



LEARNING MOTIVATION AND MATH ANXIETY IN RELATION TO MATHEMATICAL COMMUNICATION SKILLS OF HIGH SCHOOL STUDENTS

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Article Info

Article history:

Received Mei 25, 2024

Revised Mei 30, 2024

Accepted Jun 05, 2024

Keywords:

Motivation

Anxiety

Mathematical Communication

ABSTRACT

The goal of this study was to ascertain how high school students' mathematical communication skills related to their learning motivation and math anxiety. In this study, a correlation approach to quantitative research methodology was employed. 192 students made up the sample, whereas 324 students made up the population. This investigation was carried out for grade X in the 2023/2024 academic year students at one of the public high schools in East Jakarta. Tests of mathematical communication skills and questionnaires on learning motivation and math anxiety were the tools employed. Multiple linear regression tests with the F and T tests were used to process this data. The finding of the research are (1) there was a simultaneously connection between learning motivation and math anxiety on mathematical communication skills, (2) there was a partial connection between learning motivation and mathematical communication skills, (3) there was no connection between math anxiety on mathematical communication skills.

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How to Cite:

Risdani, N.A & Miatun., A. (2024). Learning Motivation and Math Anxiety in Relation to Mathematical Communication Skills of High School Students. *JME: Journal of Mathematics Education*, 9(1), 128-141

1. INTRODUCTION

Mathematics can be interpreted through educational knowledge which is very important and compulsory to learn from childhood to college level (Andriani et al., 2016). Wijaya et al., (2019) expressing the notion of mathematics is a complicated subject and difficult for students to understand because it has many different formulas, theorems to mathematical symbols, so most students do not like mathematics (Juliyanti & Pujiastuti, 2020). Mathematics is closely related in everyday life, namely about communication in

mathematics (Hidayati & Armiati, 2022). According to Darkasyi et al., (2014), mathematical communication can be explained as reciprocal events / conversations that are established so that the delivery of messages arises, the information conveyed contains mathematical material that has been learned, then communicated by teachers and students, and the way of delivering information can be conveyed in writing or orally between the two parties, so that communication runs smoothly. Otherwise, if the communication that occurs is not responded by one of the interlocutors, then the existing mathematical communication skills will be low because there is no reciprocal answer and response to the information provided. There are various types of comprehension skills in mathematics, one of which is that students are required to be proficient in mathematical communication because during education and so on it will not be separated from communication (Nugraha & Pujiastuti, 2019).

Previous research has revealed low mathematical communication skills which is confirmed by evidence that students still find it hard to interpret mathematical problems into graphs, tables or figures (Hakiki & Sundayana, 2022 ; Nugraha & Basuki, 2021 ; Sari & Madio, 2021). Adellia, (2022) research also results in students' mathematical communication skills decreasing. Research findings Putri et al., (2021) shows the percentage of each level of mathematical communication skills during the online learning period, namely 13.8% of students with the excellent category, 41.6% of students with the good category and 19.4% of students with the medium category. In addition, according to research by Yuliastuti & Sholihah, (2021) mathematical communication skills are not good due to remote learning carried out during the pandemic, so it must be improved so that students are not passive while learning mathematics. It must be remembered that mathematical communication skills are absolutely crucial to improve because of this low due to students who do not try to solve mathematical problems, the importance of improving mathematical communication skills is so that students are able to analyze, combine and interpret mathematical language well (Astuti et al., 2020). Mathematical communication skills can be carried out when there are no problems in learning mathematics, but in fact in the world of mathematics, some arguments state that the obstacle that interferes with mathematical communication skills is mathematical anxiety (Santri, 2017).

The anxiety that students have must be different, the difference depends on the interests and preferences of students in a subject (Anita, 2014). When feelings of panic, nervousness and tension are felt by students when learning mathematics with signs of facial expression such as confusion or pale face, then the situation is a mathematical anxiety (Ekowati et al., 2021). Winardi, (2019) explained that the effect of mathematics anxiety is very large, which interferes with one's mathematics learning activities because it is difficult to understand mathematics so that there is a dislike for mathematics. Usually, students with less math ability will be more inclined to have high math anxiety because they lack of honing math skills, thus causing students to stay away or even unwilling to participate in mathematics learning (Salvia et al., 2022).

Santoso, (2021) showed anxiety of math was caused by the student's own personality as well as based on the influence of external circumstances and the environment around the student. Anxiety can be known if the student looks uncomfortable and not relaxed, meaning that the student feel anxious because of math lessons, and otherwise (Wibowo, 2018). Previous research initiated by Disai et al., (2018) shows that math anxiety and student learning outcomes are interconnected. Research by Nurjanah & Alyani, (2021) stated that the position of mathematics anxiety levels during the Covid 19 pandemic was 17.33% of students in the high category, 73.78% of students in the medium category and 8.89% of students in the low category. In line with previous research, students who are good at describing to solve math problems must have a low level of mathematical anxiety because

they are able to communicate mathematical language well (Riki et al., 2021 ; Humaira & Miatun, 2023). Refer to the results of the study Hidayati & Armiati, (2022) expressing mathematical anxiety has a close connection to mathematical communication skills. When students' mathematical communication skills are low, students' math anxiety will be high, and otherwise.

In addition to developing mathematical communication skills and also reducing and anticipating math anxiety, teaching and learning activities must also be able to foster learning motivation and student behavior about mathematics. The action can be improve communication skills and reduce math anxiety is increase your own learning motivation as well as from teacher support (Abdi, 2018). According to Suardana & Simarmata, (2013), the definition of learning motivation is the driving force from within students to develop interest in learning and achieve the target of desire. Students who are motivated in learning will continue to be enthusiastic about learning and do not easily give up and despair when they feel difficulties in learning (Nurmala.et.al. 2014). Low student learning motivation is evidenced by students who do not have the effort and enthusiasm to grow and increase learning motivation, they will fail in learning because they cannot express their abilities (Emda, 2018 ; Andriani et al., 2016 ; Akmalia & Ulfah, 2021). Same conditions with research by Zain & Ahmad, (2021) that is learning motivation is needed because it will have an impact on satisfying learning outcomes. Research by Nurmantoro, (2017) mentioning that lack of interest in learning causes low learning motivation because the two are interrelated. Based on this study's Nurfallah & Pradipta, (2021) finding the percentage difference between each category of learning motivation during the online learning period was 13% of students in the high category and 70% in the medium category.

Research on learning motivation conducted by Jatmiko, (2015) ; Abdi & Hasanuddin, (2018) suggests that student learning motivation has a role in mathematical communication. Rohid et al., (2023) presenting the results of his research is proving that students with high learning motivation are able to solve mathematical communication ability test problems, and the otherwise. Then Abdi, (2018) stated in his research that learning motivation has a positive impact and a suitable bond to mathematical communication skills. Research results Prasetyo & Dasari, (2023) found that there was a negative impact between math anxiety and learning outcomes and a good impact within learning motivation and the development of learning outcomes. Refer to research by Adellia, (2022) explains there was an important connection between mathematical anxiety and mathematical communication skills.

This study was carried out after the 2013 curriculum was modified to an independent curriculum, with no difference between science and social studies specializations in the present curriculum. Based on the problems described, so researchers decided to examine learning motivation and math anxiety in relation to high school students' mathematical communication skills in the 2023/2024 school year.

2. METHOD

In this study, a correlational approach to quantitative research methodology was employed with the intention to understand and prove the relationship between independent variables and dependent variables (Dinawati, Siswono, 2021). While the probability sampling technique used by deepening the cluster random sampling technique. The independent variables of learning motivation (X_1) and mathematical anxiety (X_2) as well as variables tied to mathematical communication skills (Y). The investigation was carried out at one of the public high schools in East Jakarta on grade X students for the 2023/2024 academic year. The population of class X was 324 students divided into 9 classes. The slovin formula used to find the minimum number of samples (Priyono, 2017), so that the sample

was obtained as many as 192 students. The mathematical communication abilities test instrument used 6 questions on the exponent material. Non-test instruments learning motivation questionnaire as many as 25 points of statements and mathematics anxiety questionnaire as many as 28 points of statements.

The indicators of mathematical communication ability test instruments based on research by Hikmawati et al., (2019) there was 3, namely (1) Wrote down math problems, students wrote and solved math problems (2) Expressed math problems, students expressed and solved math problems and (3) Describe math problems, students describe and solved math problems.

Non-test instruments of learning motivation questionnaires using indicators based on research by Kossahdasabitah & Haerudin, (2022) namely (1) Internal orientation objectives, students are able to describe the purpose of internal orientation (2) The purpose of external orientation, students are able to describe external orientation (3) Assignment notes, students are able to complete as well as show assignment notes (4) Learning trust management, students are able to manage trust management in learning (5) Self-confidence, students are able to be confident when learning in class and (6) Anxiety during the test, students are able to hold, reduce, and feel anxiety when the test.

Indicators of math anxiety questionnaire according to research mahmood, (2011) while the instrument is adapted based on research Istiqomah & Miatun, (2022) namely (1) Avoiding math class, students look for ways to leave math class (2) Feeling physically ill, students experience physical pain when learning mathematics takes place (3) Difficult to rule, students difficult to rule in mathematics learning, especially when giving assignments and (4) Unable to do math tests, students cannot complete math assignments/tests given by the teacher.

Descriptive analysis of the data was used to decipher the level of learning motivation, math anxiety and mathematical communication ability. The assessment guide uses the formula in table 1 below (Yuniarti et al., 2023).

Table 1 Data Description Criteria Scoring Guide

Range	Description
$X > Mi + 1,5 SDi$	Very high
$Mi + 0,5 SDi < X \leq Mi + 1,5 SDi$	High
$Mi - 0,5 SDi < X \leq Mi + 0,5 SDi$	Medium
$Mi - 1,5 SDi < X \leq Mi - 0,5 SDi$	Low
$X \leq Mi - 1,5 SDi$	Very low

IBM SPSS Statistics version 23 was used for the processing of this research by using several classical assumption test tests, (a) Normality Test (b) multicollinearity test, and (c) heterokedasticity test. Hypothesis test, (a) Parameter estimation, (b) Coefficient of determination, (c) F Test (d) T Test (Usmadi, 2020 ; mardiatmoko, 2020 ; Yuliara, 2016).

The following is a hypothesis that would be tested by utilizing a significance level of 5%:

Hypothesis 1

H_0 : There was no connection between learning motivation and math anxiety with students' mathematical communication skills.

H_1 : There was a connection between learning motivation and math anxiety with students' mathematical communication skills.

Hypothesis 2

H_0 : There was no connection between mathematical anxiety and mathematical communication skills.

H_1 : There was a connection between mathematical anxiety and mathematical communication skills.

Hypothesis 3

H_0 : There was no connection between learning motivation and mathematical communication skills.

H_1 : There was a connection between learning motivation and mathematical communication skills.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Description of Data

Data description analysis is carried out by identifying the number of students as well as their percentage at each category level. Here is the following data description per variable obtained at one of the public high schools in East Jakarta. In table 2 is an explanation of information on mathematical communication ability variables.

Table 2 Data Description Mathematical Communication Skills

Range	Frequency	Percentage	Description
$X > 45,2$	50	26,04%	Very high
$35,4 < X \leq 45,2$	87	45,31%	High
$25,6 < X \leq 35,4$	30	15,63%	Medium
$15,8 < X \leq 25,6$	10	5,21%	Low
$X \leq 15,8$	15	7,81%	Very low

According to table 2 above, it was be identified that the number of students with high mathematical communication skills is 87 students along with a percentage of 45,31%, the low category there are only 10 students with a percentage of 5,21%.

In this table 3 below is a description of the data on the learning motivation variables.

Table 3 Description of Learning Motivation Data

Range	Frequency	Percentage	Description
$X > 100$	24	12,50%	Very high
$88 < X \leq 100$	52	27,08%	High
$76 < X \leq 88$	67	34,90%	Medium
$64 < X \leq 76$	37	19,27%	Low
$X \leq 64$	12	6,25%	Very low

According to table 3 above, it was be identified that the level of learning motivation based on the highest number in the medium category of 34,90% and in the very low category only 6,25%.

Table 4 Description of Math Anxiety Data

Range	Frequency	Percentage	Description
$X > 98,95$	24	12,50%	Very high

$83,65 < X \leq 98,95$	60	31,25%	High
$68,35 < X \leq 83,65$	66	34,38%	Medium
$53,05 < X \leq 68,35$	36	18,75%	Low
$X \leq 53,05$	6	3,13%	Very low

The table 4 is a description of mathematical anxiety variable data based on several groups. Based on table 4, the conclusion was mathematics anxiety in the medium category of 34,38%. Then only 3,13% of students was in very low category.

3.1.2. Classical Assumption Test

a. Normality Test

The normality test intends to prove that the resulting data is normally distributed or not (Usmadi, 2020). A good result is a result with a normally distributed residual value provided that the significance value must be $> 5\%$ or $0,05$. In this table 5 below test results of kolmogrov Smirnov (KS) normality test data.

Table 5 Normality Test Kolmogrov Smirnov (KS)

Model	Test Value	Conclusion
<i>Unstandarized residual</i>	0,082	Normally distributed

The normality data test results listed in table 5 above prove a test value of 0,082. This value showed that the test value more than a significance level of $0,082 > 0,05$ would be interpreted if the information is normally.

b. Multicollinearity Test

The multicollinearity test is intended to prove a strong relationship between independent variables (Mardiatmoko, 2020). A good test result is a result that does not have symptoms of multicollinearity, namely if the tolerance value more than 0,10 and VIF less than 10,00. Table 6 below listed of multicollinearity tests based on *tolerance* and VIF values.

Table 6 Mulcollinearuty Test

Model (<i>constant</i>)	<i>Tolerance</i>	VIF
Learning Motivation	0,294	3,403
Math Anxiety	0,294	3,403

The resulted of the multicollinearity data test in table 6 above showed that the tolerance value of learning motivation and mathematical anxiety $0,294 > 0,10$ and the VIF value $3,403 < 10,00$. The resulting conclusion has met the requirement that there are no symptoms of multicollinearity between learning motivation and mathematical anxiety.

c. Heteroskedasticity Test

The heterokedasticity test is completed using the intention of showing the occurrence of variance inequality of residuals between variables or not (mardiatmoko, 2020). A good test result is a result that does not occur heterokedasticity with the condition that the significance value $> 0,05$. We can see the outcomes of the heteroscedasticity test in table 7.

Table 7 Heterokedasticity Test

Model	Test Value	Conclusion
Learning Motivation	0,747	No heterokedasticity
Math Anxiety	0,791	No heterokedasticity

The resulted of the heterokedasticity data test in table 7 above got a value of 0,747 on learning motivation and 0,791 on mathematical anxiety. This value was met the requirements of the heterokedasticity test, which is all data > 0.05 . The conclusion obtained that all data was not contain symptoms of heterokedasticity.

3.1.3. Hypothesis Test

a. Parameter Estimation

Parameter estimation tests are conducted with the goal of identifying the relationship between dependent and independent variables namely learning motivation and mathematical anxiety about mathematical communication skills together (Yuliara, 2016). Table 8 below is a parameter estimation tests.

Table 8 Parameter Estimation

Model	Constant	Learning Motivation (X_1)	Math Anxiety (X_2)
	25,534	0,135	0,016

Based on table 8 above, it showed a *constant* value of 25,535 (b_0), as well as consecutive x values 0,135(b_1) and 0,016(b_2). Then it would be concluded that the equation $Y = 25,534 + 0,135X_1 + 0,016X_2$ means that if learning motivation increases, it was expected that mathematical communication skills would also increase by 0,135, if mathematical anxiety was high then mathematical communication skills also increase by 0,016. Below is attached figure 1 which is a graph of the equation $Y = 25,534 + 0,135X_1 + 0,016X_2$.

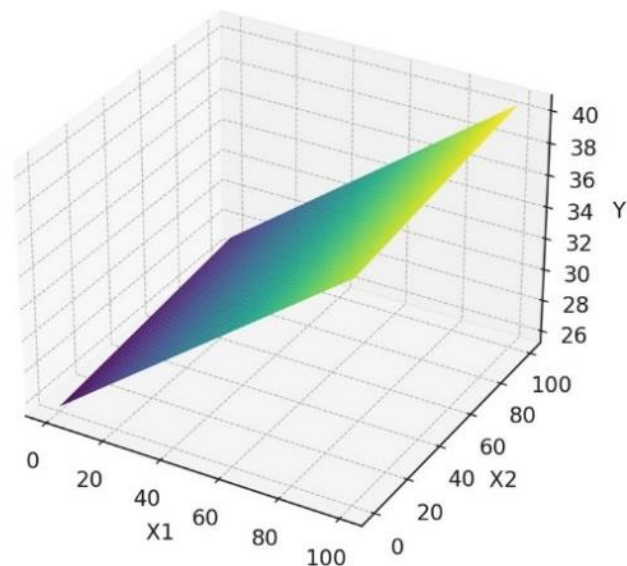


Figure 1 Multiple Linear Regression Surface**b. Coefficient of D**

The Coefficient of determination test used to view and prove the level of relationship between variables of learning motivation, mathematical anxiety about mathematical communication skills (Usmadi, 2020). Table 9 below is a coefficients of determination.

Model	R	R Squared	Adjusted R Square
	0,296	0,087	0,078

Table 9 would be observed, namely the value of R 0,296 and the value of R Squared 0,087. Based on the value of R square so as to explained that the percentage of learning motivation variables, mathematical anxiety about mathematical communication skills was only 8,7% so that 91,3% was caused by other things.

c. F Test (Simultaneous Significance Test)

The F test is made with the intention of checking whether the independent variable has a simultaneously connection with the dependent variable using a significance level of 5% (Yuliara, 2016). Based on the F test, the hypothesis with the value of F_{count} more than F_{table} then H_0 was rejected. The F value of the table is obtained using the n-k formula, which is with denominator or a lot of data (n) as many as 192 and a numerator or many independent variables (k) as many as 2, then the F value of the table seen based on $n-k = 190$ is 3,04. The description of F test listed in table 10 below.

F count	F table	Conclusion
9,042	3,04	Have a simultaneous relationship

It could be saw in table 10 above, which proves the value of F_{count} more than F_{table} with values of $9,042 > 3,04$ so that it indicated that H_0 was rejected, it could be interpreted that was a connection together, learning motivation (X_1) and math anxiety (X_2) have a relationship with mathematical communication skills (Y).

d. T Test (Partial Significance Test)

The T test is conducted with the goal of proving the occurrence of a partial connection between the independent and dependent variable (Yuliara, 2016). Based on the T test, the hypothesis with the value of T_{count} more than T_{table} so that H_1 is accepted. The T value of the table is obtained using the formula $n-k-1$ which is with a lot of data (n) of 192 and many independent variables (k) are 2, then the table T_{count} seen based on $n-k-1 = 189$ is 1,972. Table 11 below is the description of T test.

Model	T count	T table	significance	Conclusion
Learning Motivation (X_1)	2,589	1,972	0,010	There is a partial relationship

Math Anxiety (X₂)	0,347	1,972	0,729	No partial relationship
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It could be saw in table 11 of the value of T_{count} more than T_{table} between the variables of learning motivation with mathematical communication skills and a significance value of 0,01 which is $< 0,05$, H_0 was rejected so that learning motivation had a relationship with mathematical communication skills.

3.2. Discussion

According to table 2 above, it was be identified that the number of students with high mathematical communication skills is 87 students with a percentage of 45,31%, the low category there are only 10 students with a percentage of 5,21%. Referring to the results of table 2 analysis, which is consistent with studies by Somawati, (2016) which reveals if mathematical communication skills in the high category are more than low criteria. Mathematical communication skills are located in the high category with the largest number of students, which are listed in the research results Winardi, (2019). In contrast to researched by Salahuddin, (2018) showed if mathematical communication skills was in the medium category more than in the high category. According to table 3 above, it was be identified that the level of learning motivation based on the highest number in the medium category of 34,90%. This is in line with the conclusion of the study Abdi, (2018) was the highest number of students is in the medium category. Research by Salahuddin, (2018) getting similar findings that state that student learning motivation is at a moderate level. It's different with research Haerudin et al., (2021) which explains that the level of learning motivation is in the low category. Based on table 4 above, the conclusion was mathematics anxiety is in the medium category of 34,38% and only 3,13% of students are in the very low category. The same direction based on the table 4 as Waruwu et al., (2023) states that math anxiety is in the moderate category. Research based on Haerudin et al., (2021) also got the same result, namely math anxiety in the moderate category of 55%. Sourced from research Somawati, (2016) it has an inversely proportional result, namely anxiety in the high category is less than anxiety in the low category.

Based on the table 9 value of R square so as to explained that the percentage of learning motivation variables, mathematical anxiety about mathematical communication skills only 8,7% so that 91,3% was caused by other things. Explained according to table 9 namely in he study Waruwu et al., (2023) there was only 0,21% of students' mathematical communication skills have a relationship with mathematical anxiety. In contrast to the results of the study Fitriani, (2021) which states that 62,3% of mathematical communication skills are influenced by learning motivation and initial ability and 37,7% are influenced by other factors. It could be saw in table 10 above that H_0 was rejected, it could be interpreted that learning motivation (X_1) and math anxiety (X_2) have a relationship with mathematical communication skills (Y). Guided by that results, writing research with the theme of learning motivation, mathematical anxiety and mathematical communication skills has never been done together until now. Based on research Salahuddin, (2018) was having a relationship between Early Ability, Self-Confidence, Learning Motivation with Mathematical Communication Skills. Research results Maghfiroh et al., (2023) suggests that there is a good connection between learning motivation, learning anxiety, and student mathematics learning outcomes. Then on to the findings Haerudin et al., (2021) mentions that math anxiety and learning motivation have a shared relationship with mathematical connection skills. It could be saw in table 11 that H_0 was rejected so learning motivation had a relationship with mathematical communication skills. It is the same as in the findings Abdi, (2018) that is, learning motivation has a partial relationship with mathematical communication skills.

Based on research Fitriani, (2021) mentioned that the value of T_{value} more than T_{table} then learning motivation has a connection with mathematical communication skills. Research Nurmantoro, (2017) also obtained results are learning motivation is directly related to mathematical communication skills. While the variable of mathematical anxiety with mathematical communication skill have a value with the otherwise of learning motivation. There was no correlation between mathematics anxiety and mathematical communication abilities. Accordance with earlier studies Humaira & Miatun, (2023) which explains that mathematical anxiety and mathematical communication skills have no partial connection. Unlike the research results Adellia, (2022) shows that mathematical anxiety was a negative connection with students' mathematical communication. Inversely proportional to the results of the study Somawati, (2016) the value of T_{value} more than T_{table} which means that there was a negative connection between mathematical anxiety and mathematical communication ability.

4. CONCLUSION

The goal of this study was to ascertain how high school students' mathematical communication skills related to their learning motivation and math anxiety. The most common results obtained based on field data were mathematical communication skills are in the high category while learning motivation and mathematical anxiety are in the medium category. Only 8.7% is influenced by communication skills, so that 91,3% was caused by other factors that were not studied in this study. Furthermore, learning motivation, mathematical anxiety and mathematical communication skills have a simultaneous relationship. Learning motivation was a relationship to mathematical communication skills but mathematical anxiety was no relationship to mathematical communication skills.

ACKNOWLEDGEMENTS

Thank you to Allah Almighty for giving the author the blessing of health and safety. Thank you to the supervisor, Mrs. Asih Miatun, M.Pd. Thank you to my parents, family, friends and all parties involved that I cannot mention one by one.

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