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The effect of mathematics communication ability on students' learning achievement in year five

Mukti Sintawati [a,1,*], Metti Dwita [a,2], Baharun [b,3], Irma Yanti [c,3]

[*a] PGSD Universitas Ahmad Dahlan, Indonesia;
[b] SD Negeri Gantung 08 Bangka Belitung, Indonesia;
[c] SD Negeri Gantung 10 Bangka Belitung, Indonesia;
[1] mukti.sintawati@pgsd.uad.ac.id; [2] mettidwita@gmail.com
*Correspondent Author

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh keterampilan komunikasi matematis terhadap prestasi belajar siswa kelas V SDN 08 dan 10 Kecamatan Gantung. Penelitian ini menggunakan pendekatan penelitian kuantitatif dengan penelitian ex-post facto. Populasi dalam penelitian ini adalah siswa kelas V SDN 08 dan 10 Kecamatan Gantung sebanyak 58 siswa, dengan sampel sebanyak 45 orang. Keterampilan komunikasi matematika (Variabel X) dan prestasi belajar matematika merupakan variabel yang diteliti (Variabel Y). Metode pengumpulan data penelitian ini menggunakan tes yang telah divalidasi dan terbukti reliabel. Program SPSS versi 21 digunakan untuk pengujian hipotesis, yang menggunakan analisis regresi linier sederhana dan korelasi Pearson. Hasil penelitian yang diperoleh dengan menggunakan uji regresi linier sederhana dan uji korelasi Pearson menunjukkan bahwa kemampuan komunikasi matematis berpengaruh signifikan terhadap prestasi belajar matematika siswa yang ditunjukkan dengan nilai sig yang lebih kecil dari 0,005 yaitu sebesar 0,000 dengan nilai sig lebih kecil dari 0,005 yaitu sebesar 0,000 dengan persamaan regresi linier Y = - 2,219 + 0,980. Korelasi Pearson diperoleh sebesar 0,0802, menunjukkan bahwa korelasi pearson berkorelasi kuat jika dilihat melalui pedoman derajat hubungan. Berdasarkan hal tersebut dapat disimpulkan bahwa keterampilan komunikasi matematika memiliki hubungan yang kuat dengan prestasi belajar matematika siswa.

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KEYWORDS
Mathematic
Mathematical
Communication Learning
Achievement

This study aims to determine the effect of mathematics communication skills on student achievement in grade V Public Elementary School 08 and 10 District Gantung. This study uses a quantitative research approach with ex-post facto research. The population in this study were 58 students of class V Public Elementary School 08 and 10 District Gantung, with a sample of 45 people. Mathematics communication skills (Variable X) and mathematics learning achievement were the variables investigated (Variable Y). This study's data collection method employs tests that have been validated and proven to be reliable. The SPSS version 21 program is used for hypothesis testing, which employs simple linear regression analysis and Pearson correlation. The study's results, obtained using a simple linear regression test and a Pearson correlation test, show that mathematics communication ability has a

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significant effect on students' mathematics learning achievement, as indicated by a sig less than 0.005, which is equal to 0.000 with the simple linear regression equation Y = - 2,219 + 0,980. Pearson Correlation is obtained for 0.0802, indicating that the pearson correlation is strongly correlated when viewed through the guidelines for the degree of relationship. Based on this, it is possible to conclude that mathematics communication skills have a strong correlation with students' mathematics learning achievement.

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Introduction

Humans use communication to comprehend and equate ideas, concepts, or thoughts with one another. Communication, according to Daryanto & Rahardjo (2016), is the process of conveying information, ideas, emotions, expertise, and others through the use of symbols such as words, pictures, numbers, and so on. According to Mulyana (2016:4), communication is carried out to express and support self-identity in order to influence others to think or behave the way we want. Communication is an essential component of humans as social beings, whether it is conveying information about themselves or equating ideas and ideas with others.

Communication is frequently used in the school environment between principals and teachers, principals and students, teachers and teachers, teachers and students, and teachers and students and other fellow students. This communication occurs both inside and outside of the classroom. When students are learning in class, the teacher will communicate to convey the material so that they can understand it. Mathematical communication is one of the types of communication found in class. This type of mathematical communication can only be found in the process of learning mathematics (Herdini et al, 2019; Harun et al, 2021).

Mathematical communication is one of the abilities that students must have in elementary school mathematics subjects. According to Zulfa & Rianti (2018: 50)(Feriansyah et al., 2021), one of the important abilities is mathematical communication. This is due to the fact that through mathematical communication skills, students will sharpen their way of thinking, increasing their ability to see the relationship between mathematical content, develop problem solving, improve reasoning, develop self, and improve social skills, and develop critical, rational, problem solving abilities, and skills in socializing through writing and talking.

According to the National Council of Teachers of Mathematics (NCTM 2000), ideas emerge from the problem-solving process to become objects of reflection, improvement, discussion, and change in mathematical communication. Mathematical communication plays an important role in translating or linking the content, ideas, and mathematical ideas of students in written

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and oral form in the form of stories, pictures, or diagrams, as well as in developing other mathematical abilities such as critical thinking, rational thinking, and problem solving.

Indonesia is ranked 45th out of 50 participating countries in the Trends in International Mathematics and Science Study 2015 (TIMSS) measurement and assessment survey, with a score of 397 points (Mullis et all, 2016). TIMSS measures and assesses students' mathematical cognitive domains, specifically their ability to understand, apply, and reason. The evaluation is concerned with the variables of this research, namely mathematical communication, which necessitates comprehension, application, and reasoning in problem solving. This demonstrates that, in comparison to other countries, the mathematical ability of Indonesian students remains relatively low.

According to Piaget, fifth-grade students aged 11 to 12 are already in the concrete operational phase (Pitadjeng, 2015; Khalil & Zahoor ul Haq, 2019). The ability seen in this phase is the ability of students in the thought process to apply logic rules while still tied to concrete objects. At this age, students are expected to have mastered mathematical communication skills. In order to connect or translate mathematical ideas and ideas, mathematical communication necessitates logical rules with concrete objects.

According to the findings of an interview with one of the fifth-grade homeroom teachers at Gantung 08 Public Elementary School in May 2020, some students have poor mathematical communication skills. The ability of students who still have difficulty working on math problems when they are in the form of stories and pictures demonstrates a lack of mathematical communication. Interviews with fifth grade teachers at Gantung 10 Public Elementary School revealed the same issue: students still struggled to work on math problems when they were presented in the form of stories and pictures. Furthermore, many students still do not write down the steps of completion when working on math story problems.

Based on the findings of the interviews, it is possible to conclude that fifth-grade students at Gantung 08 Public Elementary School and Gantung 10 Public Elementary School continue to have poor mathematical communication skills. This can be seen in students' ability to solve math problems when they have not been able to communicate mathematical ideas or ideas into other forms such as stories, pictures, and vice versa. Furthermore, students do not write down the steps for correctly, clearly, and sequentially solving problems.

Low mathematical communication skills contribute to unsatisfactory mathematical learning achievement. Learning achievement, according to Arifin (2012), is the evaluation of learning outcomes and aspects of knowledge that are realized in the form of numbers or values. Learning outcomes and learning achievement are not dissimilar. learning outcomes are the result of the interaction of learning actions and teaching actions and from the teacher's side,

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the action ends with the process of evaluating learning outcomes, while for students, learning outcomes are the end of the learning experience (Sugiharti, 2018; Feriansyah et al, 2021). Learning outcomes are completed after learning, whereas learning achievement is completed after learning outcomes are completed (Kustawan, 2013; Fadilah & Afriansyah, 2021). This was evident during the Odd Semester Final Examinations in Gantung 08 and Gantung 10 Public Elementary Schools, where there were still students who did not meet the KKM standard of 75. Gantung 08 Public Elementary School students have an average UAS score of 72.5, while Gantung 10 Public Elementary School students have an average UAS score of 70.

Based on the data presented above, students' mathematics scores remain low, particularly in learning mathematics. Furthermore, the results of an interview with the Class V teacher at Gantung 08 Public Elementary School revealed that the students' low Odd Semester Final Exam scores were caused by their inability to work on story questions in the form of a sequential and correct formula, which is part of mathematical communication. As a result, the reason for conducting research on these two variables, namely the effect of mathematical communication on students' mathematical learning outcomes, becomes clear.

Method

The research method used in this study is ex-post facto with a quantitative approach. Ex-post facto research is a type of empirical investigation in which the researcher has no direct control over the independent variables. A causal associative research design was used in this study. According to Siregar (2017:106), a causal associative design (causation) is a research design that expresses an influencing relationship between two or more variables. The independent variable was mathematical communication skills, and the dependent variable was mathematics learning achievement.

This study included 53 grade 5 elementary school (SD) students from Gantung 08 and Gantung 10 Public Elementary Schools in East Belitung Regency, Bangka Belitung Province. The sampling formula developed by Isaac and Michael was used to determine the research sample (Arikunto, 2014). Using the Isaac and Michael table, the sample in this study was 45 students from a population of 53 students with a 5% error rate. Furthermore, the Simple Random Sampling Technique was used to collect samples.

Data collection methods based on tests A mathematical communication test and a mathematics learning achievement test were used as data collection instruments. The communication test instrument included up to 5 essay questions, while the multiple choice test instrument included up to 8 multiple choice questions.

Both instruments were first tested to determine their validity and reliability. There are two

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types of validity used: content validity and construct validity. Experts assessed the test instrument's content validity for mathematical communication skills and mathematical learning achievement. The content validity results indicate that the instrument can be used for research. The instrument was pilot tested on 23 5th grade students from Manggar 03 Public Elementary School in Belitung Regency to assess construct validity. The Corrected Item-Total Correlation method was used to assess construct validity using SPSS version 24 software. Tables 1 and 2 summarize the results of the construct validity of the mathematical communication ability test instrument and mathematics learning achievement.

Table 1. Summary of the Mathematical Communication Instrument (X)

No	*r count*	*r table*	*description*
1	0,662	0,4132	valid
2	0,855	0,4132	valid
3	0,761	0,4132	valid
4	0,867	0,4132	valid
5	0,538	0,4132	valid

Table 2. Summary of the Mathematics Learning Achievement Instruments (Y)

No	*r count*	*r table*	*description*
1	0,529	0,4132	valid
2	0,531	0,4132	valid
3	0,652	0,4132	valid
4	0,460	0,4132	valid
5	0,635	0,4132	valid
6	0,645	0,4132	valid
7	0,470	0,4132	valid
8	0,482	0,4132	valid

The r-count results for each item about the mathematical communication instrument are shown in Table 1. Table 2 displays the r count results for each item on the mathematics learning achievement instrument. The calculated r value was compared to the r table with a significance level of 0.05 and a sample size of 23 students, yielding r table = 0.4132. Based on these findings, it was determined that the calculated r value for each item was greater than the r table, indicating that each item in the two instruments was valid.

Tables 3 and 4 show the results of the reliability test output using Cronbach's alpha with SPSS version 24 on the mathematical communication test instrument and mathematics learning achievement.

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Table 3. Reliability Results of Mathematical Communication Instrument (X)

Reliability Statistics	
Cronbach's Alpha	N of Items
0,780	5

Table 4. Reliability Results of Mathematics Learning Achievement Instruments (Y)

Reliability Statistics	
Cronbach's Alpha	N of Items
0,676	8

The results of reliability tests based on Crobach's alpha values in Tables 3 and 4 were compared to Guilford's reliability criteria (1956). Table 5 displays the criteria.

Table 5. Criteria Reliability

Interval	***Kriteria***
$0,80 < r_{11} < 1.00$	Very high reliability
$0,60 < r_{11} < 0,80$	High reliability
$0,40 < r_{11} < 0,60$	Medium reliability
$0,20 < r_{11} < 0,40$	Low reliability
$-1.00 < r_{11} < 0,20$	Very low reliability

Based on these criteria, it is possible to conclude that the reliability of the developed mathematics communication test instrument and mathematics learning achievement are in the high category. This demonstrates that the instrument is reliable and can be used to assess students' communication skills and mathematical learning achievement.

After the test instrument has been determined to be valid and reliable, it is used to collect data on a predetermined sample. After the data has been collected, it is processed. Data is processed using descriptive and inferential analysis. Data such as mean, median, and mode are described using descriptive analysis. The normal curve was used to categorize the results of the average data on mathematical communication skills and mathematics learning achievement (compared to the normal curve). Table 6 shows the ideal assessment categories.

Table 6. Assessment

Interval	***Description***
MI –3SDI ≤ X ≤ MI - 1,5 SDI	Very Low
MI - 1,5SDI < X ≤ MI - 0,5SDI	Low
MI - 0,5SDI < X ≤ MI + 0,5SDI	Medium
MI + 0,5SDI < X ≤ M + 1,5SDI	High
MI + 1,5SDI < X ≤ M + 3SDI	Very High

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Following the descriptive analysis of the data, the inference analysis was carried out using simple linear regression analysis. However, before testing the hypothesis with simple linear regression, a prerequisite test, namely the normality and linearity tests, is performed first.

Result and Discussion

The outcomes of data processing on mathematical communication skills and learning outcomes are presented in a descriptive and inferential professional way. Table 7 displays the average, mode, median, standard deviation, maximum value, and minimum value of mathematical communication skills based on descriptive data processing results.

Table 7. Description of mathematical communication ability data

Components	***Value***
Mean	74,04
Median	75
Mode	95
Std. Deviation	17,49
Minimum	41
Maximum	100,00

Based on the assessment categories in Table 6, the average mathematical communication ability of students is 74.04, placing them in the medium category. Table 8 also shows the averages and categories for each aspect of mathematical communication skills.

Table 8. Description of the data of mathematical communication skills

No.	***aspect***	***Average***	***Category***
1	Connecting objects, pictures and stories into mathematical ideas	78	High
2	Expressing mathematical ideas by writing or describe it in visual form	85	High
3	Using mathematical language in solving problems	72	Medium
4	Communicating logically, clearly, and sequentially arranged mathematics	69	Medium
5	Organizing and combining mathematical thoughts, ideas, or concepts in solving problems	63	Low

According to Table 8, Aspects of connecting objects, pictures, and stories into mathematical ideas are in the high category, implying that students can understand questions in the form of pictures on average. Students can deduce information from the image and deduce what is being asked from the image. The average aspect of expressing mathematical ideas in writing or visually describing them is in the high category. This means that students can comprehend the problem and present it in the form of images. The average aspect of using mathematical language in problem solving is in the medium range. This means that some students used mathematical symbols to solve problems, such as p for length, l for width, and so on. However,

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some students continue to avoid using mathematical symbols when solving problems. The average aspect of communicating mathematics is organized logically, clearly, and sequentially, which also falls under the moderate criteria. This means that some students can work through the questions sequentially and logically, beginning with knowing, being asked, solving, and drawing conclusions. However, some students have not written the answers in the correct order. Figure 1 shows examples of sequential and logical student work, while Figure 2 shows the results of student work where answers were not completely written down.

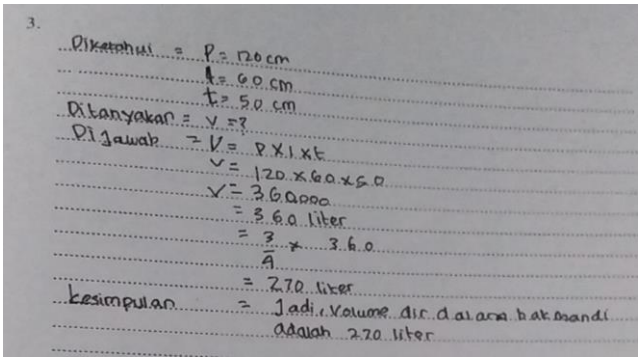

Figure 2. Results of student work done sequentially and completely

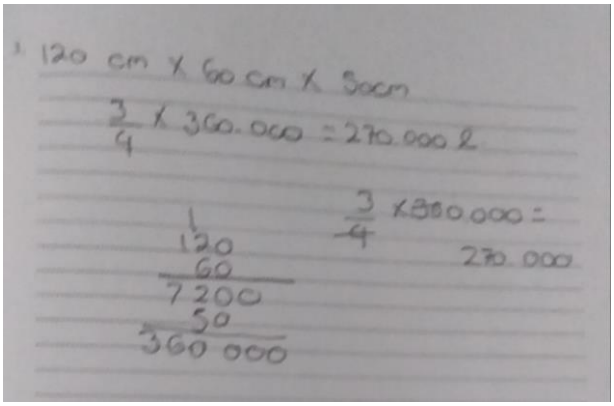

Figure 3. Results of student work done incompletely

Table 9 displays the descriptive results of data processing on mathematics learning achievement.

Table 9. Descriptive data on learning achievement

Components	***Components***
Mean	70,83
Median	75
Mode	62,50
Std. Deviation	20,98
Minimum score	37,50
Maximum value	100

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According to Table 9, the average student learning achievement in mathematics is 70.83. Table 6 shows that the average student learning achievement in mathematics is in the medium range. This means that some students are capable of resolving wake volume issues (cubes and blocks). However, some students continue to struggle with these questions, particularly those involving the combined volume of the geometric figures.

Table 10 also contains a recapitulation of the prerequisite tests, which are the normality and linearity tests.

Table 10. Results of normality and linearity test with SPSS

Test	Hail asymp. Sig.
Uji Normalitas	0,089
Uji Linearitas	0,147

Table 10 shows that the significance value for the normality test using the one-sample Kolmogorov-Smirnov test is 0.089, indicating that the normality prerequisites are met. The linearity test results using the test of linearity method show a value of 0.0147, indicating that the significance level is 0.05 and the linearity assumption is met.

Tables 11 and 12 show the output results of the SPSS simple linear regression test after the two assumptions are met.

Table 11. Summary model of the SPSS output

Model Summary[b]				
Model	***R***	***R Square***	***Adjusted R Square***	***Std. Error of the Estimate***
1	,806[a]	,650	,642	12,56105

Table 11 explains the magnitude of the correlation/relationship value of 0.806 as well as the magnitude of the presentation of the influence of the independent variable (communication) on the dependent variable (achievement) as the coefficient of determination (R2) of 0.650. This means that the independent variable has a 65% influence on the dependent variable, while the rest is influenced by other variables.

Table 12. The results of the coefficients from the output of SPSS

Coefficients[a]						
		Unstandardized Coefficients		***Standardized Coefficients***		
	Model	***B***	***Std. Error***	***Beta***	***t***	***Sig.***
1	(Constant)	-,764	8,231		-,059	,926
	Communication	,967	,108	,806	8,933	,000

a. Dependent Variable: Learning Achievement

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According to Table 12, the significance value of 0.00 is less than the significance value of 0.05. As a result, it is possible to conclude that the variable of mathematical communication ability (X) influences the variable of learning achievement (Y).

According to the table, the simple regression equation in this study is as follows:

$$Y=-0,764+0,967X$$

The equation denotes that mathematical communication (X) has a 0.967 effect on learning achievement (Y). This means that if the value of mathematical communication rises by one unit, learning achievement rises by 0.967; if it falls by one unit, learning achievement falls by 0.967.

The Pearson correlation test was also used to determine the degree of linear relationship between the variables of mathematical communication and learning achievement. Table 13 displays the SPSS output results.

Table 13. SPSS output results Pearsoncorrelation test

Correlations			
		Communication	Achievement
Communication	Pearson Correlation	1	,806**
	Sig. (2-tailed)		,000
	N	45	45
Achievement	Pearson Correlation	,806**	1
	Sig. (2-tailed)	,000	
	N	45	45
**. Correlation is significant at the 0.01 level (2-tailed).			

Based on Table 13, a significance value of 0.00 is obtained, implying that the variable of mathematical communication ability has an effect on the variable of learning achievement because a significance value of 0.00 is less than 0.05. Pearson correlation coefficient is 0.806. As a result, it is possible to conclude that mathematical communication skills and learning achievement are highly correlated.

Based on the findings of the research, it is possible to conclude that there is a significant relationship between the variables of mathematical communication skills and fifth-grade learning achievement at Gantung 08 and Gantung 10 Public Elementary Schools for the 2019/2020 academic year. This means that mathematical communication skills are crucial to learning achievement. Mathematical communication necessitates students' ability to master mathematical concepts, connect mathematical ideas into other forms such as oral, written, and picture, use mathematical language, communicate mathematics in a coherent, clear, and sequential manner, and combine mathematical ideas in solving problems in order to affect

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mathematics learning achievement.

There are two factors that influence learning achievement: internal factors and external factors (Sawawa et al, 2018; Zaiful et al., 2019; Asriyanti & Purwati, 2020). Physiological factors, such as health and body condition, are examples of internal factors. There are also psychological factors such as interests, talents, intelligence, emotions, fatigue, and learning methods. As a result, talent, which is a psychological factor in learning achievement, becomes a component of mathematical communication skills in the ability to solve mathematical problems, particularly numerical talent.

Several factors can influence student learning achievement in mathematics. According to the study Contribution of numerical talent, spatial intelligence, and mathematical logical intelligence to the mathematics learning achievement of State Elementary School students in Buleleng Regency by Jayantika et al (2013), numerical talent, spatial intelligence, and mathematical logical intelligence all contribute to learning achievement.

Numerical aptitude refers to students' ability to perform manual calculations such as addition, subtraction, multiplication, and division. Numerical aptitude is also a component of fundamental mathematical abilities and mathematical communication skills, both of which influence learning achievement. Furthermore, the study defines spatial intelligence as students' ability to recognize and describe objects received by the brain. This demonstrates that spatial intelligence is a component of mathematical communication skills because it is linked to students' ability to understand math problems presented in the form of pictures. As a result, spatial intelligence in mathematical communication skills is required in order to solve math problems that have an impact on learning achievement.

Logical intelligence refers to students' ability to analyze and deduce relationships from problems they encounter. Because solving math problems in stories or pictures requires analysis, logical intelligence is also part of students' mathematical communication skills. As a result, the logical intelligence found in mathematical communication skills has an impact on learning achievement.

The findings of this study support the findings of previous research that mathematical communication skills have a significant effect on students' mathematics achievement (Afiani, 2016; Riswandha & Sumardi, 2020; Sari et al, 2020). Teachers can gain a better understanding of students' abilities to interpret and express their understanding of the mathematical concepts and processes they are learning by assessing their mathematical communication skills. Margiana's (2015) research also demonstrates that basic mathematical abilities and students' criticality level abilities influence learning achievement. In order to solve math problems such as addition, subtraction, multiplication, and division, basic math skills are required.

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Furthermore, the higher a student's criticality level, the greater his or her basic mathematical ability. Mathematical communication also necessitates the use of fundamental mathematical skills such as addition, subtraction, multiplication, and division in order to solve math problems. This demonstrates that students' basic mathematical abilities, criticality level abilities, and mathematical communication abilities all have an impact on learning achievement.

Conclusion

Based on the findings and discussions, it is possible to conclude that mathematical communication skills have an impact on the learning achievement of fifth-grade students at Gantung 08 and Gantung 10 Public Elementary Schools. The obtained regression equation is Y = -0.764 + 0.967X, indicating that mathematical communication skills have a positive effect on students' mathematics learning achievement. The Pearson correlation results show a very strong correlation.

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