Likert Scale test shows that there are good student learning habits in the experimental class. This is evidenced by the average percentage results of 65%, with the

percentage value indicating that there are strong learning habits in students in the experimental classes.

4. Conclusions

From the results of the above study, it can be concluded that the mathematical communication skills of students in class XI of SMA Negeri 2 Tambang obtained an average score of 65.89, with a minimum score of 45.00 and a maximum score of 85.00. The qualification, with a very high category, showed that six students (21.43%) in the subject could meet the three indicators of mathematical communication skills well and precisely. Furthermore, with the high category, it shows that nine students (32.14%) still have obstacles in expressing mathematical ideas to describe the problem situation in a mathematical model in question 1. In question number 2, students can interpret and evaluate mathematical ideas where students are directed to interpret the problem in the form of a matrix correctly. However, some students experience obstacles in determining the form of the matrix and do not understand the concept of matrix multiplication. Then, based on the results in question number 3, the average subject can state the information presented in the form of a matrix quite well, although it is good that it needs to be accurate enough so that the results are more massive.

Then, in the last one, there were 13 students (46.43%) subjects with medium categories, showing that there were several subjects who still did not understand the solution requested in question no. 1. Based on problem number 2, the subject is unable to interpret and evaluate mathematical ideas to interpret the problem in the form of a matrix correctly. In question number 3, the subject can write a matrix that is known based on the problem, but the student is not careful in the process of working on the question.

Conflict of Interest

The authors declare no conflicts of interest.

References

Afsari, S., Safitri, I., Harahap, S. K., & Munthe, L. S. (2021). Systematic Literature Review: Efektivitas Pendekatan Pendidikan Matematika Realistik pada Pembelajaran Matematika. *Indonesian Journal of Intellectual Publication*, 189-197.

Astuti, A., & Leonard. (2015). Peran Kemampuan Komunikasi Matematika Terhadap Prestasi Belajar Matematika Siswa. *Jurnal Formatif*, 102-110.

Daiyan, Y., Nani, K. L., & Bani, A. (2020). Analisis Kemampuan Komunikasi Matematis Siswa SMP Pada Materi Bangun Ruang. *Jurnal Pendidikan MIPA*, 65-70.

Dewanti, S. S., & Muna, K. (2023). Analisis Kemampuan Komunikasi Matematis pada Soal Cerita Aritmatika Sosial. *Jurnal Nasional Pendidikan Matematika*, 263-279.

Hendriana, H., & Kadarisma, G. (2019). Self-Efficacy dan Kemampuan Komunikasi Matematis Siswa SMP. *JNPM (Jurnal Nasional Pendidikan Matematika)*, 153-164.

Hodiyanto. (2017). Kemampuan Komunikasi Matematis dalam Pembelajaran Matematika. *Jurnal Ilmiah Pendidikan Matematika Ilmu Matematika dan Matematika Terapan*, 9-18.

Jusniani, N., & Nurmasidah, L. (2021). Penerapan Model Pembelajaran Generatif untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa. *Jurnal Ilmiah*

Matematika Realistik, 12-19.

Maskar, S. (2018). Alternatif Penyusunan Materi Ekspresi Aljabar Untuk Siswa Smp/Mts Dengan Pendekatan Pendidikan Matematika Realistik. *Jurnal Prisma*, 53-69.

Rohmah, H. F., & Warmi, A. (2021). Analisis Kemampuan Koneksi Matematis Siswa pada Materi Barisan dan Deret Aritmatika. *Jurnal Pembelajaran Matematika Inovatif*, 469-478.

Saputri, A. E. (2017). Pendampingan Anak Dalam Keluarga di TK Pertiwi Kebasen Kabupaten Banyumas. *Fakultas Ilmu Pendidikan Universitas Negeri Yogyakarta*.

Sari, I. P. (2017). Kemampuan Komunikasi Matematika Berdasarkan Perbedaan Gaya Belajar Siswa Kelas X SMA Negeri 6 Wajo pada Materi Statistika. *Jurnal Nalar Pendidikan*, 86-92.

Sarumaha, K. S., Sarumaha, R., & Gee, E. (2022). Analisis Kemampuan Komunikasi Matematis Siswa pada Materi SPLDV di Kelas VIII SMPN 3 Maniamolo Tahun Pembelajaran 2020/2021. *AFORE: Jurnal Pendidikan Matematika*, *1*(12), 2439–2450.

Siagian, M. D. (2016). Kemampuan Koneksi Matematika Dalam Pembelajaran Matematika. *Journal of Mathematics Education and Science*, 58-67.

Sinaga, W., Parhusip, B. H., Tarigan, R., & Sitepu, S. (2021). Perkembangan Matematika dalam Filsafat dan Aliran Formalisme yang Terkandung dalam Filsafat Matematika. *Journal of Mathematics Education and Applied*, 17-22.

Siregar, E. R., & Mardiati. (2020). Pengaruh Model Pembelajaran Snowball Throwing Terhadap Kemampuan Matematis Siswa pada Materi Matriks Kelas XI SMK Negeri 1 Stabat Tahun Pelajaran 2019/2020. *Jurnal Serunai Matematika*, 19-25.

Soleha, S., & Ferdianto, F. (2022). Kemampuan Komunikasi Matematis Siswa SMA dalam Menyelesaikan Soal Matriks ditinjau dari Kecerdasan Interpersonal. *Prosiding Seminar Nasional Pascasarjana*, 1016-1022.

Sugiman. (2008). Aspek Keyakinan Matematika Siswa dalam Pendidikan Matematika. *Jurnal Matematika Integratif*.

Sya'diah, H. (2018). Pengaruh Model Pembelajaran Terhadap Kemampuan Penalaran dan Koneksi Matematika (Eksperimen pada Siswa Kelas XI MIPA SMA Negeri di Kota Tangerang). *Jurnal Pendidikan MIPA*, 58-67.

Turrosifah, H., & Hakim, D. L. (2019). Komunikasi Matematis Siswa dalam Materi Matematika Sekolahan. *Prosiding Seminar Nasional Matematika dan Pendidikan Matematika*, 1183-1192.

Wahyudi, Suyitno, H., & Waluya, B. (2018). Dampak Perubahan Paradigma Baru Matematika Terhadap Kurikulum dan Pembelajaran Matematika di Indonesia. *Inopendas Jurnal Ilmiah Kependidikan*, 38-47.