

# Students Descriptions in Problem-Solving Based on Cognitive Domain Bloom's Taxonomy Viewed from Logical-Mathematical Intelligence

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**Abstract.** This study aimed to describe the levels of thinking students in mathematical problem-solving based on Bloom's taxonomy as seen from logical-mathematical intelligence. The cognitive domain contains intellectual-centered behavior, such as knowledge, and thinking skills. The logical-mathematical intelligence is the ability to handle relevance/argumentation and recognizes patterns and sequences, the ability to use numbers and logic effectively, sensibility in logic, abstraction, categorization, and calculation. The type of this research is descriptive research with a qualitative approach. The research subjects were taken by one student in each logical-mathematical category (high, moderate, and low) which then given the mathematical problem-solving test and the result was triangulated by interview. From this research, it is found that high logical-mathematical intelligence students can achieve analyzing thinking level, subject with moderate logical-mathematical intelligence being able to reach the level of understanding thinking, and subject with low logical-mathematical intelligence able to reach remembering level.

## INTRODUCTION

The development and prosperity of a nation are strongly influenced by the level of education level. National education functions to develop the ability and potential of learners to become knowledgeable, capable, creative, and independent human being that includes the domain of attitude, knowledge, and skills so as to realize a quality education. One of the levels of education that gives great effect is the quality of mathematics that is in the school curriculum. For most people to be able to develop their life, not be separated from the basic skills in learning that is reading, writing, counting, and life skills, and mathematics education is present to develop these skills [1]. A good understanding of mathematics is essential for success in modern society, not only in the prospect of good work but also in a better quality of life [2, 3, 4]. It is characterized by the existence of mathematics in every aspect of life in the community.

Children develop a gradual understanding of mathematics through their primary and secondary education, both formal and non-formal education. To ensure the effectiveness of pedagogy that supports the needs of all learners it is important to recognize the various factors that contribute to mathematical achievement so that the teaching practice can be targeted appropriately. One of the factors that play an important role in mathematical achievement is cognitive that can be drawn by the individual [5]. In a joint statement [6] about mathematics in children's education states that one way of realizing a qualified mathematics education is to use curricula and teaching practices that strengthen the process of problem-solving and child reasoning, as well as representation, communication and linking mathematical ideas [7]. To be able to strengthen the problem-solving process it is necessary to master the problem-solving process and use the right way to solve the problems to be faced so as to raise the expectation that the solution of problems to be faced in the future becomes more effective and efficient.

Based on research conducted by [8], students use all kinds of problem-solving strategies to solve problems. In addition, when students solve problems, they work together to create their problem-solving strategies. Thus, it can

be assumed that different students' way of thinking supports students to use various problem-solving strategies. Bloom's Taxonomy, a taxonomic goal of education and learning, was developed by Benjamin Bloom. Bloom's taxonomy raises ways to align school goals, curricula, and educational assessments, and develops in-depth and in-depth instructional activities and curricula that teachers provide for students. The learning domains as described by Bloom's Taxonomy are cognitive, affective and psychomotor [9].

Bloom's taxonomy on the cognitive domain consists of six levels of knowledge, understanding, application, analysis, synthesis, and evaluation [10]. As time passes and the changing times, Bloom's taxonomy is changing. The cognitive domain dimension of Bloom's taxonomy is remembering, understanding, applying, analyzing, evaluating, and creating. Remember is an action performed by the student to extract the required knowledge from long-term memory. Understand is an act of constructing the meaning of instructional messages, whether oral, written, or graphics, delivered through teaching, books, or computer screens. Apply is an action that students do to apply or use a procedure in solving a problem. Analyze is an action done by students in breaking the material into small parts and determining how the relationship between parts and between each part of the overall structure. Evaluate is an action performed by a student in taking a decision based on a criterion or standard. Create is an action performed by students in combining or arranging elements into a coherent or functional whole [11].

Another factor that affects the cognitive domain is multiple intelligence. According [12], Gardner argues for nine relatively autonomous bits of intelligence, there are linguistic intelligence, logical-mathematical intelligence, musical intelligence, bodily-kinesthetic intelligence, spatial intelligence, interpersonal intelligence, intrapersonal intelligence, naturalist intelligence, and existential intelligence. The intelligence of mathematical logic is one's ability to handle numbers and logic, and to arrange solutions in a logical sequence in solving mathematical problems. The types of processes used in logic-mathematical intelligence services include categorization, classification, conclusions, generalizations, calculations, and test hypotheses. People who prefer to use their logic-mathematical intelligence usually do well on written comprehension standards/tests. They love to solve abstract problems and often do so with experiments and errors [13].

Abilities in logical-mathematical intelligence include numerical abilities, algebraic concepts, number series, and logic. Numerical abilities are numeracy-related skills and numeracy as well as performing mathematical operations. The ability of the concept of algebra is the ability to work in the concept of algebra to solve mathematical problems. The ability of a series of numbers is the capacity to sort, detect and analyze patterns of certain numbers. The ability of logic is the ability of a person in thinking inductively and deductively, thinking according to the rules of logic, understanding and solving problems with the ability to think [14, 15].

Those who exhibit high degrees of logical-mathematical intelligence are able to easily perceive patterns, follow series of commands, solve mathematical calculations, generate categories and classifications, and apply those skills to everyday use [16]. One of the materials taught in class VIII is a two-variable linear equation system. It is hoped that by giving this material, students can help solving problems in everyday life. The purpose of this research is to know how the strategy of mathematical problem-solving based on Bloom's taxonomy, especially in terms of cognitive domains viewed from students' logical-mathematical intelligence on linear equations of two variables.

## **RESEARCH METHOD**

This study used grounded theory, which is a fit to analyze large quantities of unstructured or semi-structured data is qualitative [17, 18]. In order to understand the progress of students' abilities, this study deals with Bloom's taxonomy in terms of students' logical-mathematical intelligence. The research subject was taken at random based on the results of logical-mathematical intelligence test consisting of 30 questions. The test is a multiple-choice examination that refers to numerical abilities, algebraic concepts, number series, and logical-mathematical. Based on the results of intelligence tests of mathematical logic, the subject is classified into three categories, high, intermediate and low. In each category, students will be given two questions about mathematical problem-solving. The results will be analyzed based on Bloom's Taxonomy. Triangulation of data is done to test the data validation analysis by interviews with each subject.

## RESULT AND DISCUSSION

The logic-mathematical intelligence test is used as an instrument to determine the subject. The results of these tests aim to classify subjects into three levels of high logical-mathematical intelligence, moderate logic-mathematical intelligence, and low logic-mathematical intelligence. This level is obtained based on the norm-referenced where the success of the students is compared with the success of the group's friends. The following table presents its grouping rules as follows.

Table 1. Category of Logical-Mathematical Intelligence Level

Score Range ( $X$ )	Logical-Mathematical Level
$X > \mu + 0,5\sigma$	High
$\mu - 0,5\sigma \leq X \leq \mu + 0,5\sigma$	Moderate
$X < \mu - 0,5\sigma$	Low

One student was chosen randomly from each level of logical-mathematical intelligence to obtain a total of three students to perform problem-based tests and provide explanations about the solution of the problem.

### High Logical-Mathematical Intelligence

$$\begin{array}{l}
 1. \quad 2x + 3y = 18 \\
 \quad 2x - y = 2 \\
 \hline
 \quad 4y = 16 \\
 \quad y = \frac{16}{4} \\
 \quad y = 4 \\
 \quad 2x - 4 = 2 \\
 \quad 2x = 2 + 4 \\
 \quad 2x = 6 \\
 \quad x = \frac{6}{2} \\
 \quad x = 3 \\
 \quad 2x - 3y = 2(3) - 3(4) \\
 \quad \quad = 6 - 12 \\
 \quad \quad = -6
 \end{array}$$

Figure 1. High Logical-Mathematical Intelligence answer for number 1

Figure 1 showed that the subject is able to understand the question and recall one of the ways to obtain the set of solutions from the system of linear equations. It is seen in the use of the substitution-elimination method to find the solution set. Subject remembers how to use the method he uses that is by eliminating the variable  $x$  first so that the variable  $y = 4$ . From the interview results obtained that he chose to eliminate the variable  $x$  because the coefficient of variable  $x$  on both systems of the equation is the same so it makes it easier to do it. The next step chooses one equation  $2x - y = 2$  and substituting  $y = 4$  to obtain the variable  $x = 3$ . The steps taken do not face difficulties and get the set of solutions. In addition, the subject understands the given task that the student is assigned to find the value of  $2x - 3y$  and by substituting the value of the variable  $x = 3$  and  $y = 4$  so the result is  $-6$ .

$$\begin{array}{l}
 2. \text{ Satu tahun yang lalu, Syifa : Gita = 3 : 4 maka} \\
 a-1 = \frac{3}{4} \Leftrightarrow 4(a-1) = 3(b-1) \\
 4a - 4 = 3b - 3 \\
 4a - 3b = 4 - 3 \\
 4a - 3b = 1 \dots (1) \\
 \text{Jumlah umur mereka sekarang 16 tahun} \\
 \text{maka } a + b = 16 \dots (2) \\
 \begin{array}{l}
 4a - 3b = 1 \quad | \times 1 | \quad 4a - 3b = 1 \\
 a + b = 16 \quad | \times 4 | \quad 4a + 4b = 64 \\
 \hline
 \quad \quad \quad -7b = -63 \\
 \quad \quad \quad b = \frac{-63}{-7} \\
 \quad \quad \quad b = 9 \\
 a + b = 16 \\
 a + 9 = 16 \\
 a = 16 - 9 = 7
 \end{array} \\
 \text{Jadi, perbandingan umur Syifa dan Gita 3 tahun yang akan datang adalah} \\
 10 : 12
 \end{array}$$

Figure 2. High Logical-Mathematical Intelligence answer for number 2

Figure 2 showed that the subject is able to analyze the problem in story so that subject is able to understand and apply a problem-solving that a subject is able to change the problem into a mathematical form, in this case, a system of two linear equations. After obtained the system of linear equations in two variables  $4a - 3b = 1$  and

$a + b = 16$ , where  $a$  for age Syifa and  $b$  for age Gita. It seems clear that subjects are able to analyze by breaking up problems and determining relationships with one another over the whole. Subjects use the method of substitution-elimination and obtained the value of variables  $a = 7$  and  $b = 9$ . In addition, the subject is able to choose and use one of the procedures for problem-solving that is using elimination-substitution. Thus, the comparison of the three-year-old Syifa and Gita years is 10:12. The final answer given by the subject is correct so that he understands perfectly well that his task is to look for the age comparison of Syifa and Gita for the next three years.

Based on the interview the subject is able to analyze a problem given by the researcher and solve it in a good way even no errors. The subject is also able to explain the steps he took in solving the problem. Based on the results of the analysis and interviews it can be concluded that students with high logical-mathematical intelligence can reach the fourth level of Bloom's education taxonomy that is analyzing.

### Moderate Logical-Mathematical Intelligence

$2x + 3y = 18$   
 $2x - y = 2$   
 $4y = 16$   
 $y = \frac{16}{4}$   
 $y = 4$   
 $2x - 4 = 2$   
 $2x = 2 + 4$   
 $x = \frac{6}{2}$   
 $x = 3$   
 $2(3) - 3(4)$   
 $6 - 12$   
 $= -6$

Figure 3. Moderate Logical-Mathematical Intelligence answer for number 1

Figure 3 showed that the subject is able to understand the question and remember one way to solve the two-variable linear equation system. It is characterized by the subject's ability to find the set of settlements by a substitution-elimination method. He recalled that the method of using the substitution-elimination method is by eliminating the variable  $x$  first so that the value  $y = 4$  is obtained. Next choose one equation,  $2x - y = 2$  and substitute the value  $y = 4$  to obtain the value  $x = 3$ . The steps are taken also did not experience any problems to obtain the set of settlements. In addition, subjects are also able to understand the real question that students are asked to look for a  $2x - 3y$  value and the result is  $-6$ .

2) Umur Syifa sekarang =  $\frac{3}{7} \times 21$  th = 6 th  
 Umur Gita sekarang =  $\frac{4}{7} \times 21$  th = 8 th  
 Umur Syifa 3 th akan datang =  $6 + 3 = 9$  th  
 Umur Gita 3 th akan datang =  $8 + 3 = 11$  th  
 Perbandingan 3:4 (3 th yang lalu)  
 Jumlah umur 3 th yang lalu = 16 th - 2 th = 14 th

Figure 4. Moderate Logical-Mathematical Intelligence answer for number 2

Figure 4 shows that the subject has not been able to analyze the problems given so as not being able to understand and apply a problem-solving. Although in Figure 3 the subject is able to execute well the problem given when the problem is presented in the form of stories relating to everyday life, he has not been able to execute well the problem. Based on interview results, the subject is still experiencing difficulties in understanding the problems presented in story form. The subject has not been able to turn the problem into a linear equation of two variables. This causes the subject to find other alternatives to solve the problem. Because the alternative in solving the problem is not appropriate then the results are also not in accordance with what is expected. Based on the results of the analysis and interviews it can be concluded that students with moderate logic-mathematical intelligence can achieve the second level of Bloom's education taxonomy that is understood.



mathematical intelligence, teachers are expected to be able to design an instrument of learning activities of mathematics that can improve problem-solving skills and student learning outcomes.

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