The Level of Mathematical Logic Intelligence towards the Solving of Mathematical Problem Solving

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Abstract. The purpose of this study is to find the relationship between the levels of intelligence of mathematical logic with the ability to solve problems in terms of the various strategies used at the stage of planning problem solving. This problem is useful for students who solve non-routine problems. The method in this research uses a case study. The results of this study indicate that the average mathematical intelligence of Grade VII students of MTsN 6 Agam is at a complex level. The ability to solve problems in algebra and geometry material in the sample class is at the basic level with an average of 50.6, at the complex level with an average of 62.66 and at a coherent level with an average of 74.75. There is a significant influence between the level of intelligence of mathematical logic with the ability of students to solve problems in Algebra and Geometry material in mathematics in class VII.1 MTsN 6 Agam at 38.2% and for the remaining 61.8% influenced by other factors such as teachers’ competence, learning style, learning environment and lack of students in practicing in answering problem solving questions.

Keywords. level of intelligence, problem solving, problem solving strategies

1. Introduction
At present, there are still many students who have difficulty in working on math problems. In fact, students' ability to solve problems is still low. This, based on a survey conducted by PISA in 2012 which showed the position of Indonesian students in solving problems in the order of 64 of the 65 countries surveyed. It can be seen that the problem solving skills in mathematics learning are still low. As for practice, the success of mathematics learning when students are able to solve the problems they face.[1] Learning is an active process where students construct new knowledge based on the experience / knowledge they have[1]. There are various factors that influence learning, one of which is an internal factor, namely[2]

Based on Law No. 20 of 2003, it can be concluded that intelligence is one of the aspects developed through learning. Humans were created by Allah SWT with various advantages compared to other creatures. One of the greatest strengths is that humans are given a mind (intelligence). With intelligence, humans can continuously maintain and improve their quality of life which is increasingly complex, through the process of thinking and learning continuously. One effort that can be done to develop the abilities and potential of students is through mathematics learning. Permendiknas No. 22 of
2006 concerning the standard content of mathematics subjects states that the stated objectives of mathematics learning include abilities or competencies:

1. Understanding mathematical concepts, explaining the interrelationships between concepts and applying concepts or algorithms flexibly, accurately, efficiently, and precisely in problem solving.
2. Using reasoning on patterns and traits, carrying out mathematical manipulations in making generalizations, compiling evidence, or explaining mathematical ideas and statements.
3. Solve problems that include the ability to understand problems, design mathematical models, solve models, and interpret the solutions obtained.
4. Communicating ideas with symbols, tables, diagrams or other media to clarify the situation or problem.
5. Having an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention, and interest in learning mathematics, as well as being tenacious and confident in problem solving[3].

Along with the development of science and technology, intelligence which originally consisted of intellectual intelligence (IQ), spiritual intelligence (SQ), and emotional intelligence (EQ), Howard Gardner developed the concept of intelligence by creating multiple intelligence or multiple intelligence theories. It consists of: (1) linguistic intelligence; (2) intelligence of mathematical logic; (3) visual-spatial intelligence; (4) musical intelligence; (5) kinesthetic intelligence; (6) interpersonal intelligence; (7) intrapersonal intelligence; (8) naturalist intelligence[4]. Given that there are many types of intelligence, we should realize that no student is stupid. However, most students do not recognize their intelligence. The reason for not recognizing student talent is that one of them is due to lack of thought process stimuli associated with mathematical abilities. The diversity of expertise is based on various types of intelligence that a person has.

One of the multiple intelligences related to mathematics is the intelligence of mathematical logic which is the ability to calculate, qualify, formulate propositions, hypotheses, and solve complex mathematical calculations[5]. Indicators of mathematical logic intelligence include the recognition of patterns of abstraction, inductive reasoning, deductive reasoning, intelligence in capturing relationships and relationships, completing complex calculations, and scientific considerations[6]. According to Howard Gardner, the intelligence of mathematical logic is related to the ability to count, reason and think logically and solve problems.[4] Prawira also believes that mathematical logic intelligence can help someone understand logic, analyze structured patterns that aim to solve problems that occur[7].

In general, problem solving is defined as an attempt to achieve a way out of a difficulty in order to achieve a goal that includes indicators of the ability to understand the problem, compile a plan for completion, carry out a plan of resolution, and recheck it.[8].

Weak ability of students to solve this problem states there are learning difficulties faced, the cause is internal and external factors. Internal factors of learning difficulties due to neurological disorders, one of which is limited intelligence, and external factors due to wrong strategies, lack of motivation for poor classroom management. Given that mathematical logic intelligence contributes to problem solving, and the unknown intelligence of students while that intelligence can change and can also be developed, the researcher conducted mathematical logic intelligence tests. Then, from the low level of students' mathematical problem solving abilities, researcher conducted research aimed at finding out the level of intelligence of students' mathematical logic and how much influence the students' mathematical logic intelligence had in solving mathematical problems or solving mathematical problems.

2. Literature Review

The development of intelligence is obtained by someone along its development in life. Intelligence is divided into three parts, namely intellectual intelligence (IQ), spiritual intelligence (SQ), and emotional intelligence (EQ). These three intelligences are inseparable from one another. For balance, all three must be sharpened well through a learning process and through experiences. According to Piaget, the
development of children's intelligence is divided into four stages, namely the sensory motor stage between the ages of 0-2 years, the pre-operational stage (2-7 years), the concrete operational stage (7-12 years), and the formal operational stage (12 years onwards). These stages must be passed by a child, it will affect the intelligence of children.[5]

It can be concluded that intelligence is a person's ability to solve existing problems, look for, solve, and find a way out until the problem is solved by using his/her potential. Intelligence is also the main asset in learning to achieve optimal results.

Factors that can affect one's intelligence include:
- a. Trait
  The trait is determined by the traits and characteristics that are carried from birth.
- b. Maturity
  Every organ in the human body experiences growth and development. Each organ (physical or psychological) can be said to have matured if it has reached the ability to carry out their respective functions.
- c. Formation
  Formation is all the conditions outside oneself that affect the development of intelligence. Formation factors can be divided into intentional establishment (as is done in schools) and accidental formation (the influence of the natural surroundings).
- d. Distinctive interests and traits
  An interest directs an action toward a goal and is an impetus for that action.
- e. Freedom
  Freedom means that people can choose certain methods to solve problems.[5]

Therefore, in determining whether a child is intelligent or not cannot be guided by only one of these factors. Intelligence is a total factor. The whole person participates in determining one's intelligence actions.

Howard Gardner's idea of Multiple Intelligence that intelligence is not only single but each individual has different intelligence, which is referred to as Multiple Intelligence. It can be specified into eight intelligences, namely:
- a. Linguistic intelligence, related to the ability to read, write, discuss, argue and make friends.
- b. Mathematical-Logical Intelligence, related to the ability to count, reason and think logically, solve problems.
- c. Visual-Spatial Intelligence, related to the ability to draw, take photographs, make sculptures, design.
- d. Musical intelligence, related to the ability to create songs, hear tones from sound sources or musical instruments.
- e. Kinesthetic intelligence, related to the ability of motor movement and balance.
- f. Interpersonal intelligence, related to the ability to get along with others, lead, social sensitivity, cooperation and empathy.
- g. Intrapersonal intelligence, related to understanding yourself, self-motivation, life goals and self development.
- h. Naturalist intelligence, related to the ability to research natural developments, identify and observe the surrounding environment.[4].

It can be concluded that there is no child who is stupid or smart, there is child who stand out in one or several types of intelligence. Every human being has an intelligent tendency in one field without having to struggle to sharpen it and must try to sharpen the other intelligences to solve the problems that exist in everyday life.

Mathematical intelligence is one of eight theories of multiple intelligences introduced by Howard Gardner. Mathematical logic intelligence is intelligence that involves the ability to process numbers
properly and / or skills using reasoning or logic correctly [7]. Mathematical Logic Intelligence is the ability to handle relevance / argumentation and recognize patterns and sequences. Mathematical logic intelligence basically involves the ability to analyze problems logically, find or create mathematical formulas or patterns and investigate things naturally[10]. The intelligence of mathematical logic is also the ability to calculate, qualify, formulate propositions, hypotheses, and solve complex mathematical calculations. According to Syaodih, mathematical logic intelligence includes the skills to calculate, quantify, formulate proportions and hypotheses and solve complex mathematical calculations[11]. According to Connell, people who have mathematical logic intelligence are very fond of numbers. Mathematical logic intelligence is related to the ability to think deductively and inductively and recognize and manipulate the separation of patterns and relationships. Students who have mathematical logic intelligence will have strong problem solving skills and reasoning skills and answer questions on a logical ethic[7]. Mathematical intelligence is an intelligence related to the ability to use numbers and logic effectively, such as those of mathematicians, scientists, and programmers. Included in this intelligence is sensitivity to patterns of logic, abstraction, categorization, and calculation. The thinking of people who have the intelligence of mathematical logic is inductive and deductive. His/her way of thinking reasoned and easily developed a pattern of cause and effect[2]. Mathematical logic intelligence proposed by Jasmine is that people with this intelligence like working with data that is collecting and organizing, analyzing and interpreting, concluding then predicting[7].

This mathematical logic intelligence is a person's ability to measure and count. Mathematical logic intelligence has several characteristics, including:

a. Calculate arithmetic problems quickly.
b. Like to ask questions that are analytical.
c. Expert in chess, halma, and so on.
d. Like to design experiments to prove something.
e. Able to explain problems logically.
f. Spend time with logic games like puzzles.
g. Having achievement in mathematics and science.[12]

Measurement of mathematical logic intelligence can be done by tests because indicators of mathematical logic intelligence are related to patterns of numbers, numbers and logic for decision making.[13] Mathematical Logic Intelligence deals with numbers, solving problems, analyzing things, showing accuracy in problem solving, working in situations that contain clear answers[14]. So, the intelligence of mathematical logic has a close relationship with problem solving.

Basically, the ultimate goal of learning is to produce students who have the knowledge and skills to solve problems faced later in the community. To produce students who have reliable competence in problem solving, a series of learning strategies for solving problems is needed. Furthermore, Polya put forward two kinds of mathematical problems, namely:

1. Problems to find where we try to construct all types of objects or information that can be used to solve the problem.
2. Problems to prove where we will show one truth of the statement, namely the statement is true or false. This type of problem prioritizes hypotheses or conclusions from a theorem whose truth must be proven.[15]

Lencher defines mathematical problem solving as the process of applying previously acquired mathematical knowledge to new, unknown situations. As an implication, problem solving activities can show the development of other mathematical abilities such as communication and mathematical reasoning[15]. Mathematical problem solving is seen as the goal of mathematics learning in both SBC and NCTM[16]. According to Polya, there are four important stages that must be taken by students in solving problems, namely:

1) Understand the problem
2) Planning for completion
3) Implement the completion plan
4) Recheck [8]

It was also explained in the Director General of Primary and Secondary Education Regulation No. 506 / C / PP / 2004 (Ministry of National Education, 2004), that problem solving is a strategic competency shown by students in understanding, choosing approaches and problem solving strategies, and completing models to solve problems. Indicators that show problem solving include:

1. Demonstrate problem solving.
2. Organizing data and selecting relevant information in problem solving.
3. Presenting mathematical problems in various forms.
4. Choosing the right approach and method of solving the problem.
5. Develop problem solving strategies.
6. Creating and interpreting mathematical models of a problem.
7. Resolve routine problems[3].

According to Prawira, mathematical logic intelligence is a person's ability to think inductively and deductively, the ability to think according to the rules of logic, understand and analyze patterns of numbers, and solve problems by using the ability to think. Prawira also believes that mathematical logic intelligence is able to help someone in understanding logic, analyzing structured patterns that aim to solve problems that occur.[7].

Gardner illustrates that there are two important facts regarding the intelligence of mathematical logic. First, in talented people, the process of solving problems often takes place very quickly. Second, the solution of a problem can be arranged before the solution is expressed.[11].

Lazear groups mathematical logic intelligence into three levels, namely coherent, complex and basic levels. The basic level is 53 and below, complex levels from 53 to 68, and from 68 and above are coherent levels. [17] Mathematical logic intelligence contributes to solving mathematical problems. Mathematical logic intelligence is the intelligence that a person has to analyze a problem logically, solve mathematical operations, and examine a problem scientifically. Mathematical logic intelligence contributes to the problem solving process.

3. Methodology
This research is a case study research that is a research method used to look for the effect of certain treatments on others under controlled conditions [18]. By using a quantitative approach, this study aims to test existing theories[19]. Quantitative approach is a process of finding knowledge that uses data in the form of numbers as a means of finding information about what we want to know[20]. The design of this study was Expose Facto Design because there was no treatment for the independent variables.

The population in this study was all students of class VII MTsN 6 Agam because they already had the results of intelligence or IQ levels of mathematical logic and varied ways of solving problems. The school also has an A accreditation. Samples are part of the population as examples taken by using certain methods[21]. To get the sample, a simple random sampling is done by testing the normality, homogeneity of variance, average similarity. So, the sample in this study was class VII.1 which was 29 students. After a mathematical logic intelligence test, the data obtained on the level of mathematical logic intelligence are shown in table 1:

| Inteval | Frequency | Category | Total |
|---------|-----------|----------|-------|

Table 1. Intelligence level Grouping
4. Result and Discussion
The results of the research are the test of problem solving skills by using several problem solving strategies such as guessing strategies, simpler problem solving strategies, strategies for finding patterns, and strategies for sketching or drawing. Problem solving test material is using algebra and geometry material for class VII. Students in the basic level category received an average score of 52.6. For the complex category has an average of 64.8 and at a coherent level has an average of 76.8. For the process of students in answering problem solving tests for each ability in accordance with the polya indicator can be seen in the table 2 until tabel 5:

| Level of Intelligence in Math Logic | Questions | Total | Percentage (%) |
|------------------------------------|-----------|-------|----------------|
| Basic level                        | 13 14 15 13 12 | 67    | 74.44%         |
| Complex level                      | 18 19 18 18 20 | 93    | 77.50%         |
| Coherent level                     | 15 14 13 14 14 | 70    | 87.50%         |

| Level of Intelligence in Math Logic | Questions | Total | Percentage (%) |
|------------------------------------|-----------|-------|----------------|
| Basic level                        | 13 10 12 10 10 | 55    | 40.74%         |
| Complex level                      | 18 22 20 24 15 | 99    | 55.00%         |
| Coherent level                     | 14 16 17 16 15 | 78    | 65.00%         |

| Level of Intelligence in Math Logic | Questions | Total | Percentage (%) |
|------------------------------------|-----------|-------|----------------|
| Basic level                        | 9 17 7 8 19 | 60    | 44.44%         |
| Complex level                      | 16 20 18 26 15 | 95    | 52.78%         |
| Coherent level                     | 15 18 19 18 15 | 85    | 70.83%         |

| Level of Intelligence in Math Logic | Questions | Total | Percentage (%) |
|------------------------------------|-----------|-------|----------------|
| Tingkat Dasar                      | 10 8 8 7 13 | 46    | 51.11%         |
| Tingkat Kompleks                   | 14 20 13 21 21 | 89    | 74.17%         |
| Tingkat Koheren                    | 12 13 14 13 14 | 66    | 82.50%         |

Based on the table above, the results of students' problem solving abilities are still low at the planning and implementing stages of planning. In the planning stage, students are seen using the strategy chosen to solve problem solving.
The ability of students to solve mathematical problems based on [22], that each level of intelligence has differences in the process of answering. For the basic level, 74.44% of students are able at the stage of understanding the problem, 40.74% at the stage of planning the completion, 44.44% at the stage of carrying out the planning and 51.11% at the stage of re-checking. For the Complex level, 77.50% of students are able at the stage of understanding the problem, 55% at the stage of planning the completion, 52.78% at the stage of carrying out the planning and 74.17% at the stage of re-checking. For the coherent level, as much as 87.5% of students are able to understand the problem stage, 65% at the stage of planning the completion, 70.83% at the stage of carrying out the planning and 82.5% at the stage of re-checking.

The results of testing the mathematical logic intelligence hypothesis obtained a regression equation, \( Y = 2.908 + 1.17X \). These numbers can be interpreted as follows: (1) Constant of 2.908, meaning that if the intelligence of mathematical logic is 0, the students' ability to solve problems in algebra and geometry; (2) Variable regression coefficient (X) of 1.17, meaning that if the value of students 'mathematical logic intelligence increases 1, the students' ability to solve algebraic and geometrical problems in mathematics (Y) will increase by 1.17.

Positive coefficient means that there is a positive relationship between students' mathematical logic intelligence and problem solving in algebra and geometry in mathematics. The more students improve their mathematical logic intelligence; the problem solving ability will also increase. To determine the assumption that mathematical logic intelligence affects the problem solving of mathematics in class VII 1 MTsN 6 Agam, by comparing \( F_{\text{reg}} \) with \( F_{\text{table}} \) and also by comparing the calculated \( \text{prob.} F \) (Sig.) with its significance level. If \( F_{\text{reg}} > F_{\text{table}} \) and \( \text{prob.} F \) (Sig.) <Significance level, then the assumption is appropriate. If on the contrary \( F_{\text{reg}} < F_{\text{table}} \) and \( \text{prob.} F \) (Sig.) >Significance level, then the assumption is not appropriate.

The results of the hypothesis test analysis, using a significance level of 1%, obtained the calculated \( \text{prob.} F \) (Sig.) For the level of mathematical logic intelligence of 0.000, while the value of \( F_{\text{reg}} \) for the level of mathematical logic intelligence obtained \( F_{\text{reg}} \) of 65.195 with \( F_{\text{table}} \) of 3.99 at level of 1%, then \( F_{\text{reg}} = 65.195 > F_{\text{table}} = 3.99 \). Based on this comparison significant results are obtained, which means these results not only apply to the sample but also to the population. So, it can be concluded that the level of intelligence of mathematical logic influences the ability of students in problem solving in the material of Algebra and Geometry in mathematics in class VII 1 MTsN 6 Agam. The product moment correlation test results obtained \( r_{xy} = 0.981 > 0.256 \) r table (0.01), then between these variables a positive correlation occurs. Thus, it is known that there is a positive relationship between the level of intelligence of mathematical logic on students' mathematical problem solving in Algebra and Geometry subjects in class VII 1 MTsN 6 Agam. In addition, based on the correlation criteria, the \( r_{xy} = 0.596 \) is included in the category of strong correlation, so it can be concluded that the increase in students' ability to solve problems is closely related to the increase in mathematical logic intelligence.

After testing the hypothesis with \( t_{\text{count}} \) as above, the results obtained were consulted with \( t_{\text{table}} \) and it was found that \( t_{\text{count}} = 26.47 > 2.025 \) t table (0.05), so that the influence of mathematical logic intelligence on students' mathematical problem solving on Algebra and Geometry material Mathematics in class VII 1 MTsN 6 Agam is significant.

The resulting coefficient of determination for the level of intelligence of mathematical logic is \( r^2 = 0.382 \). It explains that in solving problems in the material of composition function and inverse function, the level of intelligence of mathematical logic has an effect of 38% given through the equation \( Y = Y = 2.908 + 1.17X \) with the remaining 38.2% influenced by other factors. Here, it is clear that the mathematical logic intelligence factor is indeed a big influence on students' problem solving. The success of students in solving problems cannot be separated from the teacher factor. Teachers in learning have a central role. Based on observations, it was found that communication between students and teachers during the learning process was quite balanced. In addition, the questions given have led to
non-routine problems, so this becomes a process of accustoming students to problem solving problems. In addition, student learning styles also influence the ability of students to solve problems.

5. Conclusion

Based on the results of data analysis and discussion, the following conclusions can be drawn: (1) Mathematical intelligence of students at grade VII.1 MTsN 6 Agam, 31% are at the complex level, 41% are at the basic level and 27% are at the coherent level, with average scores of mathematical logic intelligence test of 61.09; (2) Students' problem solving abilities in Algebra and Geometry material for mathematical logic intelligence at the basic and complex levels are included in the less category, with an average test result of 50.66 for the basic level and 62.66 for the complex level, whereas for students with a coherent level included in good category with 74,75 obtained from the test; (3) There is a significant influence between the level of intelligence of mathematical logic with the ability of students to solve problems in Algebra and Geometry material in mathematics in class VII.1 MTsN 6 Agam at 38.2 and for the remaining 61.8% influenced by other factors such as teachers' competence, learning style, learning environment and lack of students in practicing in answering problem solving questions.

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