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MATHEMATICAL COMMUNICATION ABILITY PROFILE OF LINGUISTIC INTELLIGENCE AND LOGICAL-MATHEMATICAL INTELLIGENCE STUDENTS IN SOLVING TASK

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Abstract

One of the skills that is needed in the 21st century is communication skills. In mathematics learning, students need to develop communication skills. Intelligence is one of the internal factors that affects students' communication skills. There are two types of intelligence that needed in mathematical communication skills, namely linguistic intelligence and logical-mathematical intelligence. The purpose of this study is to describe mathematical communication skills of linguistic and logical-mathematical students in solving task. Mathematical communication skills is the ability in the process of conveying mathematical ideas using symbols, terms, or notations in solving mathematical task verbally or in writing that are assessed from aspects of accuracy, complexity, and fluency. This type of research is qualitative descriptive. The researcher used quantitative and qualitative data. Data collection techniques that be used are questionnaires, tests, and interviews. In the process of data collection on mathematical communication skills, the data will be tested for validity by using time triangulation. The results showed that the mathematical communication ability profile of linguistic intelligence students in solving task is the student can convey mathematical ideas using symbols, terms, or notations in solving mathematical task verbally or in writing fluently but inaccurately and not complete. While, the mathematical communication ability profile of logical-mathematical intelligence students in solving task is the student can convey mathematical ideas using symbols, terms, or notations in solving mathematical task verbally or in writing completely and fluently but inaccurately.

Keywords: Mathematical communication ability, Linguistic and Logical-mathematical

INTRODUCTION

Life in the 21st century required students to develop various skills. According to the Partnership for 21st Century Skills (P21) in 2007, learning and innovation skills that was needed by students in the 21st century were known as 4C, namely communication, collaboration, critical thinking, and creativity. As like P21, Permendikbud Number 21 of 2016 concerning about content standards of K-13 curriculum said that competencies that be used in teaching and learning activities cover three domains, namely attitudes, knowledge, and skills. One of the skills that was required to be mastered by students from both elementary and secondary school was to have good communication skills.

In mathematics learning students must develop communication skills so that students were able to share ideas and convey their understanding to others. According to the National Council of Teachers of Mathematics (NCTM) in 2000, mathematical communication was a way to share ideas and clarify understanding. Ula in 2013 stated that there were various factors that influenced in the learning process and results of study. Intelligence is one of the internal factors that influence the mathematical communication.

The several types of intelligence proposed by Gardner, there are at least two types of intelligence that was needed in mathematical communication. Because of the mathematical communication according to NCTM was a way to share ideas and clarify understanding of mathematics, mathematical communication involves two abilities. These two abilities were the ability to share ideas that can be categorized as communication ability and the ability to understand about mathematics. These two abilities were manifestations of two types of intelligence.

Two types of intelligence that support communication ability and mathematical reasoning abilities of each were linguistic intelligence and logical-mathematical

intelligence. Linguistic intelligence was the ability to think clearly and to convey their thoughts through conversation, reading, and writing (Meliala, 2004). Such intelligence was certainly related to communication activities. While logical-mathematical intelligence was the ability to use numbers and calculations, patterns and logic, and scientific mind set (Meliala, 2004). Such intelligence was related to students' mathematical reasoning abilities, so students need to improve linguistic and logical-mathematical intelligence in order to improve their mathematical communication ability. The purpose of this study is to describe mathematical communication ability profile of linguistic and logical-mathematical students in solving task.

There are three paradigms or aspects of communication, namely accuracy, complexity, and fluency (Rausch, 2017). OECD (2013) mentions the communication activities involved in solving math tasks were as follows: (1) read, decode, and make sense of statements, questions, tasks, objects or images, in order to form a mental model of the situation, (2) articulate a solution, show the work involved in reaching a solution and / or summarize and present intermediate mathematical results, and (3) construct and communicate explanations and arguments in the context of the problem. Based on the activities of mathematical communication and the three paradigms, the indicator of mathematical communication ability in solving task in this study were saw the accuracy, complexity, and fluency in;

(1) Mentioning things that are known and asked about the mathematical task given
(2) Writing statements, questions, or assignments into mathematical models or using representations verbally, graphically, diagrams or symbols
(3) Explaining ideas, situations or mathematical relations in mathematical task given
(4) Writing mathematical task solving steps towards the final solution mathematically
(5) Conveying mathematical task solving steps towards the final solution mathematically
(6) Explaining the reasons related to mathematical solutions in the original context.

METHOD

The type of the research was qualitative descriptive. To get the data that was needed in this study researchers used quantitative data and qualitative data. The selection of subjects in this study was based on the following criterias: (1) the results of the type of intelligence grouping, (2) mathematical abilities, (3) gender similarity, and (4) clear in speaking.

Supporting instruments that were used in this study include: Questionnaire of Multiple Intelligence (AKM), Question of Mathematics Ability Test (TKM), Task of Mathematical Communication Ability Test (TKKM), and interview guidelines. In the data collection process, the data of mathematical communication ability would be validated by using triangulation of time to saw the consistency of the data. The criteria of the valid data was the consistency of the first data and the next data reached 80%. The research was taken in VII grade of SMP Negeri 1 Parengan, in the even semester of 2018/2019.

FINDING AND RESULT

The subject that was got as the following:

Table 1 The subject of Research

No	Name	Gender	Intelligence	TKM Sore	Code
1	YNF	F	Linguistic	55	SL
2	DAS	F	Logical-Mathematical	51	SM

SL	Linguistic Subject	SM	Logical-Mathematical Subject

Mathematical Communication Ability of Linguistic Student

The data of triangulation from TKKM and interview of linguistic student was showed in the following table.

Table 2 Triangulation of Linguistic student

Indicator	TKKM-I and Interview-I	TKKM-II and Interview-II
Mentioning things that are known and asked about the mathematical task given	Accurate, not complete, fluent	Accurate, not complete, fluent
Writing statements, questions, or assignments into mathematical models or using representations verbally, graphically, diagrams or symbols	Inaccurate, not complete, and not fluent	Inaccurate, not complete, and not fluent
Explaining ideas, situations or mathematical relations in mathematical task given	Inaccurate, not complete, and not fluent	Inaccurate, not complete, and not fluent
Writing mathematical task solving steps towards the final solution mathematically	Inaccurate, not complete, and not fluent	Inaccurate, not complete, and **fluent**
Conveying mathematical task solving steps towards the final solution mathematically	Inaccurate, not complete, and fluent	Inaccurate, **complete**, and fluent
Explaining the reasons related to mathematical solutions in the original context.	Accurate, complete, and fluent	Accurate, complete, and fluent

Linguistic student mentioned things that were known and asked about mathematical task given using the same sentence with the sentence contained in the task. Linguistic student wrote things that were known by rewriting the sentences. The things that were known on the task was written by linguistic student on the answer sheet sequentially according to what were known in the task. Linguistic student wrote things that was asked by writing sentence in the form of question sentences. Linguistic student wrote the question sentence with a question mark (?). According to the procedure for writing in a good question sentence, this is matched with the statement De Roos (2011) that students with linguistic intelligence have knowledge of the structure of language, the student could can recognize and apply the rules of grammar.

Linguistic student mentioned things that were known and asked **accurately**, the things was mentioned correctly as written in the task. Linguistic student mentioned things that were known and asked **not completely**. The situation was like with the characteristics of students who have the type of linguistic intelligence according to De Roos (2011), which has a high sensitivity to all aspects of language. Therefore students of the type of linguistic intelligence did not wrote down what she did not understand. While, linguistic students could mention the things that were known and asked **fluently.** Linguistic student mentioned without some scribbles in the worksheet.

Linguistic student wrote statements, questions, or assignments into mathematical models or use representations verbally, graphically, diagrams or symbolically **inaccurately**. This was because students of linguistic represent known sentences in questions in verbal and venn diagrams that are incompatible with mathematical concepts. Verbal representations written by linguistic students were not used to model statements on questions into mathematical models, but only symbolize the sentence in the question to make it simpler. Diagram representation that made by linguistic student was not compatible with mathematical concepts.

Linguistic student wrote statements, questions, or assignments into mathematical models or representations verbally, graphically, diagrams or symbols **not completely**. There were things that have not been written in representing the statement on the task. Linguistic student made representations of the questions into words or verbally more dominant. Linguistic student wrote verbal sentences more than mathematical models. Linguistic student made mistakes in writing sentence representations on the questions with scribbles on the linguistic student's answer sheet. Some scribbles appeared to be written words instead of numbers or mathematical symbols. Linguistic student tended to use representations verbally, because on the answer sheet linguistic student use words more than numbers or mathematical symbols. This situation was like with the statement Meliala (2004) that people who have linguistic intelligence have good writing skills and love to write. But, linguistic student wrote statements, questions, or assignments into mathematical models or representations verbally, graphically, diagrams or symbols **not fluently.**

Linguistic student explain ideas, situations or mathematical relations on mathematical task given **not accurately, not complete, and not fluently** because she still confused. This situation was not in accordance with the statement (Meliala, 2004) that people with linguistic intelligence also easily explain, teach, even tell their thoughts to others. Linguistic student needed a long time to answer questions from researchers related to the ideas that will be used to solve the task. However, linguistic students still try to tell the ideas that was used. Although the idea could be said to be not mathematical, it just based on her own reasoning, linguistic student got a reasonable solution according to what is known and what is asked in the question.

Linguistic student wrote steps to solve mathematical task towards **inaccurate** mathematical solutions. Linguistic students made mathematical calculations simply and tended to be very short, simply by adding up and subtracting the numbers that are known in the task. Linguistic student sort out the sentences contained in the task, so that she could distinguish which sentences must be added or subtracted. Calculations performed by linguistic students are not systematic and irregular. This situation is not consistent with the statement by De Roos (2011) that students with linguistic intelligence are organized and systematic individuals.

Linguistic student did the calculations by using the inconsistent operating marks in presenting the results of the number operations. In addition, linguistic student also wrote **incomplete** mathematical task solving solutions to the final solution. Linguistic student only wrote few completion steps. Linguistic student wrote down steps used verbal sentences rather than mathematical symbols. Even though there still appear numbers, but very few and short step. Then, the solution written by linguistic student to obtain a final solution was very short and not done mathematically. Even the simple completion steps flow based on reason without taking into account some of the mathematical facts given in the task, but linguistic student could wrote mathematical task solving solutions to the final solution not fluently in TKKM I but rather fluently in TKKM II. But in TKKM II linguistic student just wrote mathematical task solving solutions to the final solution in the short steps, so it could be concluded that linguistic

student wrote mathematical task solving solutions to the final solution **not fluently.**

Linguistic student could convey the origin of getting answers to solve the task, even though the steps to completion were **inaccurate but fluently**. Linguistic student have made mathematical calculations by simply summing and subtracting known numbers in the task. Linguistic student sorted out the sentences contained in the task, so that linguistic student distinguish which sentences must be added or subtracted. Linguistic student convey steps to solve mathematical task towards mathematical solutions without stumbling. The words of linguistic student in conveying their thought processes to solve problems flow smoothly, but not deeply. The settlement step was based on her own opinion without taking into account other mathematical facts known in the task. This was consistent with the statement of De Roos (2011) that students with a type of linguistic intelligence can communicate their point of view clearly.

Linguistic students convey steps to solve mathematical problems towards mathematical solutions in TKKM I not completely but in TKKM II completely. But in TKKM II linguistic student just convey mathematical task solving solutions to the final solution in the short steps, so it could be concluded that linguistic student convey mathematical task solving solutions to the final solution **not complete.**

In addition, linguistic students could explain the reasons related to mathematical solutions in their original context accurately, completely, and fluently. This was match with the statement (Ula, 2013) that students of the type of linguistic intelligence have a strong linguistic analysis, in addition to expressing a fact, they use varied vocabulary. Then, according to (De Roos, 2011) students with the type of linguistic intelligence often talk about things they have read, so that they look smooth in expressing the steps and explain the reasons related to the solutions that have been made.

The description of the profile of mathematical communication ability was represented by the following mathematical communication ability result test by linguistic student.

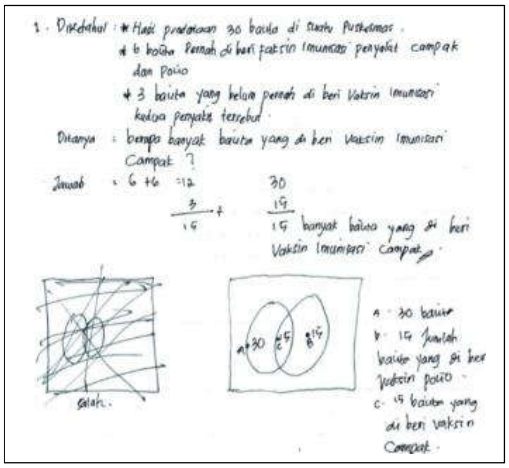

Image 1 TKKM by Linguistic Student

Mathematical Communication Ability of Logical-Mathematical Student

The data of triangulation from TKKM and interview of logical-mathematical student was showed in the following table.

Table 3 Triangulation of Linguistic student

Indicator	TKKM-I and Interview-I	TKKM-II and Interview-II
Mentioning things that are known and asked about the mathematical task given	Accurate, not complete, fluent	Accurate, **complete,** fluent
Writing statements, questions, or assignments into mathematical models or using representations verbally, graphically, diagrams or symbols	Inaccurate, not complete, and fluent	Inaccurate, not complete, and fluent
Explaining ideas, situations or mathematical relations in mathematical task given	Accurate, complete, and fluent	Accurate, complete, and fluent
Writing mathematical task solving steps towards the final solution mathematically	Inaccurate, complete, and not fluent	Inaccurate, complete, and not fluent
Conveying mathematical task solving steps towards the final solution mathematically	Inaccurate, complete, and fluent	Inaccurate, complete, and fluent
Explaining the reasons related to mathematical solutions in the original context.	Inaccurate, complete, and not fluent	Inaccurate, complete, and not fluent

Logical-mathematical student mentioned things that were known and asked **accurately**, the things was mentioned correctly as written in the task Logical-mathematical student mentioned things that were known and asked about the mathematical task given using the same sentence with the sentence contained in the task. Student logical-mathematical mentioned things that were known and asked about mathematical questions given not completely at TKKM I and complete at TKKM II. This was because the logical-mathematical student only wrote three out of four things that are known, so this logical-mathematical student is only writing one thing less. In contrast, student with linguistic intelligence do not write two things out of four known things. So it could be said that logical-mathematical student mentioned things that were known and asked about the mathematical task given **completely.** While, linguistic students could mention the things that were known and asked **fluently.** Linguistic student mentioned without some scribbles in the answer sheet. This was matched with Gardner's statement in (Ula, 2013)

that logical-mathematical intelligence was an ability that more related to the use of numbers and logic effectively, so that there is less attention to good and correct language writing.

Logical-mathematical student wrote statements, questions, or assignments into mathematical models or use representations verbally, graphically, diagrams or symbolically **inaccurately**. This was due to logical-mathematical student representing the known sentence in the question in the form of verbal and venn diagrams that were not compatible with mathematical concepts. Verbal representation written by logical-mathematical student in mathematical models.

Logical-mathematical student was able to make mathematical models of things that were known and asked in task into the form of mathematical equations. This situation was consistent with the statement of Davis et al. (2011) that students with logical-mathematical intelligence have the ability to develop equations and evidence, make calculations and solve abstract problems. Although the logical-mathematical student was able to represent the sentence in the form of mathematical verbal but, the representation made was inaccurate because the mathematical model made was not in accordance with the mathematical facts in the problem. Logical-mathematical student wrote statements, questions, or assignments into mathematical models or representations verbally, graphically, diagrams or symbols **not completely**. There were things that have not been written in representing the statement on the task. Logical-mathematical student wrote statements, questions, or assignments into mathematical models or representations verbally, graphically, diagrams or symbols **not fluently.**

Logical-mathematical student explained ideas, situations or mathematical relations on mathematical task given **accurately, completely and fluently**. This was consistent with the statement (Gangadevi & Ravi, 2014) that students with logical-mathematical intelligence are able to concentrate on mathematical problems, hypotheses and logical thinking, so that with ideas that have been thought logically, the student could explain the idea smoothly. Logical-mathematical student did not need a long time to answer questions from researchers. Logical-mathematical student told the ideas that will be used using logical thinking. The idea that was used by the student also mathematically. Logical-mathematical student would use equations in which equations are arranged when representing sentences in a question to a mathematical form. Logical-mathematical student explained ideas that will be used to solve questions confidently because they use mathematical facts given in the task.

Logical-mathematical student wrote steps to solve mathematical problems towards the final solution mathematically **inaccurately**. Calculations made by logical-mathematical student used signs of operation correctly and got the correct results according to the equation model made, but because the equations made at the beginning were wrong, the results do not match with the correct answers. The completion steps carried out by logical-mathematical student carried out systematically and neatly. The situation was consistent with the statement according to Kezar students with logical-mathematical intelligence have the ability to explore patterns, categories, and relationships by manipulating objects or symbols to conduct experiments in a controlled and orderly manner (Yaumi & Ibrahim, 2013).

However, logical-mathematical student wrote steps to solve mathematical task towards a final mathematical solution **completely**. Logical-mathematical student did the calculation long enough to get the final result. Logical-mathematical student tended to use sentences and mathematical symbols, both in the form of numbers and signs of operation. This situation was consistent with Meliala's statement (2004) that students with logical-mathematical intelligence have the ability to use numbers and calculations, patterns and logic, and scientific mindset. But, logical-mathematical student wrote steps to solve mathematical task towards a final mathematical solution **not fluently.**

Logical-mathematical student could convey steps to solve mathematical task towards the final mathematical solution **inaccurately.** But, Logical-mathematical student could convey steps to solve mathematical task towards the final mathematical solution **completely and fluently**. The words of the logical-mathematical student in conveying her thought processes to solve the task flowing smoothly, according to what was written in the answer sheet and expressed mathematically. When conveying the steps to solving the task, logical-mathematical student thinking of the possibilities that exist while correcting the answers that have been obtained.

Logical-mathematical student explained the reasons related to mathematical solutions in the original context **inaccurately but completely.** She could explain the reason of her solution form the beginning to the end. However, logical-mathematical student explained the reasons related to mathematical solutions in the original context **not fluently**. This is because logical-mathematical student was doubtful about the final answer that has been obtained.

The description of the profile of mathematical communication ability was represented by the following mathematical communication ability result test by logical-mathematical student.

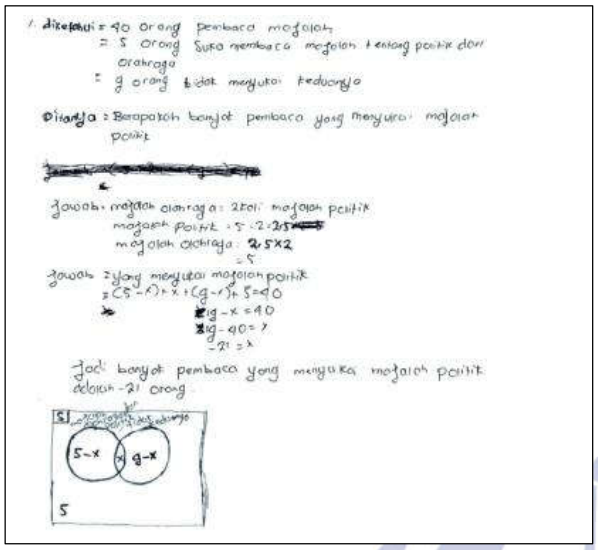

Image 2 TKKM by Logical-Mathematical Student

The Difference of Mathematical Communication Ability of Linguistic Student and Logical-Mathematical Student

The following is the difference in mathematical communication skills of linguistic student and logical-mathematical student from the three aspects of communication, namely the accuracy, completeness, and fluency of each given mathematical communication indicator. There are six indicators and each indicator is seen from three aspects of communication. Table 4 shows the total differences in each communication aspect of the mathematical communication indicators given.

Table 4 Achievement of Communication Aspects

Communication Aspect		Subject	
		Linguistic	Logical-Mathematical
Accuracy	Accurate	4	4
	Inaccurate	8	8
Complexity	Complete	3	9
	Incomplete	9	3
Fluency	Fluent	7	8
	Influent	5	4

Based on the table above, it could be seen that linguistic students have good mathematical communication skills on aspects of fluency. While logical-mathematical student have mathematical communication skills that are good on aspects of complexity and fluency.

CLOSURE

Conclusion

Students with linguistic intelligence have good mathematical communication skills on aspects of fluency. While student who have logical-mathematical intelligence have mathematical communication skills that are good on aspects of complexity and fluency. Linguistic student was able in giving reason verbally, but the reason in solving mathematical task was not mathematically. Logical-mathematical student was good in explain the idea for solving mathematical task. The ide given was mathematically.

Suggestions

Based on the results of the research that has been obtained, the following researchers provide suggestions for further research.

1. In this study only two students were used to represent each type of intelligence, but the strength of the intelligence possessed by students was not controlled, so that one student had the type of strong linguistic intelligence and one student had the type of logical-mathematical intelligence which tended to be weak. Therefore, researchers suggest that further researchers control the type of intelligence that students have in order to obtain better data.
2. For further research, researchers to do readability tests on each supporting instrument, so as to minimize the presence of students who experience confusion with the sentences contained in the supporting instruments used.
3. For further research, researchers suggest conducting research on students' mathematical communication skills in terms of other types of intelligence to add to the completeness of research on mathematical communication in terms of intelligence type.

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