



## Higher Order Thinking Skill of IX Grade Students in Solving Mathematics Problems Based on Bloom's Taxonomy

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**ABSTRACT:** The purpose of this study is to describe and find out the high-level thinking skills of IX grade students in solving PISA mathematical problems based on Bloom's Taxonomy. The subjects in this study were 58 students drawn from several junior high schools and MTs in Banyuwangi district. The instrument used was a PISA test item that was loaded into the Indonesian PISA Center. The sampling technique is purposive random sampling with descriptive qualitative research methods. The data were analyzed using data collection techniques with the method of documentation, tests and interviews. The results of a high-level thinking study of class IX students in solving PISA mathematical problems based on Bloom's Taxonomy found 1) the existence of subjects with moderate abilities that meet the analysis and evaluation stages and subjects with high abilities that meet the stages of analysis, evaluation and creation, 2) the existence of a hierarchical relationship between the abilities of analysis, evaluation, and creation means students can be said to be highly capable if they can complete and fulfill all three stages in a sequence.

**KEYWORDS:** Bloom's Taxonomy, High order thinking skills, Mathematics education, Students thinking skills.

### I. INTRODUCTION

The quality of Human Resources (HR) is influenced by one factor, namely Education. Quality human resources are the demands of the Asean Economic Community (AEC) in facing the era of globalization. Improving the quality of education comes from improving the quality of learning. Improving the quality of learning can be started by setting appropriate learning objectives [1]. According to Kurniati et al., [2] quality human resources have critical, systematic, logical, creative thinking, and a willingness to work together effectively. Human resources who have these thoughts come from school education institutions. One of the fields of science that plays an important role in the world of education is mathematics.

Understanding of mathematics plays an important role in the younger generation who live in modern society. Situations encountered in daily life and challenges in personal, work, social, and scientific aspects, including in a professional context. They require some level of understanding of mathematics, mathematical reasoning and mathematical tools. Thus, it is important to have an understanding of the extent to which students are sufficiently prepared to apply mathematics in solving problems [3].

PISA (The Program for International Student Assessment) is a program initiated by countries that are members of the OECD (Organization for Economic Cooperation and Development). The subject of the PISA assessment consists of basic literacy tests in reading, mathematics, and science without looking at national curriculum [4]. The target was only tested on students aged 15 years and selected by *random sampling*. The subject is believed to be able to describe the quality of education in a country. This can be seen from the response of the mass media covering the official results of PISA in each participating country [5].

The ability to apply concepts in PISA questions is required to be applicable in various situations. Whardani, [6] argues that PISA questions are very demanding of reasoning and problem solving skills. A student is said to be able to solve a problem if he can apply previously acquired knowledge to a new, unfamiliar situation. This ability is what we usually know as higher order thinking skills.

Based on the results of the 2018 PISA survey for the mathematics category, Indonesia is ranked 7th from the bottom, namely 73 out of 79 countries with an average score of 379. Indonesia is above Saudi Arabia which has an average score of 373. Then in first place is still occupied by China with an average score – average 591 [7]. These results make it clear that the ability of Indonesian students to solve questions that require higher-order thinking processes is still lacking. In working on PISA questions students are required to have the ability to analyze, evaluate, and create [8]. According to Krathwohl, [9] in A revision of Bloom's Taxonomy, states that indicators for measuring higher-order thinking skills include analyzing (C4), namely the ability to separate concepts into several components and relate one another to gain an understanding of the concept as a whole, evaluate (C5) namely the ability to



determine the degree of something based on certain norms, criteria or standards, and to create/create (C6) namely the ability to combine elements into a new form that is whole and wide, or to make something original. Kemdikbud, [10] also argues that higher-order thinking skills are an educational reform concept based on taxonomic learning.

The level of thinking ability is divided into two, namely low level and high level. One of the domains proposed by Bloom is the cognitive domain. The other two domains, namely affective and psychomotor, have their own levels. According to research by Prasetyani et al. [11], Low-level thinking skills include the domains of knowledge, understanding, and application/application. Meanwhile, higher-order thinking skills cover the realm of analyzing, evaluating, and creating.

According to Bloom, higher-order thinking skills are the most abstract skills in the cognitive domain and are indispensable in the learning process [12]. Therefore, improvements and updates are needed in the educational aspect to increase the PISA score and realize the quality of human resources in Indonesia. What needs to be done is to know and recognize the abilities of Indonesian students, so as to facilitate the development of students' abilities [13].

Based on the description that has been presented, the purpose of this study is to describe and determine the high-level thinking skills of class IX students in solving mathematical problems using the PISA model based on Bloom's Taxonomy. This research is expected to be useful in providing information related to the quality of students' higher-order thinking skills in mathematics, so that it can help improve students' HOTS abilities to improve PISA score levels and can help advance education in Indonesia.

## II. METHOD

The type of research used is descriptive qualitative research. In the early stages of this research, namely the preliminary activity stage. At this stage, the researcher determined the research area/place which included one of the SMP/MTs in Banyuwangi. After the research place is determined, the researcher determines the research subject. The research subjects were 58 class IX students of SMP and MTs in Banyuwangi,

A study must have valid research instruments. The instrument includes PISA test questions, indicator rubrics and interview guidelines. Then the instrument is validated to the validator. If the instrument is valid, then the instrument can be used for the research or data collection stage. At this stage it is carried out by conducting tests on standardized PISA questions to determine students' high-level thinking skills based on Bloom's Taxonomy.

After the test was carried out, in the end interviews were conducted with students to obtain data from the aspects of analysis, evaluation and creation. The next stage is data analysis. at this stage the results of student answers from the PISA test questions and interviews that have been conducted will be analyzed. This analysis aims to describe students' high-level thinking skills based on Bloom's Taxonomy C4 (analysis), C5 (evaluation), and C6 (creation). After that, do the categorization of high, medium, and low HOTS levels.

### 2.1 Research subject

The research subjects were 58 class IX students of SMP and MTs in Banyuwangi, with a sample of 2 students. Sampling used a purposive random sampling technique, namely students were selected to be research subjects based on several considerations. These considerations include:

- 1) 15 years old,
- 2) The subject's ability to work on test questions and interviews, and
- 3) Is the result of discussions and recommendations from math teachers who teach the subject, especially for students who communicate easily.

### 2.2 Research Instruments

Order thinking tests, interview guides, and recording devices. The test questions are in the form of 1 PISA question regarding linear equation material quoted from a collection of PISA questions published in the Indonesia PISA Center.

The interview guide in this study was conducted in depth (*in depth interview*), freer, and semi-structured in nature so that researchers could develop their own questions to ask to obtain complete data. Instrument test questions used in research can be seen in Figure 1.

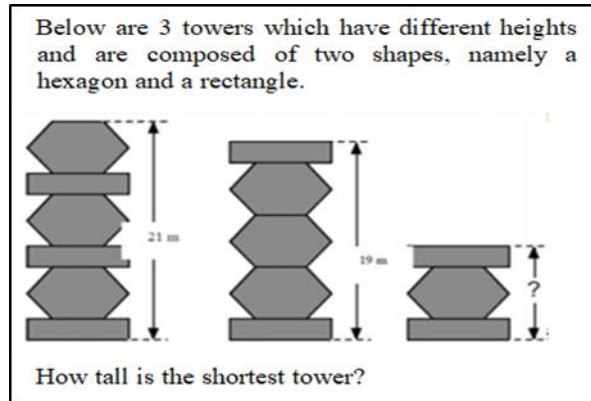


Fig. 1. Instrument Test Questions

Table 1. Higher Order Thinking Indicators

Characteristics of Components of Higher Order Thinking	Characteristics of Bloom's Taxonomy	Indicator
Analyzing	C4 Analyze . The ability to separate concepts into several components and relate them to each other to gain an understanding of the concept as a whole	Analyze the questions by looking at the pictures, so that they can structure or divide the known and asked tower heights Able to recognize and distinguish towers with rectangular and hexagonal shapes Identify / formulate the third tower height question
Evaluating (evaluating)	C5 Evaluating The ability to determine the degree of something based on certain norms, criteria or standards	For example, a rectangular tower with variable $x$ and a hexagonal tower with variable $y$ . Perform calculations by finding the value of $x$ using the elimination method.
Create (creating)	C6 Create The ability to combine elements into a whole and coherent new form, or create something original	Make a generalization of an idea using the substitution method of the $x$ value obtained Substituting the $x$ and $y$ values obtained in the third equation so that the value of the shortest tower can be determined.

This study used data collection techniques with documentation, tests and interviews. The results of the tests or data in this study will be the material to be analyzed regarding higher order thinking skills in solving PISA questions based on Bloom's taxonomy.

The higher-order thinking indicators used in this study have gone through the validation stage which can be seen in table 1. As for the HOTS level categorization stage, it can be seen in table 2.

Data analysis techniques are carried out by:

- 1) Data collection,



- 2) Data reduction, the research data are summarized and focused on important things according to the research topic, namely higher order thinking skills
- 3) Presentation of data, data is presented in the form of narrative text that is well organized and coherent so that it is easy to see, read and understand,
- 4) Conclusion.

**Table 2.** HOTS level categories

No.	Characteristics	Category
	C4 (analysis)	Low
	C4 (analysis), C5 (evaluation)	Moderate
	C4 (analysis), C5 (evaluation), C6 (Creation)	High

### III. RESULTS AND DISCUSSION

In this section, the results and discussion of the research are presented in the form of test results and student interviews in solving PISA questions based on Bloom's Taxonomy on linear equation material. The questions used to measure students' higher-order thinking skills were PISA model math questions that had been validated previously. The following is a description of each research subject.

#### 3.1 Test Result of Subject 1

As seen in Figure 2, subject 1's thinking ability level based on Bloom's Taxonomy is at C5 level (evaluating). Subject 1 was able to solve questions at the evaluating level well. Subject 1 knows all the elements in the problem and is able to exemplify elements with a variable. This can be seen in the interview excerpt as follows.

*Researcher : can you solve the problem?*

*Subject 1 : can*

*Researcher : what does this mean?*

*Subject 1 : it is assumed that the rectangle is  $x$  and the hexagon is  $y$*

*Researcher : why should we assume  $x$  and  $y$ ?*

*Subject 1 : because usually  $x$  and  $y$  are used*

*Researcher : is it permissible to use other variables, such as  $j$  and  $k$ ?*

*Subject 1 : maybe you can*

*Researcher : why is it crossed out?*

*Subject 1: I think there is length and breadth. But that turned out to be high*

Based on the results of the interview above, we can see that subject 1 was able to assume a rectangular tower with the  $x$  variable and a hexagonal tower with the  $y$  variable. Subject 1 uses  $x$  and  $y$  because he is familiar with these variables, so subject 1 is hesitant to use other variables. The level of subject 1's thinking ability is also at level C4 (analyzing). The interview continued as follows

*Researcher : what does this mean?*

*Subject 1 : what is known is that tower 1 is 21 m high, tower 2 is 19 m high meters and tower 3 is 8.5 m high*

*Researcher : where did the height of tower 3 come from?*

*Subject 1 : after I looked at the problem again, it turns out that the height of tower 3 is half of the height of tower 2, so I think the height of tower 2 divided by 2 results in the height of tower 3*

*Researcher : why is the method not written down?*

*Subject 1 : because I memorized it*

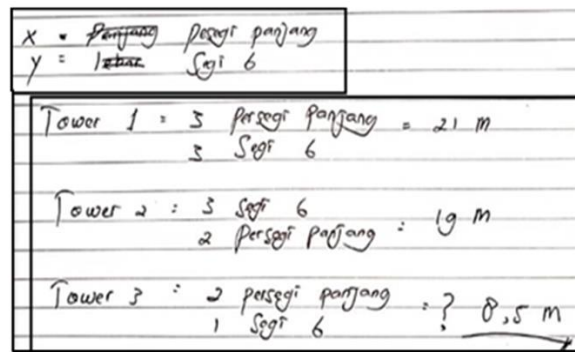


Fig. 2. Subject's 1 Answer

Based on the interview above, we can see that subject 1 is able to analyze the questions by looking at the pictures, so that they can structure or divide the known and asked tower heights and subject 1 is able to recognize and distinguish towers with rectangular and hexagonal shapes. Subject 1 assumes that the height of tower 3 is half of the height of tower 2, meaning  $19/2 \text{ meters} = 8,5 \text{ meters}$ . Even if you look back, tower 2 and tower 3 have a different flat shape. Tower 2 has 3 hexagons and 2 rectangles, while tower 3 has 1 hexagon and 2 rectangles. Subject 1 did not realize that at first glance the height of tower 2 and tower 3 had the same form ratio, but if calculated using a formula in mathematics, the heights of towers 2 and 3 were not comparable. The search was continued with interviews as follows

- Researcher : hen what's the point of assuming a rectangle and a hexagon with the variables x and y?
- Subject 1 : none
- Researcher : why?
- Subject 1 : because by looking at the picture you get results
- Researcher : did you check back the answers you have done?
- Subject 1 : no
- Researcher : why?
- Subject 1 : because I think it's correct
- Researcher : Are you sure about your answer?
- Subject 1 : sure

Based on the interview above, subject 1 did not use the x and y analogy for the rectangles and hexagons that he had done earlier. Because Subject 1 still believes that by looking at the picture, the height of tower 3 is half of the height of tower 2, so it ignores the x and y example. Subject 1 did not re-check the answers that were done, because subject 1 already felt confident with the answer. The third tower height value obtained by subject 1 is 8.5 meters.

3.2 Test Result of Subject 2

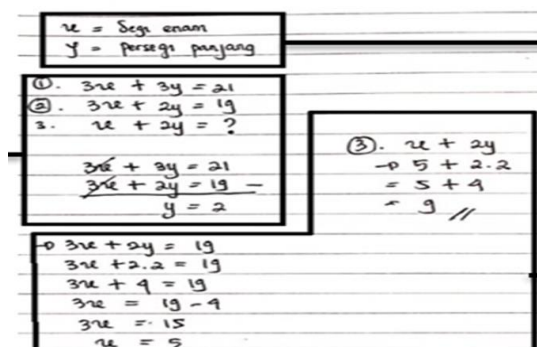


Fig. 3. Subject's Answer 2





In figure 3 the level of students' thinking ability based on Bloom's Taxonomy is at level C4 (analyzing). The search for interviews related to the writing above is as follows.

Researcher : *Can you solve the problem?*

Subject 2 : *can*

Researcher : *what does this mean?*

Subject 2 : *rectangle and A hexagon is represented by the letters x and y*

Researcher : *why do we have to assume x and y?*

Subject 2 : *because the letters x and y are easier and easier to remember. although there are also those who use a, b and others.*

Based on the interview above, subject 2 was able to analyze the problem by assuming a rectangle and a hexagon with  $x$  and  $y$  variables. Subject 2 thinks that the variables  $x$  and  $y$  are easier to remember and often used than other variables.

In addition, subject 2 is also in phase C5 (evaluating). The interview continued as follows

Researcher : *what does this mean?*

Subject 2 : *change it to equation form, so it can be done*

Researcher : *what is produced?*

Subject 2 : *the example earlier, that is  $3x + 3y = 21$  is tower 1,  $3x + 2y = 19$  tower 2 and  $x + 2y$  is tower 3.*

Based on the interview above, subject 2 can change the example of  $x$  and  $y$  into three equations, namely tower 1 equation, tower 2 equation and tower 3 equation. Subject 2 applies the indicator to determine something based on a certain standard, meaning that subject 2 assumes that if you turn it into an equation, the value it will be easier to calculate.

Unlike subject 1, this time subject 2 was able to be in the C6 (creating) phase. The search for interviews with subject 2 was continued as follows

Researcher : *what does this mean?*

Subject 2 : *find the value of  $y$  and  $x$*

Researcher : *how to find the value of  $y$ ?*

Subject 2 : *by way of elimination*

Researcher : *how to find the value of  $x$ ?*

Subject 2 : *with substitution*

Researcher : *why do you use the elimination and substitution method?*

Subject 2 : *usually if there are two equations, use this method*

Researcher : *do you know what method is usually used in the equation?*

Subject 2 : *yes. linear equation*

Based on the results of the interview above, subject 2 was able to create an idea using the elimination and substitution methods. Subject 2 looks for the value of  $y$  first by using the elimination method and looking for the value of  $x$  by the substitution method. Furthermore, Subject 2 used both methods because they were based on their learning experience. When looking for variable values from two equations, then use the method of elimination or substitution. With a familiar method, subject 2 begins to recognize the type of problem being worked on, namely linear equations. the interview continued as follows

Researcher : *then what are the  $x$  and  $y$  values used for?*

Subject 2 : *to find the value of tower 3*

Researcher : *how?*

Subject 2 : *by entering the  $x$  and  $y$  values in the 3rd equation*

Researcher : *did you check back the answers you have done?*

Subject 2 : *yes*

Researcher : *why?*

Subject 2 : *fear of miscalculation*

Researcher : *Are you sure about your answer?*

Researcher : *Are you sure about your answer?*



From the interview above, Subject 2 applied an indicator of the ability to combine elements into a new form, meaning to combine the two methods to find a new equation value. By substituting the  $x$  and  $y$  values into equation 3, then according to subject 2 the value of the third tower height is 9 meters.

#### IV. DISCUSSION

Based on the results of the answers to the PISA test questions and the results of interviews with Subject 1 and Subject 2, it was obtained an explanation of students' higher order thinking tendencies. Subject 1 was able to reach the C4 level of Bloom's Taxonomy (analyze). Analyzing, namely the ability to separate the concept into several components and relate one to another to gain an understanding of the concept as a whole. Subject 1 was able to analyze the questions by looking at the pictures and recognizing and stating things that were known and asked about the questions correctly. However, Subject 1 has not been able to provide an explanation about the use of the example he made to answer the questions given.

During the interview, Subject 1 also gave several theoretical reasons in each step of the process until the final answer was correct. For Subject 2, he was able to analyze the questions by looking at the pictures and recognizing and stating things that were known and asked about the questions clearly, concisely and precisely. Furthermore, Subject 2 was able to provide an explanation of the use of the initial example he made so that it was useful for answering the questions given. Subject 2 was also able to answer interview questions by giving theoretical reasons for each step of the process from the beginning to the final answer correctly.

The ability to evaluate (C5) is the ability to determine the degree of something based on certain norms, criteria or standards. That is, students are expected to be able to provide an assessment of the solutions and methods used in answering questions, and criticizing arguments. In this case, Subject 1 uses known values to calculate answers. In the excerpt of the interview, Subject 1 did not include the procedure, but he felt confident about the answers and the methods used in answering the questions. Furthermore, Subject 1 did not re-check and did not understand the processing steps. Whereas in Subject 2, he was able to provide an assessment of the solutions and methods used in answering the questions correctly. Subject 2 is sure of the answers and the methods used in answering the questions. This is based on the answers and methods used. Next, Subject 2 re-checked starting from what was known to the conclusion of the answer by paying attention to the correct processing steps.

The ability to create (C6) is the ability to combine elements into a new form that is whole and wide, or to make something original. In Subject 1's answer there are incomplete processing steps for the final result. During the interview, Subject 1 gave reasons for the process or method used but did not write it down on the answer sheet. So that the answer produced by Subject 1 is wrong. In Subject 2's answer there are complete, systematic, and theoretical work steps for the final answer. Next, Subject 2 gives reasons for doing it logically and writing clear and effective answers.

The results of this study differ from the results of previous studies, which stated that the absence of students with high HOTS abilities was caused by a lack of understanding of some materials and their uses [3]. In this study, subjects with high abilities fulfilled the stages of analysis, evaluation and creation.

#### V. CONCLUSIONS AND SUGGESTIONS

Based on the results of research and discussion related to higher order thinking skills (HOTS) based on Bloom's Taxonomy, it can be concluded that Subject 1 fulfilled stages C4 (analyze) and C5 (evaluate) quite well and did not fulfill stage C6 (creation). That is, Subject 1 is still in the HOTS level category with moderate ability. Meanwhile, Subject 2 fulfilled stages C4 (analyzing), C5 (evaluating) and C6 (creating) well. That is, Subject 2 is included in the HOTS level category with high ability.

In this study also obtained a statement that there is a hierarchical relationship between the ability of analysis, evaluation, and creation. Students can be said to have high abilities if they can complete and fulfill stage C4 (analyzing), then stage C5 (evaluating) and finally stage C6 (creating). The researcher hopes that the results of this study can be used as information to conduct other, broader research on how students' HOTS learn mathematics with different student characteristics and materials, so that they can explore student HOTS with the aim of improving the PISA 2021 score level in the future.



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## VII. DISCLOSURE

Regarding this study, the author has disclosed no conflicts of interest.

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