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ANALYSIS OF STUDENTS' MATHEMATICAL COMMUNICATION SKILLS ON THE MATERIAL OF TWO-VARIABLE LINEAR EQUATION SYSTEM WITH THE APPLICATION OF BRUNER THEORY

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ABSTRACT
The subjects of this qualitative descriptive research were class VIII students of SMP Negeri 4 Tarutung located in North Tapanuli Regency. The aim of this research is to determine and explain students' mathematical communication abilities when solving problems using Bruner's Theory. The data is in the form of written test results given to students to assess their mathematical communication skills in solving problems using Bruner's Theory. The results of the interview also consist of students' answers to verbal questions given to obtain additional information. Documentation data in the form of pictures and archives of test answers taken by class VIII students of SMP Negeri 4 Tarutung. Data collection methods include written tests, interviews, and documentation. Data analysis is carried out by reducing data, presenting and drawing conclusions. The results of the research show that students' mathematical communication skills when solving problems use Bruner's Theory 43% of students with high mathematical communication skills were able to solve questions correctly and well, while 36% of students with moderate abilities could only meet some indicators, and 21% of students with low abilities could not meet all the indicators.
Keywords: Mathematical Communication, Linear Equation System Two Variables, Bruner's Theory

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PRELIMINARY

In the 21st century, science is progressing rapidly, including mathematics education. According to the statement, mathematics is a field of science that is very influential in the progress of science and technology, and mathematics also makes a significant contribution to the progress of science and technology (Rahayu & Hidayati, 2018). Mathematics subjects are a tool for thinking, science and knowledge (Ahmatika, 2016). The system of linear equations in two variables (SPLDV) is one of the subjects in mathematics which presents simple problems according to existing situations related to everyday life (Achir et al., 2017). It is expected that every student can master the subject of

mathematics so that they can enjoy its usefulness. Students must have basic mathematical skills, such as mathematical communication skills, before they can master all aspects of mathematics (Kadarisma, 2018). According to Bruner (Anggia, 2015), learning mathematics means learning mathematical concepts and structures contained in the material being studied as well as the relationship between these concepts and structures.

This analysis confirms that Bruner's theory remains an effective approach to improve students' mathematical communication skills and strengthen their understanding of the material on systems of linear equations in two variables. Recent and previous research shows consistent positive trends, although there are implementation differences that may provide additional insights for further development.

Mathematical communication ability is very important and is considered a skill that must be present in every student, especially high school students. In addition, research related to mathematical communication (Dewi et al., 2021) found that mathematical communication skills are expected to help students gain a broader understanding of mathematics. Mathematical communication skills are also abilities that every student must have in learning (Yuniarti, 2014). Therefore, mathematical communication skills are essential to achieve mathematics learning objectives. Mathematical communication is the ability to express mathematical learning problems and ideas using mathematical symbols of objects, images, graphs, or tables. Mathematical communication skills are very important in learning activities because it will help students understand mathematics concepts better (Kusumah et al., 2020).

Indonesian students in particular, have poor mathematical communication skills, according to Imelda's research (2016). Compared to other Asian countries such as South Korea, Singapore, and Taiwan, which reached 50%, while Indonesia is only 5%, this shows that Indonesian students are less talented in mathematical communication. A similar situation occurs in Aceh, one of the provinces in Indonesia where junior high school students are still lacking in communicating mathematics. Silvianti & Bharata (2016) also found that mathematical communication is very important in learning activities. Ultimately, teachers should endeavour to improve students' mathematical communication skills. Learning activities should be designed so that students can construct their own knowledge, share their ideas with friends, teachers, and mathematical materials.

According to NCTM (National Council of Teachers of Mathematics) (2000), ‘Mathematical communication is a way for learners to share mathematical ideas that have been learned and clarified in understanding. Through communication, ideas become

objects of reflection, can be corrected, discussed, and changed'. When learners are challenged to communicate their thinking to others orally or in writing, they learn to explain, convince and use mathematical language appropriately. Communication in learning has a considerable influence so that students are expected to have good communication skills to achieve learning objectives (Anderha & Maskar, 2020).

Mathematical communication is a tool in the transmission of mathematical knowledge in building mathematical knowledge in mathematics learning. Meanwhile, Elida (2012) argues that mathematical communication is the ability to connect real objects, images and diagrams into mathematical ideas; explain mathematical ideas, situations and relationships orally and in writing in the form of pictures or graphs; explain and make statements about mathematics learned from given situations. Mathematical communication includes the ability of students to create and explain problems in the form of pictures, diagrams, graphs, words, or sentences, as well as table equations, and the ability to solve problems with good and correct language (Berliana & Sholihah, 2022).

According to Bruner's theory, learning activities are considered successful if they allow students to discover concepts independently. Learning based on this theory involves students in collecting and developing materials to solve problems, which improves their critical thinking ability and intellectual skills (Safrida et al., 2015). There are three stages in Bruner's theory of problem solving: 1) Information Stage, where students understand the given problem; 2) Transformation Stage, where students create and implement a problem-solving plan; and 3) Evaluation Stage, where students evaluate their answers (Nasution, 2017). Two abilities that must be achieved are mathematical communication and problem solving. Ariawan & Nufus (2017) stated that, although problem solving and mathematical communication skills are very important and need to be improved, they often have difficulty in doing so (Dina et al., 2019).

According to Murtiyasa & Wulandari (2020), errors in understanding the problem, determining the formula, and calculating are the most common errors. In addition, the results of observations before research in the field showed that mathematical communication skills were still low. The low level of mathematical communication skills in problem solving can be assessed from not achieving the indicators properly. This research will analyse students' ability in solving problems according to Bruner's Theory. The purpose of this study is to determine and explain the level of students' ability to use Bruner's Theory to solve problems.

METHODS

This descriptive research uses a qualitative approach. Riyanto (1996) defines descriptive research as research that is directed to provide symptoms, facts or events systematically and accurately, regarding the characteristics of certain populations or areas. The research subjects were 28 students of class VIII of SMP Negeri 4 Tarutung, North Tapanuli Regency. The data used consisted of test results and student interviews. Documentation data in the form of photos and archives of student test answers.

In this study, students were given tasks to solve problems that show students' mathematical communication skills. The results were analysed qualitatively to find out how good students' mathematical communication skills are in solving problems using Bruner's theory. Students were asked to solve problems related to SPLDV material and use the stages of problem solving based on Bruner's theory. Data collection methods included written tests, interviews, and documentation. Interview results consist of students' oral answers to questions related to mathematical communication skills in solving SPLDV problems based on Bruner's theory. Documentation data consisted of photographs and archives of students' answers from previous written tests.

Data analysis involved data reduction, data presentation, and conclusion drawing. The reduction stage was carried out by correcting and grouping the data according to the predetermined classification. According to Bruner's Theory, indicators of mathematical communication ability were used in the problem solving stage and the data presentation stage. The conclusion stage is done by analysing and explaining the results of the analysis related to the assessment indicators. Students should apply Bruner's Theory in problem solving to assess their mathematical communication skills. Students use the following indicators to solve mathematical problems, they are able to explain mathematical problems by using their own language, able to explain mathematical problems by using pictures or graphs, and also able to explain mathematical problems by using mathematical symbols or notations. All of these are applied to the three stages of problem solving according to Bruner's theory.

RESULT AND DISCUSSION

Mathematical communication ability in solving problems using Bruner's theory is measured through written answer data from the test. If students can solve the problem at each stage of problem solving according to Bruner's Theory, they will get the best score. This is one of the three contextual problems given to students: ‘Lia is 7 years older than

Irvan, while the sum of their ages is 43. How old are each of them?' Table 1 shows data on students' mathematical communication skills in solving problems based on Bruner's Theory.

Table 1. Test Result Data

Interval	Communication Skills	Number of Students	Percentage
$x \geq 30$	High	12	43%
$20 \leq x > 25$	Medium	10	10%
$x < 20$	Low	6	6%
	Total	28	100%

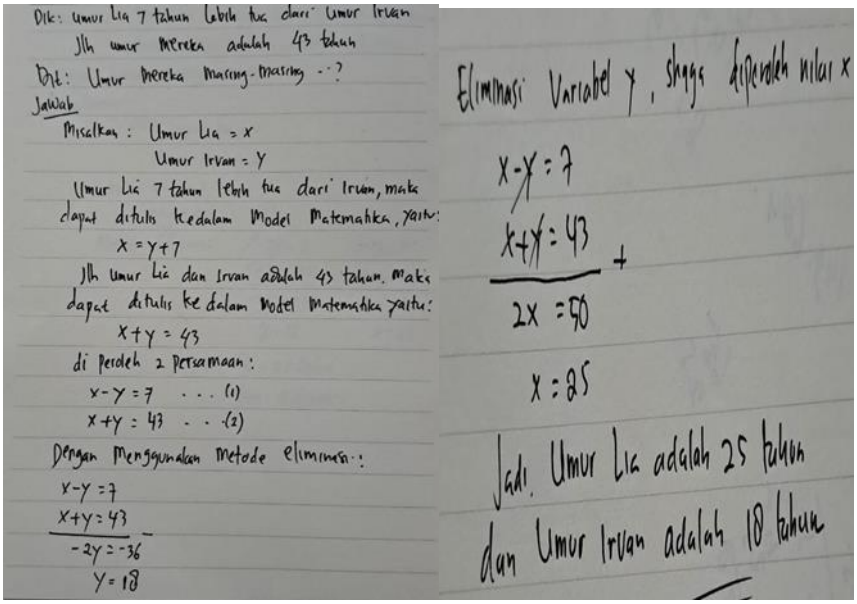
Table 1 shows that 43% of students have good mathematical communication skills, 36% have moderate skills, and 21% have low skills. Table 2 shows the measure of mathematical communication ability in solving problems using Bruner's Theory.

Table 2. Data on the Assessment of Mathematical Communication Indicators with the Application of Bruner's Theory.

Category	Mathematical Communication with Stages of Bruner's Theory			Percentage
	Information stage (own language)	Transformation stage (Symbol/Notation)	Evaluation Stage (Image/graphic)	
High	15	22	18	65,5%
Medium	10	4	7	25%
Low	3	2	3	9,5%

Table 2 shows that 65.5% of students have high mathematical communication skills, meaning they can solve mathematical problems using language, symbols, notations, and pictures or graphs well. While 25% of students have moderate mathematical communication skills, and 9.5% have low mathematical communication skills.

The following is a description of the work of students with high, medium and low mathematical communication skills.



English Version

It is known: Lia is 7 years older than Irvan
Their total age is 43 years
asked: how old are they?
Answer: Suppose Lia's age = x
Ivan's age = y
Lia's age is 7 years older than Irvan so it can be written into a mathematical model, namely;
x = y + 7
The total age of Lia and Irvan is 43 years, so it can be written into a mathematical model, namely;
x + y = 43
2 equations are obtained:
x - y = 7 ... (1)
x + y = 43 ... (2)
By using the elimination method: $\begin{matrix} x-y=7 \\ x+y=43 \\ \hline -2y=-36 \\ y=18 \end{matrix}$
eliminate the y variable, so that the x value is obtained: $\begin{matrix} x-y=7 \\ x+y=43 \\ \hline 2x=50 \\ x=25 \end{matrix}$
So, Lia's age is 25 years and Ivan's age is 18 years

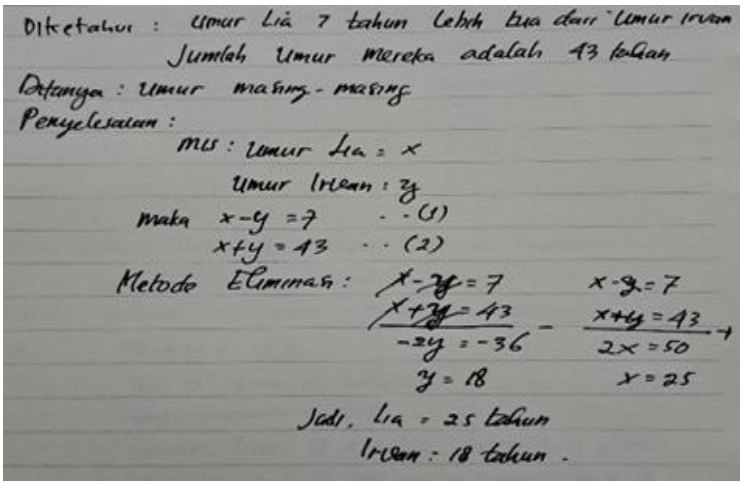
Figure 1. High Category Student Answers

As shown in Figure 1, students who have high mathematical communication skills can write down information and formalise it in their own language, then students can convert known information into mathematical notation or symbols and solve it well. then students can evaluate the answer correctly. Students who have high mathematical communication skills are able to solve problems coherently and correctly at each stage. The results of the interview allowed students to explain in their own language the information they obtained as well as the permissiveness. They could also explain how they transformed the information into mathematical notation and solved the problem correctly.

The interview results showed that students were able to explain the process of solving a system of linear equations in two variables using various representations in accordance with Bruner's theory. There is a strong correspondence between the results of students'

answers on written tests and interviews, indicating that they not only understand the concepts but can also communicate their understanding effectively in oral and written form.

The answers of students with moderate level of mathematical communication ability are presented in Figure 2 below:



English Version

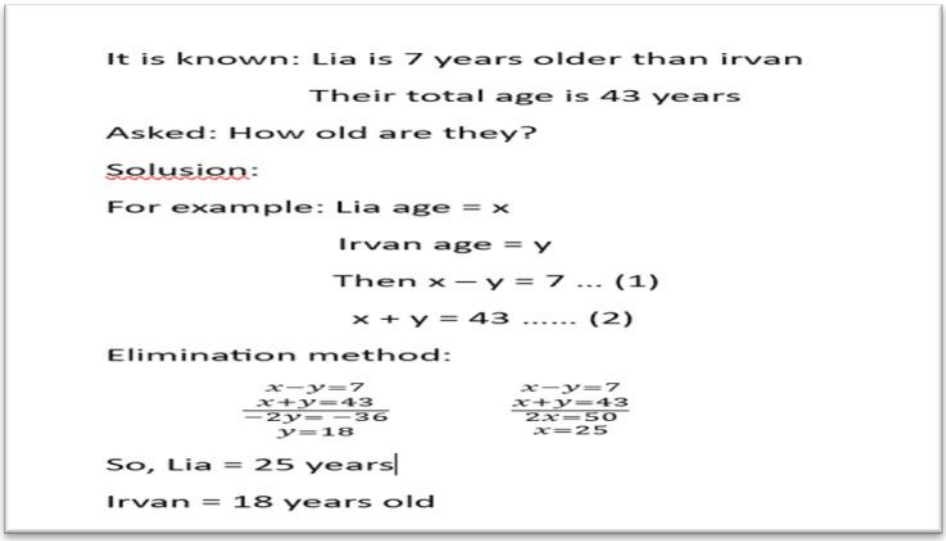
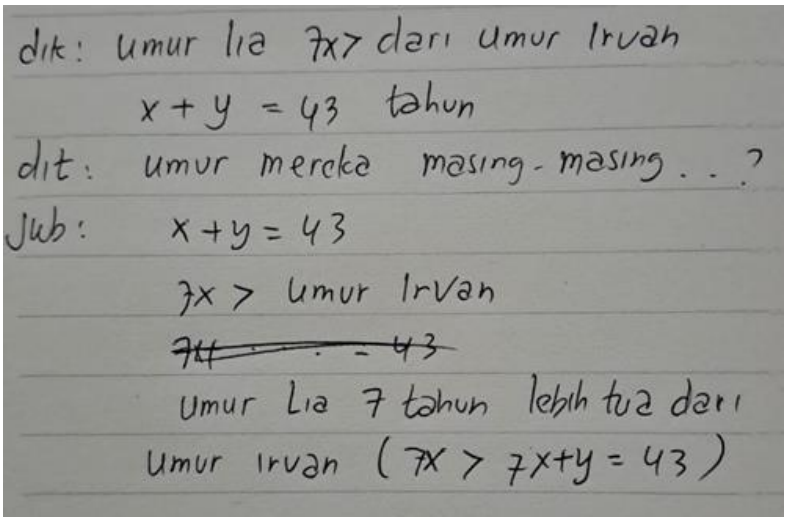


Figure 2. Medium Category Students' Answers

Figure 2 shows that students have moderate mathematical communication skills, and they can only write down some information in their own language. Furthermore, students are able to transform the information they already know into mathematical notation or symbols and solve it well. Last but not least, students have not been able to evaluate to check their answers. Students are categorised as having moderate ability if they can solve the problem coherently, although not perfectly. The results of the interview showed that students faced little difficulty in explaining the information they knew from the problem in their own language, as well as the utilisation. Furthermore, students were able to explain the steps of

the solution using mathematical notation quite well, but they still had difficulties when assessing their answers.

The answers of students with low levels of mathematical communication skills are presented in Figure 3 below:



English Version

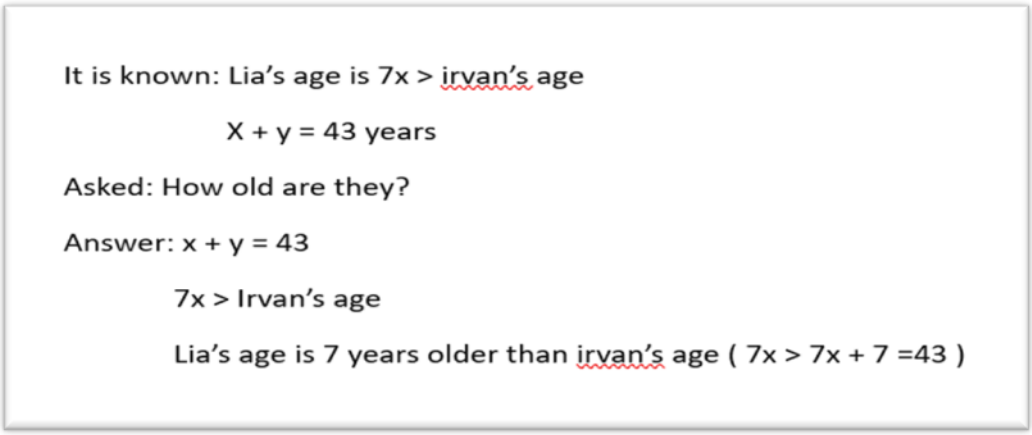


Figure 3. Low Category Student Answers

Figure 3 shows that students who have limitations in mathematical communication cannot write the information from the problem using their own language. Instead, they wrote the information in the form of inappropriate notation or mathematical symbols, and finally, students failed to evaluate the answers they had received. They also failed to solve the problem properly, which means they do not have good mathematical communication skills. The interview results show that students who have low mathematical communication skills are unable to explain information in their own language and have not been able to make calculations. In addition, students were not able to explain the

procedures used to evaluate the answers they had received, as well as the procedures used to transform the information they had received into mathematical notation.

The results of this study are also in line with the research of Marniati et al. (2021), students can explain real situations or circumstances in their own language; they can explain and describe mathematical concepts in the form of pictures and graphs; and they can solve problems using mathematical notation or symbols. According to Lisa, et al (2023), students are expected to be able to express a daily life problem related to mathematics in the form of mathematical language or sentences. Students are said to be able to understand what is known, asked and can explain the steps of the solution process using mathematical language or symbols.

CONCLUSION

The study found that 43% of students had high mathematical communication skills, able to solve problems by writing information using their own language, converting known information into mathematical notation or symbols, using pictures, graphs, and coherence to evaluate answers. Then 36% of students are considered to have moderate mathematical communication skills, where they can only fulfil some of the assessment indicators, while 21% of students with low mathematical abilities still fail to fulfil the assessment indicators. And from the table of Mathematical Communication Indicator Assessment Data with the Application of Bruner's Theory shows that 65.5% of students have high mathematical communication skills, meaning they can solve mathematical problems using language, symbols, notations, and pictures or graphs well. While 25% of students have moderate mathematical communication skills, and 9.5% have low mathematical communication skills.

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