Available online at: http://journal.uny.ac.id/index.php/pythagoras
PYTHAGORAS: Jurnal Matematika dan Pendidikan Matematika, 19 (1), 2024, 53-63

Mathematical Communication Ability of Madrasah Aliyah Students Given Self-Confidence and Learning Independence

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ARTICLE INFO

Article History:
Received: 16-Apr. 2024
Revised: 16-Nov. 2024
Accepted: 18-Nov. 2024

Keywords:
Mathematical communication ability, self-confidence, learning independence

ABSTRACT

The research aims to ascertain how mathematical communication ability is impacted by self-confidence, how learning independence affects mathematical communication ability, and how self-confidence and learning independence affect mathematical communication ability in 11th-grade students at MA Muhammadiyah 1 Medan in the 2023–2024 academic year. This is a correlational study with a quantitative methodology. This research used cluster sampling, and the total sample size was 31 students. This study collected data using questionnaires and tests. The research instruments used were self-confidence and learning independence questionnaires, as well as mathematical communication ability tests. Multiple regression analysis was used in this study's data analysis procedures. The analysis's findings indicate that self-confidence impacts on mathematics communication with a value of sig. 0.025 and a value of t_{count} 2.317; learning independence impacts on mathematics communication ability, with a value of sig. 0.12 and the value of t_{count} 2.512; self-confidence and learning independence positively and significantly impact on mathematics communication ability, with a value of sig. *0.000; and a coefficient of determination of 0.612, implying that self-confidence and learning independence affect mathematical communication by 61.2%.*

Tujuan dari penelitian ini adalah mengidentifikasi bagaimana kemampuan komunikasi matematika dipengaruhi oleh kepercayaan diri, bagaimana kemandirian belajar mempengaruhi kemampuan komunikasi matematis, dan bagaimana kepercayaan diri dan kemandirian belajar berdampak pada kemampuan komunikasi matematik di siswa kelas 11 di MA Muhammadiyah 1 Medan pada tahun akademik 2023-2024. Ini adalah studi korelasi dengan metodologi kuantitatif. Penelitian ini menggunakan pengambilan sampel cluster, dengan total ukuran sampel 31 siswa. Studi ini mengumpulkan data menggunakan kuesioner dan tes. Kuesioner kepercayaan diri dan kemandirian belajar, dan tes kemampuan komunikasi matematika merupakan Instrumen yang digunakan pada penelitian ini. Analisis regresi ganda digunakan dalam prosedur analisis data penelitian ini. Hasil analisis: kepercayaan diri memberikan pengaruh terhadap komunikasi matematis dengan nilai $sig.0{,}025$ dan nilai t_{hitung} 2,337; kemandirian belajar memberikan pengaruh terhadap komunikasi matematis dengan nilai $sig.0{,}012$ dan nilai t_{hitung} 2,512; kepercayaan diri dan kemandirian belajar secara simultan memiliki pengaruh yang positif dan signifikan terhadap komunikasi matematis dengan nilai $sig.0{,}000$; dan diperoleh koefisien determinasi dengan nilai 0,612 hal ini menunjukkan bahwa kepercayaan diri dan kemandirian belajar secara simultan mempengaruhi komunikasi matematis sebesar 61,2%.

How to Cite:
Handayani, R., Siregar, N., Simanjuntak, E., & Molliq, Y. (2024). Mathematical communication ability of madrasah aliyah students given self-confidence and learning independence. *Pythagoras: Jurnal Matematika dan Pendidikan Matematika, 19*(1), 53-63. https://doi.org/10.21831/pythagoras.v19i1.72580

https://doi.org/10.21831/pythagoras.v19i1.72580

INTRODUCTION

Mathematics is an important science that is used in education as well as every day; mathematics catalyzes the development and discovery of other fields. Early success in a rapidly expanding and cutthroat global economy depends on having a solid mathematical foundation (Dalimunthe et al., 2023; Zamnah & Ruswana, 2019). The fact that mathematics is a tool for logical thinking, which fosters creativity and helps students solve daily life difficulties is just one of the numerous reasons students should learn the subject (Putra & Ikhsan, 2019). Accuracy, thoroughness, criticality, efficiency, perseverance, and consistency are among the attitudes that can be developed via mathematical education (Gultom et al., 2020). However, most students believe that mathematics is a challenging subject; this is because in mathematics many formulas that cause students to be reluctant to solve maths (Robiah & Nuraeni, 2023). Additionally, mathematics is a tool for communication (Lubis et al., 2023). Communication skills are necessary for learning mathematics (Fay et al., 2022). As often debated by education researchers and politicians over the past few decades, guidelines for academic success need to be analyzed more deeply (Wild & Neef, 2023).

NCTM (2020) establishes three process criteria for learning mathematics: problem-solving, communication and reasoning, mathematical modeling, and application of mathematical models. Accordingly, one of the learning objectives for mathematics contained in the mathematical characteristics section of the attachment to Permendikbud Number 58 of 2014 is the ability to communicate ideas, reason, and assemble mathematical proof using full symbols, sentences, diagrams, tables, or other tools to make the situation or problem clear (Permendikbud, 2014).

Students can connect abstract mathematical concepts and convey their thoughts in solving issues through argumentation, writing, and visual forms through mathematical communication, a crucial component of mathematics education (Yuniarti et al., 2023; Rizqi et al., 2021; Lutviana et al., 2022). Mathematical communication is the practice of communicating mathematical knowledge to make a situation more understandable. Nevertheless, the majority of students need better communication skills when it comes to mathematics (Dalimunthe et al., 2023; Fitria et al., 2021; Maysaroh & Kurniasih, 2021). learning achievement will be impacted by students' deficient mathematical communication abilities, as these pupils typically struggle to solve mathematical issues (Handayani et al., 2021). This is also supported by the results of observations made based on information gathered from conversations with MA Muhammadiyah 1 Medan's mathematics teachers on the use of language and mathematical symbols; students have a relatively low ability to use them in mathematical problems and communicate visually, with a percentage of 50%. Additionally, observation tests were used to categorize the students' mathematical communication skills: three students (20%) were categorized as having "good" skills, four students (26.67%) as "sufficient," and eight students (53.33%) as having "less" skills. The development of student's abilities in mathematical communication depends on affective components, which is why it's essential to understand the factors influencing students' mathematical communication skills to assist them grow.

Self-confidence is one factor that can influence one's ability to communicate mathematical ideas. It takes courage to generate ideas and put them in writing while communicating mathematically (Maysaroh & Kurniasih, 2021). Self-confidence is a positive aspect needed to build confidence in one's abilities (Yaniawati et al., 2020). Self-confidence is related to facing obstacles that arise in achieving goals (Zamnah & Ruswana, 2019). Self-confidence is the quality of students who feel confident that they can successfully carry out activities inside and outside the classroom (Akbari & Sahibzada, 2020). Nafisah et al. (2021) state that high levels of self-confidence can inspire people to boost their learning capacities and accomplishments. Students who need more confidence tend to struggle to convey their ideas (Lubis et al., 2023). Students essentially study meaningfully so they can feel confident when they are pushed to reason logically about mathematics and then share the conclusions of their reasoning with others verbally or in writing (Maryono et al., 2021). During observations of grade XI students at MA Muhammadiyah 1 Medan, some students had sufficient understanding of mathematical communication. When students were asked to re-explain their answers in front of the class, some students felt embarrassed and said they could not before trying. A lack of self-confidence can prevent students from daring to come up with ideas needed to communicate the results of their thinking both orally and in writing, which can affect students' mathematical communication ability. Research conducted by Nafisah et al. (2021) shows that self-confidence significantly impacts mathematics communication skills. However, in research by Indrawati and Hartati (2019), self-confidence and mathematical communication ability did not significantly affect one another.

In addition to self-confidence, another critical aspect of students is learning independence. With the development of autonomy in students, students can do everything according to their abilities (Assagaf, 2017). Students with learning independence have the cognitive and metacognitive skills, and the motivating beliefs and attitudes required to analyze, monitor, and direct their learning. Learning independence involves realizing one's potential and exercising self-control to gain enjoyment learning (Efriyadi & Nurhanurawati, 2021). However, students tend to ask to be guided by teachers in education and lack the awareness to master the material independently (Asih et al., 2021). Previous research has revealed that students with a high level of learning independence can solve mathematical communication issues better than students with poor learning independence (Dalimunthe et al., 2023). However, in research Dewi (2021) found that there was no significant effect on mathematical communication skills, if learning independence is low then mathematical communication does not have to be low, because there are other variables that influence learning independence.

Based on the concerns that have been described, there is still needs to be a research gap in previous studies. Researchers believe that both learning independence and self-confidence influence learners' mathematical communication. The influence has yet to be pinpointed more precisely, though. The study's hypotheses are as follows: (1) self-confidence positively and significantly influences mathematical communication abilities, (2) learning independence positively and significantly influences mathematical communication abilities, and (3) self-confidence and learning independence together have a positive and significant impact on mathematical communication skills.

METHOD

This study's research design is correlational research with a quantitative methodology. The research aims to examine how the relationship occurs between research variables. To test preconceived hypotheses, the quantitative approach involves examining samples through research tools and quantitative data analysis.

The research was carried out in the even semester of the 2023–2024 academic year at MA Muhammadiyah 1 Medan. he study's population comprised 76 students in 3 classrooms during the 2023–2024 academic year at MA Muhammadiyah 1 Medan. The technique for sampling in this research was cluster sampling. The participants in this research were XI-IPA students MA Muhammadiyah 1 Medan had a total of 31 students. Researchers gathered information by conducting direct research in schools with research instruments like questionnaires and tests. The questionnaire was designed to measure student's self-confidence and learning independence. Tests assessed students' ability in mathematical communication. The research instrument used is an instrument that has been validated by experts, namely mathematics teachers and lecturers at the State University of Medan, and has been evaluated for validity and reliability. The research instrument used has also been tested on another sample. The self-confidence questionnaire has 32 statements that were tested for validity (Table 1). After the validity test, there were 3 invalid statements. These invalid statements were then removed because there were other statements that represented the indicators in those items.

Table 1. Validity test results for self-confidence questionnaire

Aspect/Indicator	No.	r_{count}	Information
belief in one's abilities	1	0.392	Valid
	2	0.448	Valid
	3	0.487	Valid
	4	0.444	Valid
	5	0.593	Valid
	6	0.372	Valid
optimism	7	0.459	Valid
	8	0.743	Valid
	9	0.555	Valid
	10	0.430	Valid
	11	0.110	Invalid
	12	0.435	Valid
objectivity	13	0.439	Valid
	14	0.434	Valid

Aspect/Indicator	No.	r_{count}	Information
	15	0.638	Valid
	16	-0.336	Invalid
	17	0.678	Valid
	18	0.439	Valid
	19	0.556	Valid
	20	0.573	Valid
responsibility	21	0.185	Invalid
	22	0.386	Valid
	23	0.455	Valid
	24	0.392	Valid
	25	0.582	Valid
	26	0.567	Valid
rationality	27	0.486	Valid
	28	0.529	Valid
	29	0.398	Valid
	30	0.458	Valid
	31	0.634	Valid
	32	0.597	Valid

The learning independence questionnaire has 32 statements that were tested for validity (Table 2). After the validity test, there were 3 invalid statements. These invalid statements were then removed because there were other statements that already represented the indicators in those items.

Table 2. Validity test results for learning independence questionnaire

Aspect/Indicator	No.	r_{count}	Information
self-confidence	1	0.491	Valid
	2	0.762	Valid
	3	0.464	Valid
	4	0.483	Valid
	5	0.611	Valid
	6	0.474	Valid
	7	0.804	Valid
	9	0.679	Valid
Initiative	8	0.431	Valid
	10	0.483	Valid
	11	0.629	Valid
	12	0.189	Invalid
	13	0.653	Valid
	14	0.537	Valid
	16	0.333	Invalid
	18	0.632	Valid
responsibility	15	0.506	Valid
	17	0.333	Valid
	19	0.740	Valid
	20	0.508	Valid
	21	0.441	Valid
	22	0.633	Valid
	23	0.575	Valid
	25	0.403	Valid
discipline	24	0.681	Valid
	26	0.766	Valid

Aspect/Indicator	No.	r_{count}	Information
	27	0.708	Valid
	28	0.692	Valid
	29	0.520	Valid
	30	0.664	Valid
	31	0.269	Invalid
	32	0.592	Valid

The mathematical communication ability test instrument has 5 questions that were tested for validity (Table 3). After the validity test, there was 1 invalid question. The invalid question was then removed because there were other questions that already represented the indicator in that item.

Table 3. Validity test results for mathematical communication ability test instrument

Aspect/indicator	No	r_{count}	Information
Connecting graphs, images, and tables into mathematical forms	1	0.878	Valid
	4	0.838	Valid
Explaining mathematical ideas verbally or in writing using graphs, images, and tables rationally	3	0.878	Valid
	5	0.838	Valid
Using symbols and mathematical language to construct a model of a mathematical problem	2	-0.113	Invalid
	6	0.662	Valid

This study's data analysis method was statistical analysis, namely inferential and descriptive statistical analysis. Descriptive statistics are used to characterize the collected data. Multiple regression analysis, a type of inferential statistics, examines hypotheses already tested.

RESULTS

The results of the test and the questionnaire on the sample yield quantitative data. The collected data is subjected to additional analysis to verify the research hypothesis. For data processing in this study, Microsoft Excel, SPSS software version 25, and manual computations are used. Table 4 summarizes the findings for the 31 students that participated in the research.

Table 4. Result of statistic descriptive analysis

	Max	Min	Mean	SD
Self-Confidence (X1)	126	88	107.10	9.357
Learning Independence (X2)	128	86	109.13	11.831
Mathematical Communication (Y)	85	45	66.45	11.045

The results of descriptive analysis in this study obtained student self-confidence scores between 88 and 126, with an average value of 107.10 and a standard deviation of 9.357. Then, the learning independence score is between 86 to 128, with an average value of 109,13 and a standard deviation of 11.831. The value of mathematical communication skills obtained in this study is between 45 to 85, with an average value of 66.45 and a standard deviation of 11.045.

Table 5. Category distribution of self-confidence (X1)

Category	Criteria	Frequency	Percentage (%)
Very Low	$X < 93$	1	3.23
Low	$93 < X \leq 102$	10	32.26
Medium	$102 < X \leq 112$	11	35.48
High	$112 < X \leq 121$	7	22.58
Very High	$121 < X$	2	6.45

According to Table 5, the majority of students' confidence is in the medium category with a total of 11 students (35.48%) out of the total sample of 31 students. Students in the lower category amount to 10 students (32.26%),

and students in the high category to 7 students (22.58%). In this case, the student's self-confidence needs to be taken into account so that the student has an improvement in his confidence.

Table 6. Category distribution of learning independence (X2)

Category	Criteria	Frequency	Percentage (%)
Very Low	X < 91	1	3.23
Low	91 < X ≤ 103	11	35.48
Medium	103 < X ≤ 115	8	25.81
High	115 < X ≤ 127	9	29.03
Very High	127 < X	2	6.45

Table 6 shows that students' learning independence tends to be in the lowest category with a total of 11 students (35.48%) out of 31 students in the total sample. Then, the learning activities need to be observed to be able to train students to learn independently so that their independence of learning in students can be increased.

Table 7. Category distribution of mathematical communication (Y)

Category	Criteria	Frequency	Percentage (%)
Very Low	X < 50	2	6.45
Low	50 < X ≤ 61	10	32.26
Medium	61 < X ≤ 72	9	29.03
High	72 < X ≤ 83	8	25.81
Very High	83 < X	2	6.45

Table 7 shows that the majority of students' mathematical communication ability is in the lowest category with a total of 10 students (32.26%) out of 31 students in the total sample. Students in the highest category were 8 students (25.81%).

Hypothesis Test

After the prerequisite tests have been met, multiple regression analysis is used to test the hypothesis.

Table 8. Coefficient of multiple regression analysis results

Model		Unstandardized Coefficients B	T	Sig.
1	Constant	-29.287	-1.949	0.61
	Self-Confidence (X1)	0.483	2.377	0.025
	Learning Independence (X2)	0.404	2.512	0.016

Dependent Variable: Mathematics Communication (Y)

To find out how each independent variable affects the partial dependent variable, the t-test can be used by looking at t_{count} values and significance values. Based on Table 8 shows the effect of self-confidence on mathematical communication ability with a value of $sig. 0.025 < 0.05$ and the value of t_{count} (2.337) > t_{table} (1.312). Then, there is an impact of learning independence on mathematical communication with a value of $sig. 0.16 < 0.05$ and t_{count} (2.512) > t_{table} (1.312).

Table 8 also obtained the value of $87, b_1 = 0.483$ and $b_2 = 0.404$. Then, the regression equation is obtained, which is $Y = -29.287 + 0.483X_1 + 0.404X_2$. After receiving the regression coefficient and regression equation, to know the influence simultaneously a be performed F test which can be found in the ANOVA table of regression test results presented in Table 9.

Table 9. Multiple regression analysis results

ANOVA[a]

Model		Sum of Square	Df	Mean Square	F	Sig.
1	Regression	2239.899	2	1119.950	22.087	0.000[b]
	Residual	1419.778	28	50.706		
	Total	3659.677	30			

a. Dependent Variable: Y

b. Predictors: (Constant), X2, X1

According to Table 9 above, the value of F_{count} is 22.087 with a value of $sig.\ 0.000$. Because of F_{count} (22.087) > F_{table} (3.354) and $sig.\ 0.000 < 0.05$. So, self-confidence and learning independence together have significant effects on mathematics communication abilities.

Table 10. Model summary of multiple regression analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.782[a]	0.612	0.584	7.121

a. Predictors: (Constant), X2, X1

The correlation coefficient (R) value obtained in Table 10 of 0.782 shows a strong connection between learning independence as well as self-confidence with mathematics communication skills. A coefficient of determination (R Square) of 0.612 shows that self-confidence and learning independence affect communication skills by 61.2% while 38.8% is influenced by other factors.

DISCUSSION

To see the significant influence, inferential statistical analysis was carried out, namely, multiple regression analysis, which had previously been carried out as prerequisite tests. The prerequisite tests used are normality, linearity, multicollinearity, and heteroscedasticity tests. After the prerequisite test is met then proceed with multiple regression analysis.

The results obtained in this research on the self-confidence variable do not correspond with those of Indrawati and Hartati's (2019) study, which says that there is no impact between self-confidence and mathematical communication. This is due to several other factors affecting the self-confidence of students, linked to unknown mathematical communication skills. This is not without the internal and external factors that are present in the student. This study obtained the value of count> table (2.337 > 1.312), which shows that self-confidence has a positive and significant effect on mathematical communication ability; this is consistent with the research of Aulia et al., (2021), Sopiah et al., (2022), and Yuniarti et al., (2023) it discovered that students' mathematics communication skills increased with their level of self-confidence and inversely. Students who are confident in their ability to understand math tend to prioritize communication skills. Additionally, students can to precisely and fully explain mathematical concepts with visual aids like graphs, diagrams, geometric representations, and more.

Furthermore, in the learning independence variable, the $t_{count} > t_{table}$ (2.512 > 1.312), so learning independence affects mathematical communication ability. The results of this research are proven by research that states that there is an effect of learning independence on mathematical communication ability (Efriyadi, 2021; Nurhasanah & Zhanty, 2019; Saputra & Rusdi, 2022). Learning independently is crucial to learning since it allows for more learning because it is not always reliant on the teacher. Learning independence is the freedom to learn with the ability of students to organize their own learning activities, on their initiative and responsibly, without always depending on others. Independent learning provides a solid foundation for understanding the methods of empowering students to actively participate in their own education. Independent learning is also an aspect where students are requimustred to believe in their abilities. The higher the independence of students, the higher the success of students in learning mathematics; the ability to communicate mathematically is one of the promoters of success in learning Mathematics. However, this contradicts the findings of Hadi et al. (2024), which show that increasing students' learning freedom has little bearing on their ability to communicate mathematical ideas, these findings

suggest that additional treatments or other factors may be involved in improving students' mathematical communication skills, although independent learning is considered necessary in the development of these skills. In this study together the variables of self-confidence and learning independence have a positive and significant impact, this is obtained based on the value of $F_{count} > F_{table}$ (22.087 > 3.354) with a correlation coefficient (R) of 0.782. he correlation coefficient (R) is a value used to measure the degree of rotation of the relationship between two variables; in this study, the relationship between the confidence variable and the independence of learning to mathematical communication in the same direction is strong. The determination coefficient in this research (R square) is 0.612. The factor determination explains the magnitude of the influence or contribution of the value of a variable to the rise or decrease of the values of other variables. So, in this study the contribution given by the variable of self-confidence and autonomy of learning to mathematical communication skills was 61.2%.

One of the most crucial skills that students should possess is mathematical communication ability. We can understand that mathematical communication skills are abilities that must be trained to students from an early age considering the importance of communication skills in the learning process at school and in social activities in the community. So, need to know the influencing factors so that improvements can be made to these factors which will have an impact on communication skills that are increasing as well. So far, mathematics learning has placed more emphasis on results than processes without considering students' reasoning processes in solving problems. Mathematics learning has focused more on written than oral activities to express mathematical ideas, making it difficult for students to express their work verbally (Sumaji et al., 2020). The existence of good self-confidence in students tends to have confidence and optimism. A person can be said to have self-confidence if he has confidence in his ability to overcome problems. In dealing with problems, students can express mathematical ideas through oral and written means, describe mathematical ideas in visual form, and use mathematical notation and terms to present mathematical ideas well. This can have an impact on their mathematical abilities. With maximum learning independence in students toward mathematics learning, it is expected to enhance students' mathematics communication ability so that their learning outcomes will also improve. Learning independence is also one aspect in which students are required to believe in their own abilities.

Students' learning independence tends to be within the low-tend category with a total of 11 out of 31, and mathematical communications are also in the lower-tender category with 10 out of 31, according to descriptive statistics that show that students' self-confidence levels tend to be in the middle category with a total of 11 out of 31 students (35.48%). Therefore, it is necessary to increase self-confidence and learning independence so that mathematical communication ability and other mathematical abilities increase so that student learning outcomes will have an impact and improve as well.

CONCLUSION

The findings show a moderate positive correlation between self-confidence and mathematical communication skills, and a moderate positive correlation between learning independence and mathematical communication. These findings indicate that the combined influence of self-confidence and learning independence has a substantial impact on mathematical communication skills. However, this is somewhat lower compared to previous research. To maximize this potential, it is recommended that teachers or school authorities enhance learning independence by guiding and providing space for students to take over and manage their own learning processes. Additionally, it is crucial for educators to understand the power of positive feedback in boosting students' self-confidence, facilitating active participation in class discussions, and supporting collaborative learning to improve mathematical communication skills. Aspects of self-confidence and learning independence need to be prioritized to enhance students' mathematical communication skills, with the hope of improving other mathematical abilities.

ACKNOWLEDGMENTS

We thank the parties who have helped with the research, in this case, thank you to Medan State University, especially the mathematics department where the researchers studied, thank you to the MA Muhammadiyah 1 Medan school which permitted researchers to research at the school, thank you to MA Muhammadiyah 1 Medan teachers who are willing to provide information to researchers as preliminary research data, MA Muhammadiyah 1 Medan students who are willing to fill out questionnaires.

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