The Analysis of Higher Order Thinking Skills in Solving PISA (*Programme for International Student Assessment*) Questions for Xth Grade Students

*Hikmahturrahman[1], Nurdin Arsyad[2], Hamzah Upu[3]

[1] *Mathematics Education Master's Program, Universitas Negeri Makassar, Makassar, Indonesia*
[2,3]*Universitas Negeri Makassar*
Corresponding author. E-mail: hikmat.sanggili93@gmail.com

ABSTRACT

This research aims to discover Higher Order Thinking Skills (HOTS) in solving PISA questions based on the revised Taxonomy Bloom's for Xth grade. The type of this research is qualitative with a case study approach. Data collection methods used were written tests and interviews. The Miles and Huberman model used the data analysis technique, namely data reduction, display data, and conclusion drawing/ verification. The subjects in this research were selected using purposive sampling, namely 3 high-ability mathematics students based on the written test results. The instrument used was 3 questions adapted from PISA, consisting of levels 4, 5, and 6. The time is given to solve the questions in 30 minutes. The method of interviews used is in-depth interviews. The results showed that the first subject (NU1) could meet the indicators for analyzing the categories of differentiating, organizing, and attributing and the indicators for generating, planning, and producing categories. But is not meet the evaluation indicators, both checking and criticizing categories. The second subject (AM2) can meet the indicators for analyzing the categories of differentiating, organizing, and attributing and the indicators for generating, planning, and producing categories. But is not meet the evaluation indicators, both checking and criticizing categories. The third subject (NA3) can meet analyze indicators for the differentiating, organizing, and attributing categories. But is not able to meet the evaluation indicators for the category of checking and criticizing, and the indicator creates for generating, planning, and producing categories.

Keywords: *Analysis, HOTS, PISA, Taxonomy Bloom.*

1. INTRODUCTION

Education is a necessity, so everyone should study. One of the fields of education that has a major influence on it is mathematics. Referring to the opinion of the National Research Council (1989) that "Mathematics is the basis of science and technology," [1]. It shows that mathematics as a science is constantly evolving in responding to the needs that exist in society. According to [2], "mathematics is one of the important subjects relating to the development of science and technology." The National Council of Teacher Mathematics (NCTM) states that there are several criteria that students need to have, namely problem-solving skills, communication skills, connection skills, reasoning skills, and representation skills. These characters are Higher Order Thinking Skills

(HOTS) [3]. According to Lestari [4] suggests that the ability to think at a high level is the ability to connect ideas and facts, analyze, explain, hypothesize, synthesize, or get to the stage of concluding to solve problems.

One theory that addresses high levels of thinking ability is bloom's taxonomy. Bloom taxonomy is a hierarchical structure that identifies thinking skills from low to high [5].

While the revision of Bloom Taxonomy states that students' thinking ability can be distinguished into 6 levels: remembering, understanding, applying, analyzing, evaluating, and creating. The level of thinking ability is divided into two groups; namely, Lower Order Thinking Skills (LOTS), including remembering/C-1, understanding/C-2, and applying/C-3, higher-order thinking skills (HOTS)

include analysing/C-4, evaluating/C-5, and creating/C-5 [6].

One of the main assessments that assess students' math and science skills at the international level is PISA (Programme for International Student Assessment). PISA is an international study conducted by the Organization for Economic Cooperation and Development (OECD) and attended by 70 countries worldwide. Pisa monitors the results of the system from the point of view of student learning achievement in each participating country, which includes three literacies: reading literacy, mathematics literacy, and scientific literacy.

Table 1. Comparison of Bloom's Taxonomy and its Revision.

Bloom's Taxonomy	Revised Bloom's Taxonomy	Description
Knowledge	Given the	Lower Order Thinking Skills
Understanding	Understanding	
Application	Apply	
Analysis	Analyzing	Higher Order Thinking Skills
Synthesis	Evaluating	
Evaluation	creating	

Source:[5]

The general purpose of PISA is to assess the extent to which 15-year-old students in OECD countries (and other countries) acquire the right skills in reading, maths, and science to make a significant contribution to their society.
According to [7], Indonesia's involvement in PISA is one of the efforts to see the quality of Indonesian Education develop in the world. Pisa's study resulted in 2003, Indonesia ranked 39th out of 40 countries, and PISA results in 2009 showed that the math literacy ranking of Indonesian students ranked 61 out of 65 countries. PISA resulted in 2012, Indonesia ranked 64th out of 65 participating countries.

Table 2. Indonesia participated in PISA

Year	Indonesia Ranking	Score	Country Participants
2000	39	367	41
2003	38	360	40
2006	50	391	57
2009	61	371	68
2012	64	375	65

Although the PISA 2015 results rose by 64 points from 72 countries, [8] this shows that students' math literacy in Indonesia is still low. The low yield requires the Indonesian education world to prepare for the rapid development of knowledge and technology of the 21st century. PISA questions demand problem-solving and reasoning skills. A student is said to solve problems if able to apply previously gained knowledge into new unknown conditions. The OECD explains that PISA includes three major components of the mathematical domain: content, context, and competency groups. Content groups are Change and relationship, Space and Shape, Quantity, Uncertainty, and data. Context groups are personal contexts, Educational and occupational contexts, general contexts, and scientific contexts. The last competency groups are the reproduction group, the connection group, and the reflection group.

Table 3. Relationship Level PISA with Bloom's Taxonomy

Level PISA	Bloom's Taxonomy	Level
Level 4	C-4	HOTS
Level 5	C-5	
Level 6	C-6	

Source:[7]

Level 4 is students work effectively and select and integrate different representations, then connect them to the life context, while C-4 is the ability to classify concepts to understand the concept. Level 5 is that students work with complex situations and can solve complex problems, while C-5 is the ability to assess solutions using existing criteria to ensure their effectiveness. Level 6 is students solving mathematical problems, generalizing, formulating, and communicating their findings, while C-6 is the ability to connect elements into new and coherent results.

Several researchers have analyzed the ability of Indonesian students to solve PISA standard questions. As [9] in their research have discussed students' higher-order thinking skills in solving PISA standard questions by using several indicators such as logic, reason, analyze, evaluate, and create.

This study also aims to analyze higher-order thinking skills in solving PISA questions. Still, the indicators of higher-order thinking skills based on Bloom's Taxonomy revision are analyzed, evaluated, and created.

2. RESEARCH METHODOLOGY

Qualitative research with a case study approach designed to analyze high-order thinking skills in solving PISA questions (*Programme for International Student Assessment*). Case study research is an attempt to describe and analyze a particular case in depth. Qualitative research is a process of research to uncover a social phenomenon and human problems of individuals, groups, communities such as behavior, perception, or action [10]. Data collection techniques used are written tests and interviews. The Miles and Huberman model used data analysis, data reduction, data presentation, and conclusion drawing/ verification.

Subjects of this research are 3 students of class X SMAN 2 Takalar. Variable analyzed is high order thinking skills based on Taxonomy Bloom revision. The instruments of this research are the researcher as the main instrument and written questions as supporting instruments. Supporting instruments used are 3 questions adapted from PISA. They are questions levels 4,5, and 6 that have been validated by experts who are competent in their field and then conduct an interview that aims to explore and clarify students' answers in depth.

The scores obtained are categorized into three with a scale as shown in Table 4

Table 4. Category Ability

Score (x)	Description
$66 \leq x < 100$	High
$33 \leq x < 66$	Medium
$0 \leq x < 33$	Low

3. FINDING AND DISCUSSION

In this research, students were asked to complete three PISA-standard mathematics questions at levels 4, 5, and 6, which competent experts in their fields validated. The questions used are as follows.

1. Pizza Hut Delivery (PHD) is a pizza shop that provides two servings of pizza of different sizes but has the same taste and thickness. If a small portion has a diameter of 30 cm and is sold at Rp. 60,000 and the large one with a diameter of 40 cm for Rp. 80,000, so which portion of the pizza is more profitable for the seller?
2. SLANK is one of the famous rock bands in Indonesia. When holding a concert, it is necessary to prepare a field with 100 m x 75 m for the audience. If the concert tickets have been sold out and the field is starting to fill up with fans standing up, which of the following is the approximate number of spectators present at the concert?
   a. 2,500 people
   b. 5,000 people
   c. 22,500 people
   d. 75,000 people
   e. 100,000 people
3. A glass manufacturer produces glasses of the same shape and size. However, it turns out that there is 1 glass made of material A mixed with 999 glasses made of material B. The glass made of material A has a lighter weight than the glass made of material B. The manufacturer only has 1 scale that can weigh a maximum of 700 glasses with an accuracy of up to milligrams. Determine the minimum number of weighing's carried out to obtain 1 glass made of material A?

Table 5. Percentage of HOTS Test Results using PISA Questions

Question	Level	Analyze	Evaluate	Create
1	4	19 %		
2	5		17 %	
3	6			7 %

The results showed that the percentage value of 30 students of class X SMAN 2 Takalar in solving PISA questions was very low on all questions, namely levels 4, 5, and 6. This confirmed the results of the PISA survey, which showed that students' mathematical literacy skills in Indonesia were very low.

Table 6. HOTS Subject Test Results using PISA Questions

No.	Name	Score	Category
1.	Nia Utami	80	High
2.	Andi Mariska	70	High
3.	Nur Afni S.	30	Low

The three subjects were students who got the highest score in the written test using PISA standardized questions.

The first subject (NU1) showed that she was able to answer number 1 correctly. Not only on the results of the written test, but the results of interviews with NU1 subjects also showed that she could explain the steps in solving questions correctly. Starting from analyzing the known elements and the elements being asked, then understanding the meaning of the question, determining the right formula to solve the problem until getting the correct answer. This showed that the subject of NU1 met the indicator analyse/C-4 on higher-order thinking skills with differentiating, organizing, and attributing categories.

Question number 2 showed that the subject of NU1 could answer the question correctly but was unable to give the right reason in choosing the answer. This can be seen from the results of in-depth interviews that she chose an answer from 5 answer choices without understanding how to solve the problem. Hence she got the result according to her choice of solution. NU1 stated that it was very difficult for her to find the right way to solve the problem correctly. Therefore, it can be concluded that NU1 did not meet the evaluate/C5 indicator on the ability to think at a high level with the category of checking and criticizing.

On the written test results, the subject of NU1 in question number 3 showed that she met the create/C-6 indicator in high-order thinking skills in the categories of generating, planning, and producing. This problem required creativity to find the right way to solve the problem. However, the subject of NU1 was quite creative in finding the right way. Therefore, she can get the correct answer.

The second subject (AM2) showed that she was able to answer question number 1 correctly. This can be seen from the AM2 subject's written test results, which showed that AM2 reported the formula and steps for solving the problem correctly; hence, she got the correct answer. This was also reinforced by the results of the interview with Subject AM2, which also showed that she could explain the steps in solving problems correctly. Starting from analyzing the known elements and the elements being asked, then understanding the meaning of the question,

determining the right formula to solve the problem until getting the correct answer. This showed that the subject of AM2 met the indicator analyse/C-4 on higher-order thinking skills with differentiating, organizing, and attributing categories.

Question number 2 showed that the subject of AM2 was unable to answer the question correctly. Her written results and in-depth interviews showed that AM2 seemed confused in solving question number 2. AM2 also stated that she did not understand the meaning of the question, which made it difficult for her to find the right way to solve the problem. Therefore, it can be concluded that NU1 did not meet the evaluate/C5 indicator on the ability to think at a high level with the category of checking and criticizing.

On the results of the written test, subject AM2 on question number 3 showed that she could solve the problem correctly. Even though at the time of the interview, AM2 found it difficult to solve the problem. It took quite a long time to find the right way. Besides, the shape of the question is also quite long. Therefore, it can be concluded that AM2 met the create/C-6 indicator in higher-order thinking skills in the generating, planning, and producing categories. This problem required creativity to find the right way to solve the problem. However, the subject of AM2 was quite creative in finding the right way; hence she was able to get the correct answer.

The second subject (NA3) showed that she was able to answer number 1 correctly. This can be seen from the NA3 subject's written test results, which showed that NA3 wrote the formula and steps for solving the problem correctly; therefore, she got the answer perfectly. This was also supported by the results of interviews with NA3 Subjects, who showed that she could explain the steps in solving problems correctly. Starting from analyzing the known elements and the elements being asked, understanding the question's meaning, determining the right formula to solve the problem to get the correct answer. Therefore, it can be concluded that the subject of NA3 meets the indicator analyse/C-4 on higher-order thinking skills with differentiating, organizing, and attributing categories.

Question number 2 showed that the subject of AM2 was unable to answer the question correctly. Both the written results and in-depth interviews showed that AM2 seemed to have difficulty solving question number 2. AM2 also stated that she did not understand the meaning of the questions, which made it difficult for her to find the right way to solve the problem. Therefore, it can be concluded that NU1 did not meet the evaluate/C5 indicator on the ability to think at a high level with the category of checking and criticizing.

On the results of the written test, subject AM2 on question number 3 showed that she could not solve the problem correctly. From the results of the interview, NA3 also stated that she was confused in solving the questions. She also said that she had never encountered such a problem before. The narration of the question was also quite long, so it took a long time to understand the meaning of the question. Therefore, it can be concluded that AM2 met the create/C-6 indicator in higher-order thinking skills in the generating, planning, and producing categories. This problem required creativity and knowledge to find the right way to solve the problem. However, the subject of AM2 was quite creative in finding the right way; hence she was able to get the correct answer.

4. CONCLUSION

Based on the results of studies in Xth grade students, it seems likely that the first subject (NU1) can meet the indicators for analyzing the categories of differentiating, organizing, and attributing, and the indicators for creating the generating and planning and producing categories. But is not meet the evaluation indicators, both checking and criticizing categories. The second subject (AM2) can meet the indicators for analyzing the categories of differentiating, organizing, and attributing and the indicators for generating, planning, and producing categories. But is not meet the evaluation indicators, both checking and criticizing categories. The third subject (NA3) can meet analyze indicators for the differentiating, organizing, and attributing categories. But is not able to meet the evaluation indicators for the category of checking and criticizing, and the indicator creates for generating, planning, and producing categories.

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