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# Analysis of Mathematics Communication Capabilities in Linear Program Problem Solving during the Covid-19 Pandemic

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**ABSTRACT**

This study aims to analyze students' mathematical communication skills orally and in writing in solving linear programming problems during the COVID-19 pandemic. This research uses descriptive qualitative research. The subjects of this study research are two students of class XI MIPA at MAN Ponorogo. Determination of the subject using purposive sampling based on problem-solving tests and interviews. Subject criteria are students who answer most completely and correctly. The research instrument is in the form of problem-solving test questions and interview guidelines. The result of this study is that during the COVID-19 pandemic, learning is carried out online. Students' mathematical communication skills in solving linear programming problems in online learning during the COVID-19 pandemic include being able to express mathematical ideas orally or in writing, being able to compile mathematical models orally or in writing, and being able to write and explain the process of solving mathematical problems verbally or in writing.



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## 1. INTRODUCTION

The last two years have been called the COVID-19 pandemic. The COVID-19 pandemic has caused all fields to experience the impact of changes caused by the Corona Virus Disease, which is contagious, malignant, and deadly. The most prominent impact of change is in education, precisely in the learning process. The learning process originally carried out face-to-face has become a distance learning system (online) (Astawa & Utami, 2020). Based on data from UNICEF, there are 1.5 billion students experiencing obstacles in the online learning process during the COVID-19 pandemic (Prawanti & Sumarni, 2020). Online learning is done through google meet, google classroom, zoom, and WhatsApp.

Online learning causes students to be able to adapt to have mathematical communication skills. Communication skills in learning occur in delivering ideas to solve problems both orally and in writing (Pratiwi, 2015). According to Andriani (2020) and (Son, 2015), mathematical communication skills are very important for students because they are a tool for conveying information both orally and in writing. According to Qohar & Sumarmo (2013), mathematical communication skills are the basis or foundation of learning mathematics. According to NCTM (2000), Mardhiyanti (2013), and Ismayanti & Sofyan (2021), mathematical communication skills are students' skills in solving problems by connecting tables, graphs, conveying mathematical ideas, using symbols, and being able to provide solutions to mathematical problems. Mathematical communication skills are abilities students possess in conveying ideas orally or in writing (Maharani & Ramlah, 2021). Oral communication in question is students' activeness in explaining ideas about the concept of the material they receive. Written communication in question is the ability of students to write symbols and pictures that connect the problem with solving the problem.

Mathematical communication skills become a link in developing mathematical knowledge (Muktiranda, 2020). Based on the conditions in the field, students are still low in mathematical communication skills. This is reinforced by the research of Sriwahyuni (2019), Nurlaili (2020) and Ismayanti & Sofyan (2021), which states that students' communication skills are still low. Students' low mathematical communication skills occur because they only focus on mathematical calculations, and they lack mastery of the concepts of the material they receive. These students' low mathematical communication skills can be seen in the TIMSS (Trend In International Mathematics and Science Study) test, which compares Indonesian oral and written mathematical communication with other countries (Hadi & Novaliyosi, 2019). From the TIMSS test data, Indonesia was ranked 32 out of 38 countries in the mathematical communication competition (Hadi & Novaliyosi, 2019). From the data of the PISA test results, Indonesia was ranked 376 in 2015 and in 2018, there was a decrease to 386. The research results were obtained directly (face to face) with students. There has been no online research on mathematical communication skills, so this research is important to determine students' mathematical communication skills in solving linear programming problems.

Mathematical communication skills require mathematical problem-solving. Problem-solving is one of the methods used in solving problems so that students can communicate well (Siahaan, 2020). According to Fitriani (2021), Awi (2021), Sopian & Afriansyah (2017), problem-solving is a strategy or way of solving a mathematical problem in everyday life. Problem-solving is answering problems with no known solution (Pohan & Siregar, 2021). Problem-solving is not only focused on solving the problem but the process of solving the problem from the given problem (Nuraisa et al., 2019).

The learning process is carried out during the COVID-19 pandemic online via WhatsApp, google meet, zoom, and google form. Students' mathematical communication skills during this pandemic are still weak. This happens because students only focus on calculations and lack mastery of the material they receive. Many students have not reached the KKM score in the linear program material and have problems translating the problem into a mathematical model. So it is necessary to study more deeply about analysis of mathematical communication ability in solving linear program problems during the COVID-19 pandemic.

## 2. METHOD

This research is a qualitative descriptive study that aims to obtain data on students' mathematical communication skills from problem-solving tests and interviews. The subjects of this study were two students. Research subjects were selected based on the criteria of students who answered most completely and correctly. The data collection techniques used in this study were problem-solving test methods and interview guidelines. The instruments in this study were problem-solving test questions and interview guidelines. The data analysis technique used in this study is data reduction by summarizing, summarizing, grouping data according to the pattern, and providing codes for interview results so that it is easy to trace the data.

## 3. FINDINGS AND DISCUSSION

This research procedure was carried out in three stages: the preparation, implementation, and report preparation stages. In the preparation stage, the researcher conducted initial observations, compiled instruments in the form of test and interview questions, and conducted test questions. At the implementation stage, the researcher collects test and interview data, determines the subject, and analyzes the results of the answers and interviews. At the stage of preparing the report, the researcher prepares a report on the study results.

### *Mathematical Communication Ability Subject 1*

1. Able to Express Mathematical Ideas or Ideas Orally and in Writing

Subject 1 rewrote important information known and asked from the problems given. Here's a picture regarding this:

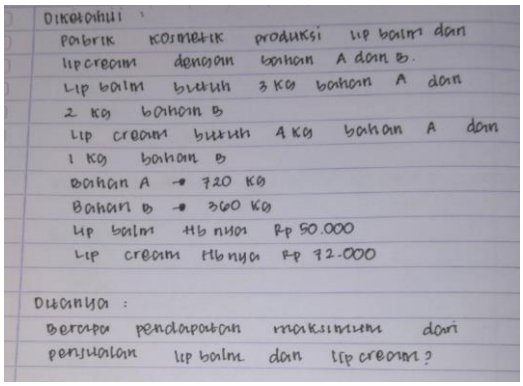


Figure 1 Express Mathematical Ideas

The picture shows that subject 1 understands mathematical problems by writing what is known and asked. In this case, they are able to express mathematical ideas or ideas in writing. At the time of the interview, subject 1 explained important information to be known and asked the questions so that they were able to express mathematical ideas orally. This shows that subject 1 meets indicator 1, namely being able to express mathematical ideas orally or in writing.

2. Able to Arrange Mathematical Models Oral and Written

Subject 1 compiled a mathematical model by writing tables and mathematical linear inequalities using mathematical symbols. Here's a picture regarding this:

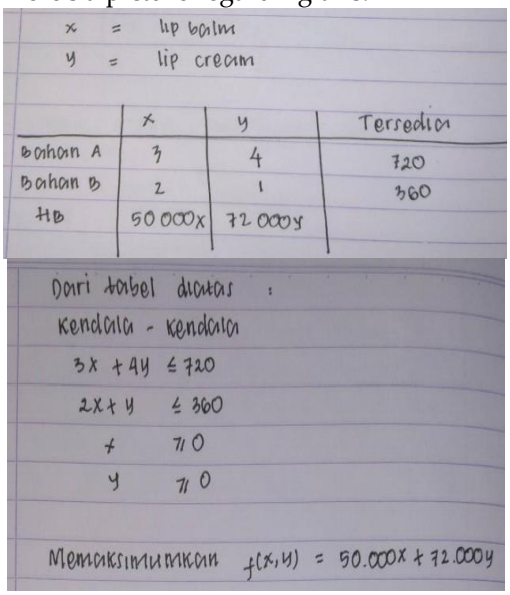


Figure 2 Arrange Mathematical Models

The figure shows that subject 1 plans the solution of the given problem by compiling a mathematical model. Subject 1 compiled a mathematical model using mathematical symbols in the form of signs x, y, , , =, so that, in this case, subject 1 was able to compose a written mathematical model. During the interview, subject 1 explained the preparation of the mathematical model according to what was written in detail and used mathematical language. In this case, subject 1 was able to compose a mathematical model orally. This shows that subject 1 fulfils indicator 2, namely compiling a mathematical model orally or in writing.

3. Able to write and explain the process of solving mathematical problems orally and in writing

Subject 1 wrote down the process of solving the given problem by describing the settlement area, writing elimination to find the value of x, and substitution to find the value of y from one of the points of intersection of the lines on the graph, writing down the corner point test to get results that match the problem in question. Here's a picture regarding this:

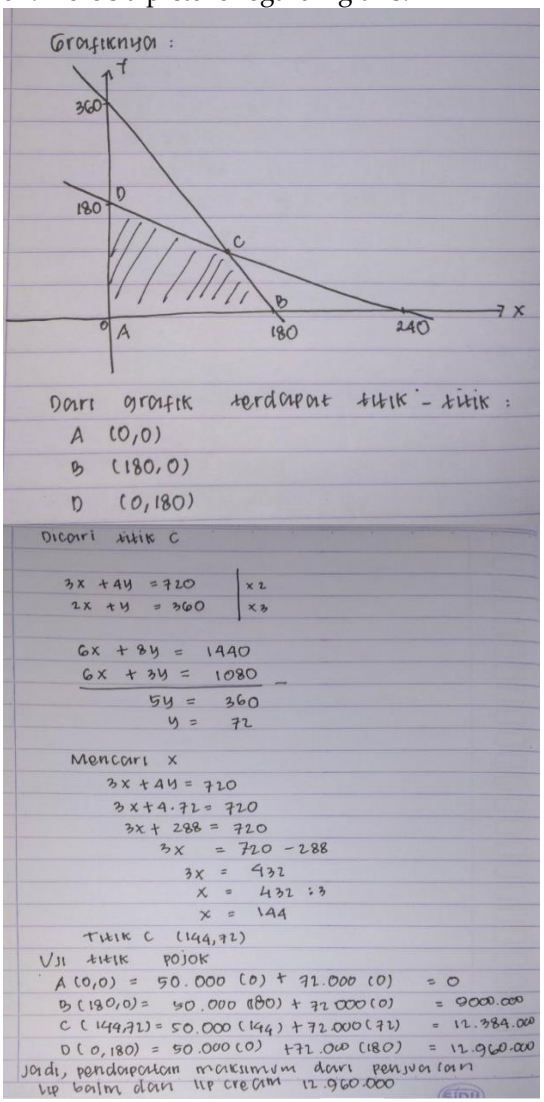


Figure 3 Process of Solving Mathematical Problems

The picture shows that subject 1 solves mathematical problems according to the previous plan so in this case, they can write down the process of solving mathematical problems in writing. Subject 1 corrected the answer again by providing a conclusion. At the interview subject 1 explained in detail using mathematical language. Subject 1 corrected the results of his answers by explaining the conclusions obtained from the final results of his answers. Subject 1 was able to explain the process of solving mathematical problems orally. Based on this, subject 1 was able to fulfil the third indicator,

namely being able to write and explain the process of solving mathematical problems orally and in writing.

***Mathematical Communication Ability Subject 2***

1. Able to Express Mathematical Ideas or Ideas Orally and in Writing

Subject 2 did not rewrite important information from the given problem, which was known and asked, so subject two did not express mathematical ideas or ideas in writing. During the interview subject 2 explained mathematical ideas or ideas orally, so that subject 2 was able to express mathematical ideas or ideas orally. This shows that subject 2 fulfils indicator 1, which is expressing mathematical ideas orally.

2. Compiling a Mathematical Model Oral and Written

Subject 2 compiled a mathematical model in the form of algebraic equations (two equations) using mathematical symbols. Here's a picture regarding this:

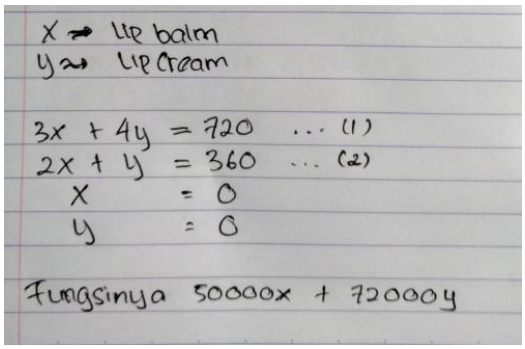


Figure 4 Compiling Mathematical Model

The picture shows subject 2 planning the solution of a mathematical problem in the form of algebraic equations (two equations) using mathematical symbols in the form of an = sign, so that the subject is able to compose a written mathematical model. At the time of the interview, subject 2 explained in detail in compiling a mathematical model using mathematical language according to what was written to be able to compose a mathematical model orally. Based on this, subject 2 is able to fulfil indicator 2, namely being able to compose a mathematical model orally or in writing.

3. Writing and Explaining the Process of Solving Mathematical Problems Orally and in Writing

Subject 2 completed the form of algebraic equations obtained by writing coherently to get the results that were asked in the mathematical problem. Subject 2 solves mathematical problems by describing the graph of the settlement area, looking for the values of x and y at the intersection of the lines, testing points and correcting them again by giving conclusions on the answers as asked. Here's a picture regarding this:

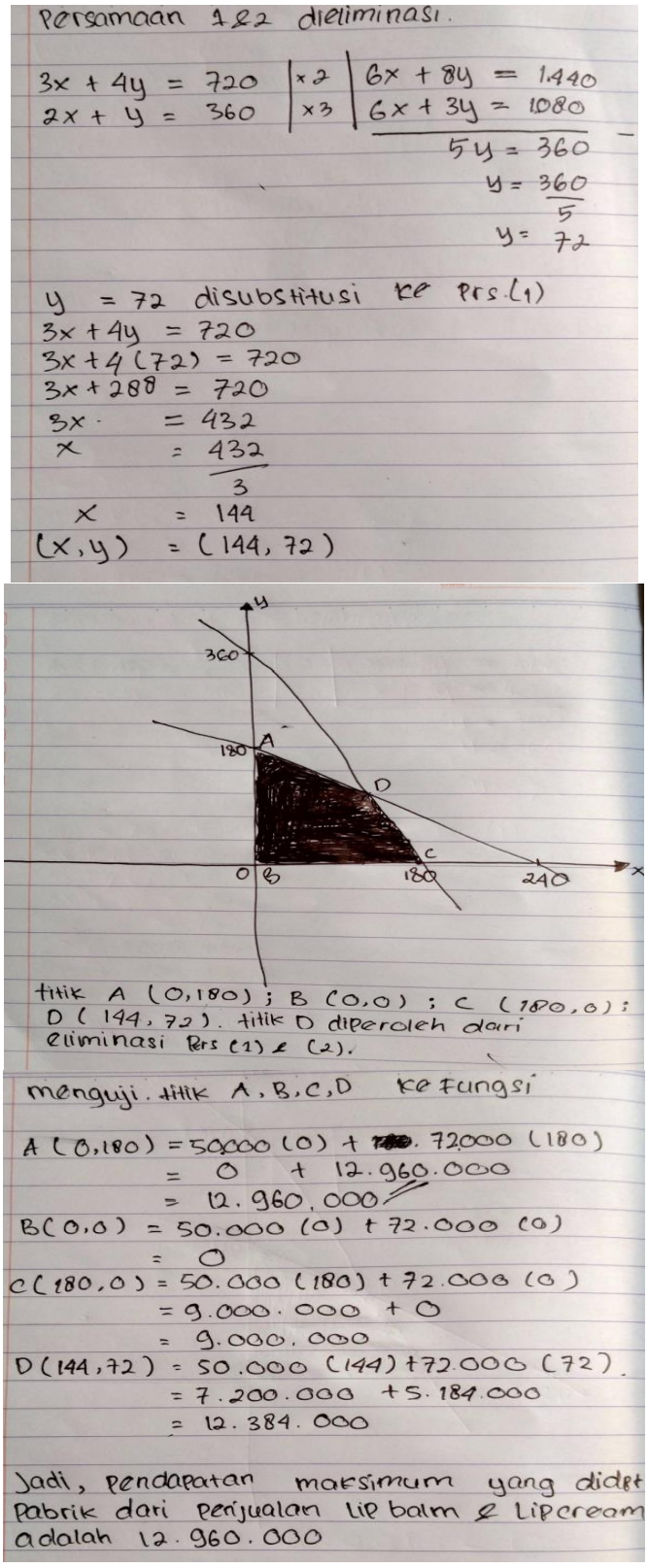


Figure 5 Process of Solving Mathematical Problem

The picture shows that subject 2 is able to write down the process of solving mathematical problems in writing. Subject 2 re-corrected the results of the answer by providing a conclusion. During the interview, subject 2 explained in detail what was written so subject 2 could explain the process of

solving mathematical problems orally. This shows that subject 2 meets indicator 3, namely being able to write and explain the process of solving mathematical problems orally and in writing.

***Expressing Mathematical Ideas or Ideas Orally or in Writing***

Subject 1 in writing is able to express mathematical ideas or ideas by writing what is known and asking about the problem well. Subject 1 can make an example with variables (x and y) from the information known and asked. Subject 1 is able to verbally express mathematical ideas or ideas by explaining using known and asked mathematical language from the questions, so that subject 1 can fulfil the indicators of expressing mathematical ideas or ideas orally or in writing.

Subject 2 did not write down important things to know and ask about the problem, so subject 2 did not express mathematical ideas or ideas in writing. Subject 2 orally explained what was known and asked by reading the questions so that they fulfilled the indicators of expressing mathematical ideas orally. In this case, subject 2 meets verbal and mathematical communication skills indicators.

***Compiling a Mathematical Model Orally and in Writing***

Subject 1 in writing is able to compose a mathematical model by writing tables and mathematical linear inequalities. Subject 1 can use mathematical symbols well by writing symbols in the form of signs x, y, , , and =. Subject 1 was orally able to compose a mathematical model by explaining in detail using mathematical symbols using mathematical language, so that Subject 1 was able to fulfil the indicators of compiling a mathematical model orally and in writing.

Subject 2 in writing is able to compile a mathematical model. Subject 2 wrote down the mathematical model in the form of a mathematical linear equation. Subject 2 can write mathematical symbols in the form of signs x, y, =, so that in this case subject 2 is able to compose a written mathematical model. Subject 2 can explain the mathematical model obtained from the questions according to what is written, so that in this case subject 2 is able to compose a mathematical model orally.

***Writing and Explaining the Process of Solving Mathematical Problems Orally and in Writing***

Subject 1 in writing was able to solve mathematical problems. Subject 1 solves the problem by writing coherent steps. Subject 1 wrote down the mathematical model obtained from the mathematical problem to be made in the form of a graph. Subject 1 describes the graph obtained from the compiled mathematical model and provides shading in the solution area. Subject 1 wrote elimination and substitution to find one of the undiscovered points in the graph. Subject 1 wrote down the process of substituting the points that had been obtained to test these points, namely, at which point the solution to the problem was obtained, so that in this case subject 1 was able to write down the process of solving mathematical problems in writing. Subject 1 was able to solve mathematical problems verbally by explaining the coherent steps according to what was written on the answer sheet, so subject 1 could explain the process of solving mathematical problems orally. This case shows that subject 1 can fulfil the indicators of writing and explain the process of solving mathematical problems orally and in writing.

Subject 2 in writing is able to solve mathematical problems coherently. Subject 2 wrote different steps from subject 1. Subject 2 wrote down the mathematical model in the form of algebraic equations (two equations). Subject 2 eliminates two equations to find the y value of one of the variables that have not been found. Then subject 2 substitutes the value of the variable found from elimination to get the value of the variable x . Subject 2 describes the graph obtained from the mathematical model and places the pair of points that have been obtained from the elimination of substitution into the graph and provides a shaded area for the solution. Subject 2 wrote down the process of substituting the points that had been obtained with the intention of testing these points, namely, at which point the solution to the problem was obtained. Subject 2 orally solves mathematical problems by explaining coherent

steps according to what is written on the answer sheet, so in this case, subject 2 fulfils the indicators of writing and explains the process of mathematical problems orally and in writing.

The results showed that subject 1 was able to fulfil all indicators, namely the indicator of being able to express mathematical ideas orally or in writing, being able to compile mathematical models orally and in writing, and being able to write and explain the process of solving mathematical problems orally and in writing. Subject 1 in this study was the student who answered most completely and correctly, so in this case, subject 1 was a student who had high mathematical communication skills. Research conducted by Ikhsan, F., Pramudya, I., & Subanti (2020) stated that students with high mathematical communication skills meet three aspects, namely aspects of writing, drawing, and expressing completion. The findings of this study are in agreement with the NCTM theory (2000), which states that students expressing mathematical communication skills orally and in writing, compile mathematical models orally and in writing, and write and explaining the process of solving mathematical problems orally and in writing are students who have the ability to high mathematical communication. The findings of this study are in accordance with the research findings of Dafik and Hobri (2015), which state that students who have high mathematical communication skills can meet three indicators, namely writing symbols and mathematical formulas in solving problems, presenting pictures, or mathematical models, and writing steps. -steps and reasons for each answer. This study also agree with the results of Anderha & Maskar's (2020) research, which states that the level of mathematical communication skills possessed by high school students is quite good and belongs to the medium to very high category.

The results of this study contradict the results of research by D. Kurniawan (2017) which states that students' mathematical communication skills in solving story questions in the form of story questions are still relatively low with indicators of writing important information obtained from mathematical problems, connecting tables or pictures in the form of mathematical models, write, and explain mathematical problems in story problems. The results of this study are by the results of Widyanti's research (2020), which states that the steps that can be taken by students in solving mathematical problems in the form of mathematical communication skills questions are writing mathematical notations that are known and asked in mathematical problems, linking known information and asking questions to students. Mathematical problems to solve problems in accordance with what was asked, develop mathematical models, and write and explain solutions to solving mathematical problems. The study results of the two subjects had almost the same mathematical communication skills. It's just that subject two does not express mathematical ideas or ideas in writing, although basically, subject 2 is able to express mathematical ideas or ideas orally, and is able to compile mathematical models orally and in writing, and is able to write and explain the process of solving mathematical problems orally or in writing.

Based on the research results, the two subjects showed that online learning during the COVID-19 pandemic hampered mathematical communication skills. This is in accordance with the results of Sari's research (2021) that online learning during the COVID-19 pandemic has a less than the optimal impact on students because teachers are disturbed in the learning process, so the material delivered is incomplete and cannot run optimally. This is reinforced by the results of research (Sadikin & Hamidah, 2020) that the lack of signals in remote areas and the high price of quotas impact the inhibition of the mathematics learning process to communicate mathematical problems well. The results of Matura & Santaria's (2020) research state that online learning has a major constraint factor, namely the lack of adequate facilities from teachers and students, so that the quality of learning is less than optimal and students' mathematical communication skills have not developed optimally.

## CONCLUSION

The results based on research and discussion can be opened that the ability of the mathematical community possessed by students is like finding problems that are found. Students are able to demonstrate mathematical communication skills in solving linear programming problems. This can be seen from the written tests and interviews of subject 1 and subject 2. Subjects 1 and 2 have good

mathematical communication skills, but subject 2 cannot express mathematical ideas or ideas in writing. Based on the data obtained, indicators of mathematical communication ability (1) express mathematical ideas or ideas in writing or verbally, (2) develop mathematical models orally and in writing, (3) write and explain the process of solving mathematical problems orally and in writing. From the results of these studies, it can be concluded that students' mathematical communication skills in solving problems on linear programming material are quite good.

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