Does students’ logical-mathematical intelligence correlate to mathematics communication skills on a linear system with three variables problems?

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Abstract. Logical-mathematical intelligence has affected the ability to analyze in a problem, create mathematical formulas or patterns, and communicate mathematical problem-solving. In Class X IPA, there are some students with a high level of logical-mathematical intelligence but are relatively low in mathematical communication, especially on solving a three-variable linear equation system problem. This study aims to investigate the correlation of logical-mathematical intelligence to students’ mathematical communication skills of students at class X SMA Jenggawah Jember. The population in this study are 144 students of class X IPA, in the 2019/2020 academic year. This study uses the Cluster Random Sampling technique involve 64 students as samples. This study used a logical-mathematical intelligence questionnaire consisting of 22 items and three mathematical communication skills essay tests. This study uses descriptive and inferential data analysis in which the hypothesis test uses a simple linear regression test. The descriptive analysis reports the percentage of each category in terms of logical-mathematical intelligence. It also reports the percentage of each category in terms of mathematical communication skills. Based on the inferential analysis with significant level 0.05, it can be concluded that logical-mathematical intelligence correlates with the mathematical communication skills in the material.

1. Introduction
One of the crucial processes to become an individual in the development of intelligence. Individuals adapt to the dynamics of life in proportion to their knowledge and diversify their behaviours regarding the instincts of existence and survival with their intelligence [1]. ‘Areas of intelligence’ refers to the different abilities and potentials that people possess [2]. Furthermore, Gardner proposes eight different types of intelligence; one is Logical-Mathematical Intelligence, which can be described as the ability to use numbers effectively, establish cause-effect relationships, and make practical reasoning about the formation and process of the events. Logical-mathematical intelligence is a combination of systematic and reasoned levels of calculation. Mathematical, logical information is closely related to mathematics because it prioritizes the ability to count and logic [3]. Someone who has a high logical-mathematical will affect the ability to analyze in a problem, create mathematical formulas or patterns, and find the problem scientifically to solve mathematical problems [4].

Students with logical-mathematical intelligence can handle numbers and calculations, patterns, logical and scientific thinking [5]. It is in line with Hermawan, Lestari, rahmawati, and Suwarno [6] that argumentation and reasoning as basic of logical intelligence are fundamental skills in mathematics. The
statement is also in line with Gartmann and Freiberg [7]. In problem-solving, there is a process of being aware of and organizing thinking about how students make approaches to problems, choosing strategies used to find solutions, and asking themselves about the problem [8]. To be a success in computer programming, individuals must first develop and acquire advanced thinking skills, such as problem-solving, logical and mathematical thinking, critical thinking, and creative [9][10][11][12].

Communication in mathematics has been given a great deal of attention over the past 20 years. One of the learning outcomes is to communicate ideas using symbols, diagrams, tables, or other media. Thus, mathematical communication skills are fundamental. Communication skills are essential in mathematics teaching-learning [13]. Communication in learning mathematics contributes to in-depth mathematics analyses on the part of teachers and students [14]. Mathematical Communication Skills (MCS) refer to the students' ability to arrange and link their mathematical thinking through communication, communicate their logical and clear mathematical thinking to others, analyze and assess mathematical thinking and strategies used by others, and express ideas correctly using mathematical language [13][15]. Students' mathematical communication skills are a place for students to obtain information and express mathematical concepts. Mathematical communication consists of written communication and oral communication [16].

There were studies conducted by previous researchers, which are almost relevant to this research. Korkmaz [17] investigated the effect of the programming activities on academic achievement concerning computer programming, problem-solving, and students' logical-mathematical thinking skills. Suhendri [18] studied the influence of mathematical-logical intelligence and independent learning on mathematics learning outcomes. The focus of his research is to determine whether there is an effect of logical-mathematical intelligence on learning independence or not. Septyaningsih [19] focused on students' mathematical representation's ability to correlate or not on logical-mathematical intelligence at MA Watoniyah Islamiyah Banyumas. Arum, Kusmayadi, and Pramudya [20] investigated the correlation between linguistic intelligence with logical-mathematical intelligence on the skill to solve problem stories.

Based on the description above, no study has examined the relationship between logical-mathematical intelligence and mathematical communication skills. Therefore, researchers are interested in investigating the correlation of logical-mathematical intelligence with mathematical communication skills. Thus, this study investigates the relationship between logical-mathematical intelligence and mathematical communication skills of students in solving mathematical problems in the material Three Variable Linear Equation System. Based on observation at SMA Jenggawah, especially in class X IPA, some students have a high level of logical-mathematical intelligence but are relatively low in mathematical communication, especially in solving a three-variable linear equation system problem. Thus, it is crucial to investigate the relationship generally between logical-mathematical intelligence to students' mathematical communication skills, where logical-mathematical intelligence is related to the ability to count and the ability to communicate mathematical solutions.

2. Methods
An associative-quantitative approach is used in this study [21] because it aims to examine the relationship between two variables, logical-mathematical intelligence, and mathematical communication skills. A random sample was selected by researchers in taking samples [22]. The population in this study were 144 students of class X IPA. In contrast, the samples are 64 students of class X IPA 3 and IPA 4. Data collection techniques in this study use instruments consisting of three essays item and 22 valid and reliable items questionnaire. This study established a questionnaire to measure students' logical-mathematical intelligence. Otherwise, three essay math problems focus on the system of equations in three variables to measure students' mathematical communication skills. Before the instruments were distributed to the students (sample), the instruments were validated by two lecturers and one teacher as expert, and the tool was first tested in class X IPA 1. By using SPSS 22 for Windows output, we know that the research instruments are valid and reliable. This research uses descriptive statistics consisting of mean, median, mode, range of data. The inferential statistics used simple linear
regression. The hypothesis was tested using simple linear regression analysis after collinearity, autocorrelation, and heteroscedasticity.

3. Results and discussion

General description of the results of the data obtained includes the categories and frequencies of each instrument with the following description:

3.1 Descriptive analysis data

3.1.1 The results logical-mathematical intelligence questionnaire. The mathematical, logical intelligence questionnaire data can be seen in table 1.

Table 1. Statistics of logical-mathematical intelligence questionnaire.

| Description | Score |
|-------------|-------|
| Maximum     | 72    |
| Minimum     | 42    |
| The mean    | 57.42 |
| Median      | 56    |
| Mode        | 53    |
| Range       | 30    |

The frequency logical-mathematical intelligence distributed into three categories calculated by using criteria as following [23].

\[ c = \frac{r}{k} = \frac{30}{3} = 10 \]

Then, figure 1 below represents the logical-mathematical of students of SMAN Jenggawah. It can conclude that the level of logical-mathematical intelligence of students of class X IPA Jenggawah Jember in a low category (42-51) is 15.63%, medium category (52-61) is 53.12%, and high category (62-72) is 31.25%.

![Figure 1. Logical-mathematical intelligence categories.](image)

3.1.2. The Results of mathematical communication skills. Table 2 shows the data about the results of mathematical communication skills as follows.
Table 2. Statistics of mathematical communication skill tests.

| Description | Score |
|-------------|-------|
| Maximum     | 55    |
| Minimum     | 0     |
| The mean    | 37.52 |
| Median      | 38    |
| Mode        | 40    |
| Range       | 55    |

The frequency distribution of mathematical communication skill scores is divided into three categories and calculated using the following criteria.

\[ c = \frac{r}{k} = \frac{55}{3} = 18.3; \text{ rounded to } 19. \]

Then, the mathematical communication skills scores presented in figure 2. It can know that level Mathematical Communication Skill class X IPA of the students in a low category (0-18) is 3.12%, medium category (19-37) is 50.57%, and high category (38-56) is 45.31%.

Figure 2. Mathematical communication skills.

3.2. Inferential analysis

Four prerequisites need to be carried: normality test, autocorrelation test, collinearity test, and heteroscedasticity test before hypothesis testing as follows:

3.2.1. Normality test. The normality test uses Kolmogorov-Smirnov, which can be normal if the significance value is greater than 0.05. By using SPSS 22 for Windows, logical-mathematical intelligence and mathematical communication skills were said to be abnormal because of the significant value is less than 0.05. Because the data used is not normal, researchers can use the second option, namely, using data transformation [24]. The p-value of logical-mathematical intelligence obtained a value of 0.200 > 0.05, and the mathematical communication skills obtained a value of 0.58 > 0.05. So,
it can be concluded that the distribution of logical-mathematical intelligence data and mathematical communication skill data is normal

3.2.2 Autocorrelation test. The Autocorrelation Test is a prerequisite for carrying out a simple linear regression test. Besides that, it is also to identify an appropriate time series model. The regression is free from autocorrelation when $1.65 < DW < 2.35$. The Durbin Watson number is 2.06. Because $1.65 < 2.06 < 2.3$, so it can be concluded that the regression is free from autocorrelation.

3.2.3. Collinearity test. The Collinearity test is used to see whether there is a strong correlation between the independent variables or not. If the Variance Inflation Factor (VIF) is close to 1, there is no collinearity between independent variables. The value of VIF = 1 and tolerance value = 1, it can be concluded that there is no collinearity in the regression used.

3.2.4. Heteroscedasticity test. Heteroscedasticity test is used to test a regression that occurs the difference in residual variation from one observation to another observation. Figure 3 shows the results of calculations using SPSS 22 for Windows. Based on figure 3, we can examine that there are unstructured patterns and scattered points below the 0 number on the Y axis, so we can conclude that heteroskedasticity does not occur. This step continued by heteroscedasticity glejser to ensure the data occurred heteroscedasticity or not. If the significance value more than 0.05, then there is no heteroscedasticity. Table 3 shows that the value of $p = 0.87 > 0.05$ states that this data does not occur heteroscedasticity and can be continued for a simple linear regression test.

![Figure 3. Heteroscedasticity of logical-mathematical intelligence and mathematical communication skill.](image)

**Table 3.** Heteroscedasticity logical-mathematical intelligence and mathematical communication skills.

|     | t   | Sig. | Collinearity Statistics |
|-----|-----|------|-------------------------|
|     | 2.860 | .006 | VIF |
|     | -1.742 | .087 | 1.000 |
3.2.5. Hypothesis test

Hypothesis testing aims to determine the correlation between logical-mathematical intelligence and mathematical communication skills of students in completing the Three Variable Linear Equation System Problems. The analysis used in this study is a simple linear regression with SPSS 22 for Windows. This simple linear regression analysis determines whether there is a significant relationship between logical-mathematical intelligence and mathematical communication skills. Table 4 below shows the results of the simple linear regression of the variables.

### Table 4. The output of simple linear regression.

| Independent Variable | Dependent variable | Constant (a) | Regression Coefficient b | t value | t table | Probability | Decision |
|----------------------|--------------------|--------------|--------------------------|---------|---------|-------------|----------|
| Logical-Mathematical Intelligence | Mathematical Communication Skills | 2.586 | 0.045 | 11.074 | 1.997 | 0.000 | Ha received |

Table 4 shows that $t_{value} = 11.074 > t_{table} = 1.997$ with $p = 0.000 < 0.05$ then $Ha$ is accepted and $H0$ is rejected. So it can be concluded that "there is a significant correlation between logical-mathematical intelligence and mathematical communication skills." The estimation results from the relationship of logical-mathematical intelligence variables can be stated as follows:

$$Y = a + bX$$
$$Y = 2.586 + 0.045X$$

The above equation shows that the constant value of the mathematical communication skill is 2.586, and the coefficient of $X$ is 0.045. It means that for every 1% increasing in the value of logical-mathematical intelligence, the value of mathematical communication skills increases by 0.045. The regression coefficient is positive, showing that the correlation between logical-mathematical intelligence and mathematical communication skills is positive. The coefficient determination ($R^2$) (0.671 or 67.1%) means that 67.1% of mathematical communication skills are implied by logical-mathematical intelligence, while 32.9% are affected by other factors not discussed in this study.

According to descriptive analysis, there are three levels of logical-mathematical intelligence of students of class X IPA SMA Jenggawah which is a low category (42-51) by 15.63%, medium category (52-61) by 53.12% students and high category (62-72) by 31.25% as many as 20 students. There are three levels of mathematical communication skills of students of class X IPA Jenggawah Jember that is a low category (0-18) by 3.12%, (2 students), medium category (19-37) by 50.57% (33 students) and high category (38-56) by 45.31% (29 students).

The results of inferential testing indicate that there is a significant relationship between logical-mathematical intelligence and mathematical communication skills. Based on the data analysis results, there is a positive and significant relationship between logical-mathematical and mathematical communication in solving the Three Variable Linear Equation System problems of Class IPA in SMA Jenggawah. The statement means that logical-mathematical intelligence is related to the communication skills of students. The results of this study also support research conducted by [18] explain that there is a significant influence of logical-mathematical intelligence and learning independence on mathematics learning outcomes. Mathematics learning outcomes are implied by logical-mathematical intelligence factors and learning independence by 68.0% and other factors by 32.0%. Besides, there are results of further research that support this research. Research conducted by [19] explains that there is a significant influence of logical-mathematical intelligence on mathematical communication skills of 18.76%, while other factors determine 81.24%. The correlation between logical-mathematical intelligence and mathematical communication skills is in line with Lwin, Khoo, Lyen, and Sim [5] because people with
logical-mathematical intelligence can handle numbers and calculations, patterns, logical and scientific thinking. Although related to numbers, logical-mathematical intelligence is not only focused on the calculation of numbers continuously but also about the skill to write mathematical communication.

Students who have logical-mathematical intelligence will easily solve mathematical story problems because they can understand, interpret, translate the mathematical story problems. Students can think with numbers and calculations, draw conclusions from logical relationships, problem-solving, and understand symbols and symbols abstract like numbers [7]. The results of this study are also related to Abidin and Tohir [25] that in problem-solving, there is a process of being aware of and organizing thinking about how students make approaches to problems, choosing strategies used to find solutions, and asking themselves about the problem. The results of this study are also in line with Tohir, Abidin, Dafik and Hobri [8] that "through the guidance of this mathematics, students are expected to have logical, analytical, systematic, critical, and creative, and have a good skill to work together". It is important to equip students with logical, analytical, systematic, critical, innovative, creative, and cooperative skills. The results of this study were further strengthened by Gardner [2] that intelligence possessed by students, namely: logical-mathematical, visual-spatial, kinesthetic, linguistic, interpersonal, and intrapersonal intelligence.

This result is consistent with Arum, Kusmayadi, and Pramudya [20] that there is a significant correlation between linguistic intelligence with logical-mathematical intelligence on the skill to solve story problems. Understanding and solving story problems requires logical intelligence and linguistic intelligence. Logical-mathematical intelligence and high linguistic intelligence will be easier to understand and solve mathematical story problems. Students can translate the intentions of mathematical story problems that are only given by abstract concepts. Students can think with numbers and calculations, conclude logical relationships, problem-solve, and understand abstract symbols and symbols such as numbers.

Based on the description above, it can be concluded that the higher students with logical intelligence mathematical are easier to understand and solve mathematical problems otherwise if students with low logical-mathematical intelligence will tend to be difficult to understand or solve a mathematical problem.

4. Conclusions
The research result shows that there is a positive relationship between logical-mathematical intelligence and mathematical communication skills. There is a significant and positive relationship between logical-mathematical intelligence and mathematical communication skills of students. Students who have high logical thinking abilities tend to understand and solve mathematical problems easily. Students who have medium and low logical thinking skills tend to have difficulty understanding and solving mathematical problems. Students who have high logical thinking skills will also have high mathematical communication skills. Simultaneously, students who have low communication skills will also have low mathematical communication skills that impact understanding and solving a mathematics problem.

Based on the conclusions and limitations of the problem in this study, there are two suggestions promote. First, mathematics teachers should create a learning process that can improve students' mathematical, logical intelligence to help them understand and solve mathematical problems in mathematics learning activities. Second, a further comprehensive study that investigates other factors that affect students' mathematical communication skills besides logical-mathematical.

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