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ANALYSIS OF STUDENTS' MATHEMATICAL COMMUNICATION SKILLS BASED ON VERBAL-LINGUISTIC INTELLIGENCE IN SOLVING LINEAR PROGRAM PROBLEMS

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ABSTRACT

Students' ability to communicate, especially in learning mathematics, is still relatively low. Communication skills, especially in solving story problems, are more or less influenced by the intelligence of each student, one of which is verbal linguistic intelligence. This research is a qualitative research with a phenomenological approach. The subjects in this study were grade XI students at Bina Dharma 2 Bandung High School in the 2022/2023 school year totaling 22 students. The sampling technique used Purposefully select. The results showed that students with high linguistic verbal intelligence level were able to answer 5 indicators of mathematical communication ability, students with medium linguistic verbal intelligence level were able to answer 3 indicators of mathematical communication ability, and students with low linguistic verbal intelligence level were able to answer 1-2 indicators of mathematical communication ability.

KEYWORDS *Communication Ability, Mathematical Communication Ability, Verbal Linguistic Intelligence*

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INTRODUCTION

One of the activities that accompany everyday life is communication. Everyone has the ability to express their thoughts and opinions, interact socially, and do many other things through communication, including learning. In the field of education, communication plays various roles, especially in learning mathematics. To learn mathematics, students must be able to define and express concepts in tables, figures, graphs, variables, and symbols, and convey their ideas orally and in writing (NCTM, 2000). (Nofrianto, A, 2017). Therefore, it can be said that communication

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plays an important role in learning mathematics. According to (Umar, 2012), there are two main reasons why communication needs to be the main emphasis of mathematics education. Mathematics as a language: Mathematics is a valuable tool for expressing ideas accurately, concisely, and clearly. It is not simply a tool for solving problems, thinking, or finding patterns. Mathematics learning is a social activity that involves interaction between teachers and students, such as student-student or teacher-student communication.

Especially in mathematics learning, students' communication skills are still relatively inadequate. (Andini and Marlina, 2021). Research findings (Wahyuni, Amelia, and Maya, 2019) which show that students' mathematical communication skills are still in the low range, further strengthen this. This is because there are still many students who have difficulty understanding and interpreting mathematical terminology into their native language, and become confused when the problem is given contextually. (Tong, Uyen and Quoc, 2021). Introducing students to methods of addressing contextual problems in a methodical, unambiguous and unhurried manner can ensure that nothing is missed and is one technique to improve their mathematical communication skills. Situational and highly relevant questions found in the mathematics literature include questions related to linear programming.

According to research (Nurfaizi and Ismail, 2021), students understand linear programs through the use of appropriate mathematical language, explanation of mathematical steps used to solve problems, and drawing the reasons used to solve problems, including the relationship between the numbers used. The findings of this study indicate that having mathematical communication skills allows students to understand the mathematical information learned.

The ability to communicate, especially when facing narrative challenges, is largely determined by students' intelligence, one of which is their verbal-linguistic intelligence. (Septyaningsih, 2018). Linguistic verbal intelligence refers to a person's ability to successfully use words, both orally and in writing. Linguistic verbal intelligence refers to a student's ability to utilize language clearly when reading, writing, listening, and speaking. According to (Widiastuti, 2012), indications of linguistic verbal intelligence include: 1) understanding the order and meaning of words; 2) the ability to remember and memorize information that has been read before; and 3) vocabulary proficiency.

According to the findings (Septyaningsih, 2018), linguistic verbal intelligence has a good and significant influence on the ability to solve story problems simultaneously. In addition, previous research (Aristyawati, 2015) on the effect of linguistic verbal intelligence on the ability to solve narrative problems showed that there was a positive relationship between linguistic verbal intelligence and the ability to solve story problems. Some of these studies only look at the correlation, the level of achievement of indicators, and the simultaneous effect. As a result, it can be concluded that there is a relationship between verbal language intelligence and mathematical communication skills, both oral and written.

Based on the explanation above, the author is interested in conducting a research entitled "Mathematical Communication Ability of Students Based on Linguistic Verbal Intelligence in Solving Linear Program Problems". This study aims

to examine students' mathematical communication skills based on linguistic verbal intelligence in solving linear program problems.

RESEARCH METHOD

This qualitative research is qualitative research with a phenomenological approach. According to The Oxford English Dictionary, what is meant by phenomenology is (a) the science of phenomena as distinct from being (ontology), and (b) division of any science which describes and classifies its phenomena. Thus, phenomenology is the science of phenomena that distinguishes it from something that already exists, a discipline that describes and categorizes phenomena, or the study of phenomena. In other words, phenomenology analyzes the phenomena that appear or occur before us, including how they arise. (Kuswarno, 2009)

The data in this study were examined using the stages described by (Bungin, 2001) which include data collection, data reduction, and conclusion drawing. Data collection began by selecting people who have verbal linguistic intelligence and logical mathematical intelligence, then giving them test questions and conducting interviews. Data reduction is the process of selecting or summarizing the rough field data collected during simplification.

The subjects in this study were aimed at class XI students at one of the equivalent high schools in Bandung City in the 2022/2023 academic year, totaling 22 students. The sampling technique in this study uses Purposefully select, where the researcher chooses deliberately and fully planning the participants to be studied. Considerations made by researchers in conducting research are students who have high, medium and low linguistic verbal intelligence.

Researchers conducted a multiple intelligences test which was limited to linguistic verbal intelligence only. The intelligence test given is an intelligence test in the form of a multiple intelligences questionnaire.

Table 1. Linguistic verbal intelligence questionnaire

No.	Statement Item	Response				
		1	2	3	4	5
1	I find it easy to create stories both oral and spoken					
2	I find pleasure in reading					
3	I enjoy games like charades					
4	I like constructing sentences more than calculations					
5	I find it easy to remember quoted words or phrases					
6	I generally like games that involve words such as *scrabble*, anagrami (putting together words with scrambled letters), or passwords.					

7	I can learn more by listening to the radio or wordy tapes than watching television or movies.	
8	For me, English, social studies, and history at school are easier than math and science.	
9	For me, learning a foreign language or reading it (e.g. English, French, German) is relatively easy.	
10	I often refer to things I have heard or read during conversations.	

Scale Description:
1 = Strongly Disagree
2 = Disagree
3 = Undecided
4 = Agree
5 = Strongly Agree

The linguistic Verbal Intelligence test scores were then divided into three intelligence level groups: low, medium and high.

Table 2. Verbal Linguistic Intelligence Level

Level	**Score**
Low	questionnaire score < 30.35
Medium	30.35 ≤ questionnaire score < 37.57
High	Questionnaire score ≥ 37.57

At the next level, students answer questions about linear programming subjects after which they proceed to the interview. The data from the test results of the essay questions given to students are used to identify and explain their mathematical communication skills, while the interview data serves as complementary data to validate the results of student work on the essay writing test.

Table 3. Indicator of Mathematical Communication Ability

Write	Oral
Able to write known and questionable information clearly and in detail on linear program problems	Able to explain the meaning of the given linear program problem using own language
Able to determine the strategy or steps to be used in solving liear program problems clearly	Able to explain the strategy or steps to be used in solving linear program problems using own language
Able to make mathematical modeling of linear program problems using mathematical symbols in the form of writing or images	Able to understand and explain the representation of mathematical language in linear program problems
Able to write the solution process and make conclusions about solving linear program problems in order and clearly	Able to explain the solution process of linear program problems in sequence, detail, and easy to understand

Able to analyze and evaluate the strategies or steps used, then write down other strategies or steps in solving linear program problems.	Able to explain the results of analysis and evaluation of other strategies to work on problems

(Nurfaizi and Ismail, 2021)

RESULT AND DISCUSSION

The results of this study were obtained from the selection of 3 subjects taken from 22 students who filled out the *Multiple Intelligences* questionnaire. The three subjects are students with low, medium, and high levels of linguistic verbal intelligence.

Table 4. Research Subject

No.	Subject Initials	score	Category
1	AA	26,42	Low
2	AB	33,43	Medium
3	AC	40,82	High

Results and Analysis of Mathematical Communication Ability Test of Writing Students with Low Level of Verbal Linguistic Intelligence

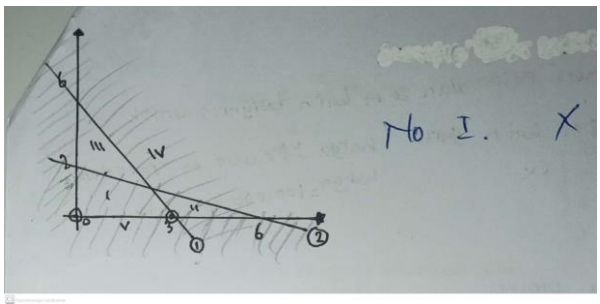


Figure 1. Answer no 1 Students with Low Level of Verbal Linguistic Intelligence

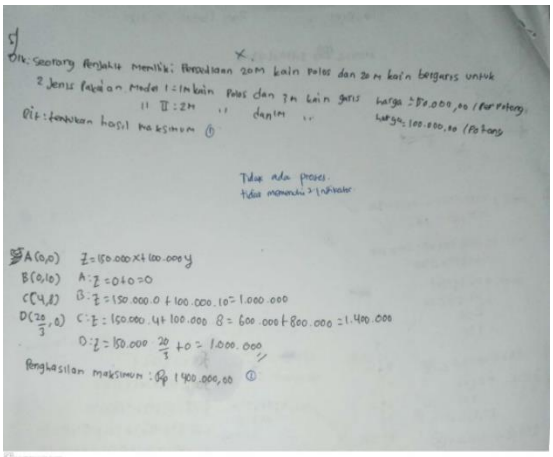


Figure 2. Answer no. 4 Students with Low Level of Verbal Linguistic Intelligence

Figures 1 and 2 show that students with poor linguistic verbal intelligence are unable to write down the information obtained from the question clearly and precisely. Students are also unable to write down the solution process and choose which technique to use in solving the problem.

Results and Analysis of Mathematical Communication Ability Test of Oral Students with Low Level of Verbal Linguistic Intelligence

Students with low verbal-linguistic intelligence admitted that they could not answer the question because they did not know the meaning and how to solve it. Students with low intelligence experienced difficulty and indecision when discussing the information gathered from the questions. They stated that there was not a single subject that they worked on with confidence. When asked about cartesian coordinates, students admitted that they did not know how to graph them. They also did not know how to convert pictures into mathematical symbols in the form of numbers or inequalities, or how to convert sentences in story problems into mathematical symbols.

Results and Analysis of Mathematical Communication Ability Test of Writing Students with Moderate Level of Verbal Linguistic Intelligence

Indicator 1: Write known and questionable information clearly and in detail on linear program problems.

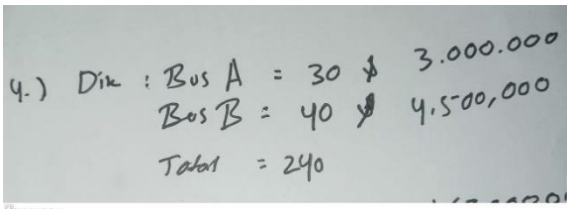


Figure 3. "Medium" student Writing down the Information on the Problem

Figure 3 shows that students with a medium level of verbal linguistic intelligence can only write down what they know, not the information asked in the inquiry. In addition, the information written by students with moderate verbal linguistic intelligence is less clear and logical, requiring additional supporting material such as the meaning of the numbers 30 and 3000,000.

Indicator 2: Able to determine the strategy or steps to be used in solving liear program problems clearly

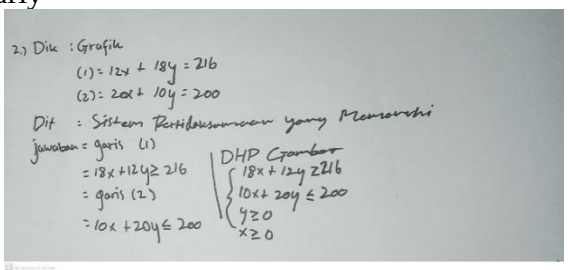


Figure 4. 'Medium" student Writing down strategies

In Figure 4 above, it is clear that the student with a medium level of linguistic verbal intelligence did not write down the process and strategy followed to arrive at the required conclusion.

Indicator 3: Able to make permissiveness or mathematical modeling of linear program problems using mathematical symbols in the form of writing or drawing.

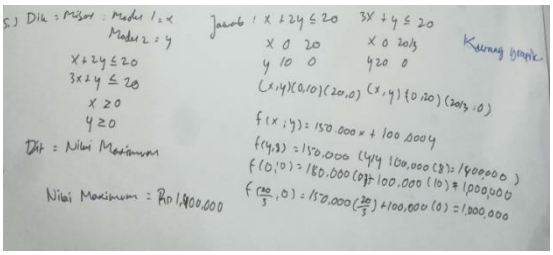


Figure 5. "Medium" student Modeling, Inequality and Cartesian Coordinates

In Figure 5 above, it can be seen that students with a medium level of linguistic verbal intelligence are only able to write the memorization and inequality system on the answer sheet, but students do not make a graph or cartesian coordinates which is a step that should be there to get to the required conclusion.

Results and Analysis of Mathematical Communication Ability Test of Oral Students with Moderate Level of Verbal Linguistic Intelligence

Students with a moderate level of linguistic verbal intelligence can explain the ideas or information in the problem clearly and correctly, but they admit to having difficulty determining some of the necessary strategies, such as developing new strategies and evaluating the results of their work. Students with moderate linguistic verbal intelligence admitted that they were only able to write the inequality smoothly and confidently, and determine the intersection point, while other students with moderate linguistic verbal intelligence admitted to guessing and doubting the other strategies they used. In some problems, students with moderate linguistic verbal intelligence did not write the required conclusion, the reason was because students did not know what was actually asked in the problem but students remembered how to solve the problem because during the learning process, students had solved similar problems but only different numbers.

Results and Analysis of Mathematical Communication Ability Test of Writing Students with High Level of Linguistic Verbal Intelligence

Indicator 1: Writing known and questionable information clearly and in detail on linear program problems.

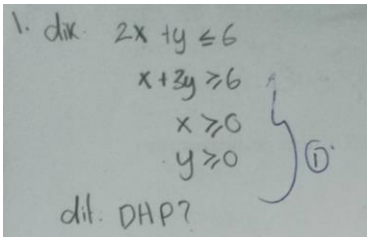


Figure 6. "High" students write down the information on the problem

Based on Figure 6, students with a high level of linguistic verbal intelligence are able to write the information known and asked in the problem precisely and clearly. Writing information in the form of what is known and what is asked is very clear and informative.

Indicator 2: Able to determine the strategy or steps to be used in solving liear program problems clearly.

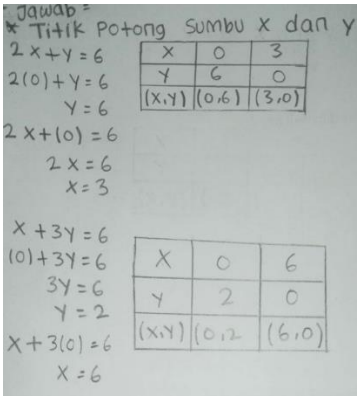
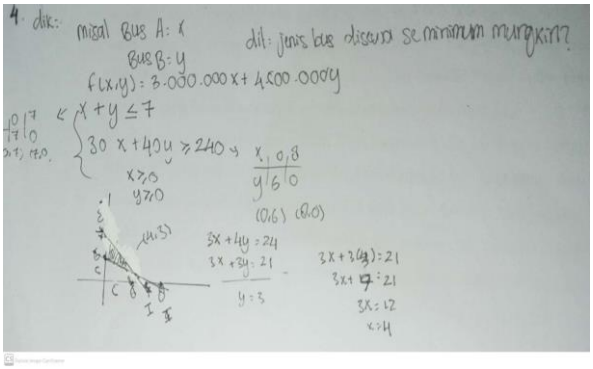


Figure 7. "High" students write down strategies or steps

In Figure 7, it can be seen that students with a high level of linguistic verbal intelligence are able to write down and determine the strategies or steps to be used in solving linear program problems.

Indicator 3: Able to make permissiveness or mathematical modeling of linear program problems using mathematical symbols in the form of writing or drawing.

Figure 8. "High" student writes down the equation, Inequalities and Cartesian Coordinates



In Figure 8, it can be seen that students with a high level of linguistic verbal intelligence can write the equation correctly as needed, write the correct inequality and in accordance with the information in the problem, and make a cartesian coordinate graph correctly.

Indicator 4: Able to write the solution process and make conclusions about solving linear program problems in order and clearly.

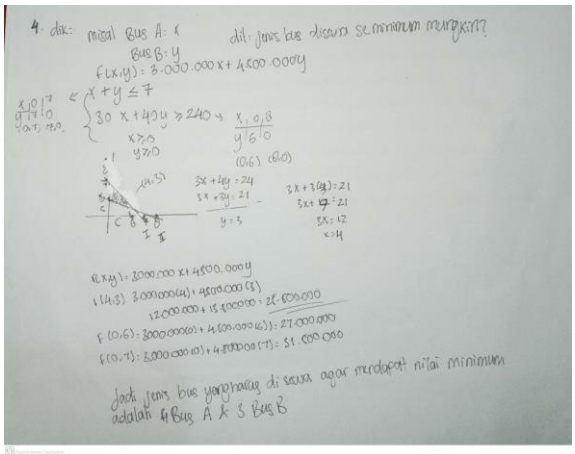
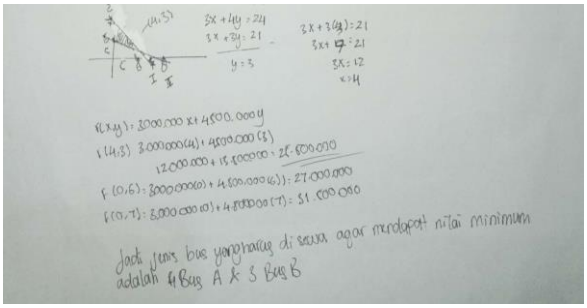


Figure 9. "High" students write down the solution process and make a conclusion

In Figure 9, it can be seen that students with a high level of linguistic verbal intelligence are able to write the solution process completely, clearly, and correctly so that it is easy to understand. In addition to writing the solution process, the student is also able to write the conclusion clearly and correctly obtained from the solution process he worked on.

Indicator 5: Able to analyze and evaluate the strategies or steps used, then write down other strategies or steps in solving linear program problems.

Figure 10. "High" students write down other solution strategies



In Figure 10, it can be seen that students with a high level of linguistic verbal intelligence are able to write down other solution strategies to arrive at the conclusion completely, in detail, and correctly.

Results and Analysis of Mathematical Communication Ability Test of Writing Students with High Level of Linguistic Verbal Intelligence

Table 5. Subject Interview High Linguistic Verbal Intelligence Levelin Explaining known information

Code	Interview
S	What information did you get after reading the problem?
AA	The information I get is that the inequality system is known and the solution area of the inequality system is asked.

Based on table 5, subjects with high linguistic verbal intelligence are able to explain the ideas or information listed in the problem clearly and correctly. The subject was very confident in what he got from the problem, and the language the subject used was very easy to understand.

Table 6. Subject Interview Verbal Linguistic Intelligence Level High in Explaining Mathematical Symbols

Code	Interview
S	Then, from the problem you read, are there any sentences that can be converted into mathematical language or mathematical symbols?
AA	Yes ma'am In problem number 4 I was able to memorize Bus $A = x$, and Bus $B = y$ with the objective function $f(x, y) = 3000.000 + 4.500.000y$. Then I can make the inequality system too ma'am. $x + y \leq 7$ $30x + 40y \geq 240$ $x \geq 0$ $y \geq 0$
S	Okay, the information is very clear, but look at your answer, are there any numbers that can be simplified?
AA	Emmm... There is, but I forgot to simplify it. The numbers that can be simplified are

$30x + 40y \geq 240$
Both segments are divided by 10, Becomes
$3x + 4y \geq 24$

In table 6, it is clear that subjects with high linguistic verbal intelligence are able to clearly and carefully answer questions. The subject explained what sentences can be converted into mathematical symbols or language. In addition, the subject was able to quickly and responsively correct the symbols that he had not written. The subject mentioned that he forgot to simplify the inequality he made, but this did not make the subject's answer wrong, it's just that if the numbers in the inequality are made the simplest, of course it will make the solution process easier because the numbers are not too high.

Table 7. Subject Interview High Linguistic Verbal Intelligence Level in Explaining the Strategy used

Code	Interview
S	What strategies, formulas, or steps did you use to solve the problem?
AA	I solve the problem by using strategy or corner point test ma'am.
S	Briefly explain the steps of the strategy you used?
AA	First, I made an initialization, then I made the inequality and objective function. After creating the inequality and determining the objective function, I determined the intersection point of the inequality that I had created. After getting the intersection point, I made a graph complete with the shaded solution area. After that, I used the SPLDV formula to find some corner points. When I got all the corner points, I directly substituted them into the objective function, ma'am. Only after all the calculations, I could draw a conclusion.

Based on table 7, the subject was able to explain the steps of the strategy he used clearly, sequentially and in detail.

Table 8. Verbal Intelligence Level Subject Interview High Linguistics in Explaining the Solution Process

Code	Interview
S	Do you think your process is in accordance with the steps or strategies you used? If so, what were the steps?
AA	It's appropriate ma'am. As I explained earlier, first I made the initialization, then I made the inequality and objective function. After creating the inequality and determining the objective function, I determined the intersection point of the inequality that I had created. After getting the intersection point, I made a graph complete with the shaded solution area. After that, I used the SPLDV formula to find some corner points. When I got all the corner points, I directly substituted them into the objective function, ma'am. Only after all the calculations, I could draw a conclusion.

The subject was able to explain the solution process in order and clearly so that it was easy to understand.

Table 9. Subject Interview High Linguistic Verbal Intelligence Level in Explaining the Results of Analysis and Evaluation of Other Strategies

Code	Interview
S	Okay, is the strategy you used the easiest and most appropriate strategy?
AA	In my opinion, the strategy I used was very easy and appropriate.
S	Are there any other strategies or steps in the solution you wrote?
AA	Yes ma'am, I used the SPLDV method and the crosshairs.
S	Does the strategy make it easier for you to get the conclusions you need?
AA	Yes ma'am

Based on table 9, the subject was able to explain the reasons why he used the strategy in solving the problem. In addition, the subject can also explain very clearly about the other strategies he used in solving the linear program problem.

CONCLUSION

Based on the discussion above, it can be concluded that students who are at a high level of linguistic verbal intelligence will be able to answer each item clearly and in detail. These students will also be able to fulfill at least 4 indicators of mathematical communication ability properly and correctly. From the interview results, it can be seen that students who are at a high level of linguistic verbal intelligence are able to straightforwardly and logically answer and explain every question asked to them.

Furthermore, students who are at the medium level of linguistic verbal intelligence are able to solve problems properly and correctly and can fulfill 3 indicators of mathematical communication ability. In the interview, the student was able to explain every information contained in the problem, it's just that the student was not sure and still seemed hesitant in answering every question asked. Students with moderate linguistic verbal intelligence level are only able to write conclusions in question number 5. This is because students admit that they are still unable to doubt and are confused about how to write conclusions, but the rest of the students can answer the questions well.

Students with a low level of linguistic verbal intelligence do not write down ideas and ideas obtained from the problem. Students did not make the modeling, inequality and solution process. When interviewed, students could not answer all the questions asked. Students at the low linguistic verbal intelligence level were only able to answer 1 to 2 indicators of mathematical communication ability.

The researcher realizes that this study has many shortcomings and limitations, and she believes that future research will be refined by researching and studying additional similar studies.

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