

# ASSESSMENT OF EXAM QUESTIONS QUALITY ACCORDING TO COGNITIVE DOMAIN OF BLOOM'S TAXONOMY

Merisa Kartikasari<sup>1</sup>, Tri Atmojo Kusmayadi<sup>2</sup>, Budi Usodo<sup>3</sup>

Postgraduate Program of Mathematics Education, Sebelas Maret University  
(merisa.kartikasari@gmail.com<sup>1</sup>), (tri.atmojo.kusmayadi@gmail.com<sup>2</sup>),  
(budi\_usodo@yahoo.com<sup>3</sup>)

## Abstract

2013 curriculum specially prepared students to compete in a global education. Therefore, it provided students an exam with Higher Order Thinking questions. In the learning process, the questions would play a central role. The aim of this research is to describe cognitive domain of middle school semester 1 exam questions composed by the teacher. This research is qualitative-descriptive research. The subjects were two teachers in Senior High School 1 Cawas. One teacher was a senior subject and the other was a beginner subject. The techniques of collecting data was documentation. The data were validated using triangulation method. All data were analyzed using the model of Miles and Huberman. The result on the study showed that the most common middle school semester 1 exam questions used by all subjects were application aspect whereas analysis aspect was least used. Even, in beginner subjects, analysis aspect was not used at all. The quality of both questions arranged by the two subject was different. Question arranged by senior subject could not be resolved directly. Students had to interpret the questions to other form. Even, the question arranged by beginner subject could be resolved directly without interpreting the intent question first. Questions of comprehension aspect arranged by senior subject demanded skills of students to change the question to other form. Even in beginner subject, questions could be solved simply by applying the formula. Question of analysis aspect was only used by senior subject. In this aspect, question was around of conclusion of logarithm.

**Keywords:** Bloom's Taxonomy, Cognitive Domain, Mathematics Teacher

## Introduction

Curriculum in Indonesia continues to change and improve. The Two thousand and thirteen (2013) Curriculum is applicable in Indonesia today. The curriculum is prepared to equip students to face the challenges of global education. It is a competency-based curriculum. Thus, each subject on the curriculum in 2013 is expected to contribute to the formation of attitudes, knowledge and skills.

The teachers as the spearhead of education need to be anticipated by implementing specific strategies to prepare students to meet the current educational changes. Based on the Six Principle of Mathematics formulated by the National Council of Teachers of mathematics (2000), students should learn mathematics with understanding, and actively building new knowledge from experience and previous knowledge. Therefore, teachers have a responsibility to facilitate the students building their understanding and knowledge. One way is by presenting exam questions which are able to raise student's creative thinking.

One of the references used by teacher in arranging questions of an exam is books, either the books provided by government or books sold in the market. But in fact the cognitive domain of questions used in preparation on BSE math books grade VII is mostly in application aspect. Over 50% questions in that book are application aspect (Giani, Zulkardi, & Hiltrimartin, 2015). Analysis aspect was least used. Whereas the proportion of questions to achieve Basic Competence (KD) in the “*Kurikulum Tingkat Satuan Pendidikan (KTSP)* or School-Based Curriculum (SBC)” suggests that application aspect and analysis aspects be in balance. Rufiana (2015) did similar research in the 2013 curriculum’s book. His reearch shows that the most common questions was comprehension aspect (98.01%). Reasoning and argumentation questions were least used in that book.

The selection of reference books are very important thing for teachers to develop their question quality. It would be better if the teacher can develop their questions quality according to the proportion of the current curriculum. However, the teacher will be difficult to choose higher order thinking question when the contained question in the book as the result of Giani, Zulkardi, & Hiltrimartin (2015) and Rufiana (2015). Whereas, 2013 curriculum emphasises on the questions of problem solving. The government has formulated core competence (KI), and basic competence (KD) in 2013 curriculum has been adapted to question of international scale such Trends in Mathematics and Science Study (TIMSS) and Programe for Internasional Student Assessment (PISA).

Based on the description above, the aim of this study is to describe cognitive domain of middle school semester 1 exam questions which are arranged by teachers in 2013 curriculum according to cognitive domain of Bloom’s Taxonomy.

### **Finding and Discussion**

This research is qualitative-descriptive research. The technique of collecting data is documentation. The data is validated using the triangulation method. The data used are middle school semester 1 exam questions which were composed by teachers. The subjects of this research were two mathematics teachers in Senior High School 1 Cawas. Each teacher was grouped into senior subject and beginner subject.

Cognitive domains related to the ability and skills of person (Micklich, 2011: 262). The cognitive domain can be interpreted as relating to one's abilities and skills in the field of knowledge. Bloom categorize cognitive domain into six categories: knowledge, comprehension, application, analysis, synthesis, and evaluation. The sixth categories are re-classified into two level of thinking called Lower Order Thinking (LOT) and Higher Order Thinking (HOT). Lower order thinking consist of knowledge aspects, comprehension aspect, and application aspect, while HOT include analysis aspects, synthesis aspect, and evaluation aspect (Heng & Ziguang, 2015: 68).

Cognitive domain in the study were classified according to the table indicators determining the cognitive domain.

#### Indicators Determining the Cognitive Domain of Questions

Aspects of Cognitive Domain	Indicators
<b>Knowledge Aspect (C1)</b>	a. Using the verb: recall, recognize, stated, b. Competence tested include things learned by student, recalled, mentioning the facts, concepts, definitions, proposition and such.
<b>Comprehension Aspect (C2)</b>	a. Using the verb: represent, show, concludes b. Competence tested include understanding the meaning of a material but in a low level, for example, interpret or construct an information into something more meaningful information.

Aspects of Cognitive Domain	Indicators
<b>Applications aspect (C3)</b>	a. Using the verb: execute, implement b. Competence tested is using the knowledge they have gained, to apply the concept, using a mathematical procedure to a problem that is familiar to the students.
<b>Analysis aspect (C4)</b>	a. Using the verb: drawing conclusions b. Competence tested in the form of the ability of learners to think critically to identify the problem to interpret part of the question into one new system
<b>Synthesis aspect (C5)</b>	a. Using the verb operations: creating b. Competencies tested is the ability of students to construct something new from a variety of elements, concepts, design rules and so on.
<b>Evaluation Aspect (C6)</b>	a. Using the verb: assess, inspect b. Competence tested is student's ability to make the criteria, review and consider the (error, accuracy, statutes) and are able to assess

Source: (Budiyono, 2015: 84-88) (Giani, Zulkardi, & Hiltrimartin, 2015: 16)

The following cognitive domain framework in this research was adopted from Giani's framework (2015).

- Identify the questions arranged by each subject
- Finding solution from each question
- Describing the solution process
- Analyze the cognitive peaks category
- Counting the number of questions on each cognitive aspect
- Make conclusion

The following description of the cognitive domain discussion of middle school semester 1 exam questions in each subject.

### Senior Subject

This data of senior subject is middle school semester 1 exam question on 10<sup>th</sup> grade. This exam is contained ten question. The question of senior subject are presented in table 1.

#### Question of Senior Subject

No	Question Number	Questions
a.	Question 1	The value of $x$ that satisfies the following statement of $\sqrt{3^{4x+2}} = \left(\frac{1}{3}\right)^{2x-5}$ is ...
b.	Question 2	When ${}^3\log 8 = p$ , then ${}^2\log 9 = \dots$
c.	Question 3	The solution set for the following equation $\left. \begin{matrix} 4x + 3y = 2 \\ x + y = 1 \end{matrix} \right\}$ is ...
d.	Question 4	A simple form from $\frac{\sqrt{3}-\sqrt{5}}{\sqrt{3+\sqrt{5}}}$ is ...
e.	Question 5	when 1,313131... expressed in the form $\frac{a}{b}$ , then the value of $a - 2b$ is ...
f.	Question 6	$\log \frac{1}{3} \cdot {}^9\log \frac{1}{4} = \dots$
g.	Question 7	The solution set of $ 3x + 1  = 7$ is ...
h.	Question 8	The value of 2 books and 1 pencil are ...
i.	Question 9	When $\left. \begin{matrix} x - y = 1 \\ y - z = 1 \\ x + z = 4 \end{matrix} \right\}$ , then $x + y - z = \dots$
j.	Question 10	When $\frac{1}{x} + \frac{1}{y} = 5$ and $\frac{2}{x} - \frac{1}{y} = 4$ , then the value of $xy = \dots$

Instruction of question 1 is finding the value of  $x$  from following equation. Question 1 can be solved with equalize the main number first. After that, students can proceed with the completion of the procedures applying a variable linear equation. Based on the table 1, competence tested is the application of mathematics

concept already familiar for students. It included in cognitive domain C3 (application aspect).

Instruction of question 2 is finding solution of  $2\log 9$  logarithm unknown. It can be solved by breaking the elements of  $2\log 9$  into an equation that match with  $3\log 8 = p$ . Based on the table 1, competence tested on critical thinking skills of students in identifying problems to interpret part of the question into new system is definition of draw conclusion. It included in cognitive domain C4 (analysis aspect).

Question 3 and question 7 have nearly same instruction. Both of equality instructed to determine solution set of an equation. Differences in the question are in the procedure settlement. Question 3 can be solved by applying concept of linear system with two variables. Even in equation 7, it can be solved by applying concept of absolute value equation. Based on the table 1, competence tested is the application of mathematics concept already familiar for students. It is definition of execution and include cognitive domain C3 (application aspect).

Instruction of question 4 is expressing in simplest radical form. It can be solved by rationalize the denominator by multiplying the expression. Based on the table 1, competence tested is interpret information into other information more meaningful. It is definition of represent and include cognitive domain C2 (comprehension aspect).

Instruction of question 5 is determine the result of  $a - 2b$  from equation unknown. It can be solved by converting a decimal into it's equivalent fraction first. Interpret information into other information more meaningful. It is definition of represent and include cognitive domain C2 (comprehension aspect). Then, substitute that value for  $a$  and  $b$  in  $a - 2b$ . Based on Table 1, competence tested is the application of mathematics concept already familiar for students and use the result to a new situation. It is definition of *implement* and included in cognitive domain C3 (application aspect). So, the cognitive domain peak in this question is C3 (application aspect).

Instruction of question 6 is calculates the operation logarithm. It can be solved by applying logarithm rules with equivalently logarithm unknown. Based on Table 1, competence tested is the application of mathematics concept already familiar for students. It is definition of execution and include cognitive domain C3 (application aspect). The next step is solving mathematics model using linear system with two variables.

Instruction of question 8 is finding the value of 2 books and 1 pencil. It can be solved by interpret question into mathematical modeling. Based on table 1, competence tested is interpreted information into other information more meaningful. This definition represented and included in cognitive domain C2 (comprehension aspect). Then, substitute that value for  $a$  and  $b$  in objective function. Based on the table 1, competence tested is the application of mathematics concept already familiar for students and use the result to a new situation. It is definition of *implement* and is included in cognitive domain C3 (application aspect). So, the cognitive domain peak in this question is C3 (application aspect).

Question 9 and question 10 have similar instruction. Both questions were to determine solution set of an equation. Differences in the question were in the procedure settlement. Question 9 can be solved using linear system with three variables directly. Even in question 10 can be solved using linear system with two variables. Based on the table 1, competence tested is the application of mathematics concept already familiar for students and use the result to a new situation. It is

definition of *implement* and is included in cognitive domain C3 (application aspect).

Based on the description above, the following result of cognitive domain mapping of senior subject represented in Table 3.

Mapping the Cognitive Domain of Senior Subject

C1	C2		C3		C4	C5	C6	C7
	Represent	Execution	Implement	Conclusion				
	4	1, 3, 6, 7	5, 8, 9, 10	2				

Based on Table 3, questions arranged by senior subject consist of comprehension aspect (C2), application aspect (C3) and analysis aspect (C4). In comprehension aspect, operational verb used is represented. Question tested only about change to another form from information known. In application aspect, operational verb used are execution and implement. Execution verb on the Table 2 is about to finding the value and solution set of an equation and inequation. Implement verb on Table 2 is about substitution the value for solution set in equation known. In the equation that arranged by senior subject, question can not be solved directly. It must be change to another form or mathematical models first. They are steps of C2 that student must complete first. Senior subject also bring analysis aspect, but in very small quantities. Analysis aspect appeared in a question of logarithms.

### Beginner Subject

This data of beginner subject is middle school semester 1 exam questions on 11<sup>th</sup> grade. This exam had 8 questions. The questions of beginner subject are presented in Table 4.

Question of Beginner Subject

No	Question Number	Question of Data I
a.	Question 1	When the polynomial $p(x) = 2x^4 + ax^3 - 3x^2 + 5x + b$ is divided by $x^2 - 1$ the remainder is $6x + 3$ . Then the value of $a$ and $b$ is ...
b.	Question 2	When $x_1, x_2, x_3$ and $x_4$ are roots of polynomials $3x^4 - 5x^3 + 8x^2 - 4x + 2 = 0$ , then finding the values of : a) $x_1 + x_2 + x_3 + x_4$ b) $x_1 \cdot x_2 \cdot x_3 \cdot x_4$ (C2)
c.	Question 3	Determine the factors and roots from ...
d.	Question 4	A function $f(x)$ is divided by $x^2 - 3x$ the remainder is $2x + 1$ , and also divided by $x^2 + 3x$ the remainder is $3 - x$ , then finding the remainder if $f(x)$ is divided by $f(x) = x^2 - 9$
No	Question Number	Question of Data I
e.	Question 5	a. $A = \begin{bmatrix} a & 2 & 3 \\ 5 & 4 & b \\ 8 & 6c & 11 \end{bmatrix}, B = \begin{bmatrix} 6 & 5 & 8 \\ 2 & 4 & 4b \\ 11 & 2a & 11 \end{bmatrix}$ and $A = B^T$ . Finding the value of ) $a, b$ and $c$ ) $a + 4c$ ) $2a - 2b + 5c$ (C3) b. Finding the value of $x$ and $y$ from ) $\begin{bmatrix} 3 & 1 \\ 3 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 9 \\ 12 \end{bmatrix}$ ) $\begin{bmatrix} x-y & 2x+1 \\ -3 & 15 \end{bmatrix} + \begin{bmatrix} 45 & 9 \\ 4y-3 & x+y \end{bmatrix} = \begin{bmatrix} 40 & 50 \\ 94 & 60 \end{bmatrix}$ (C3)
f.	Question 6	Draw the area solution from ..
g.	Question 7	Determine :

- 
- a.  $A^{-1}$   
 b.  $B^{-1}$   
 c. When  $X$  is a matrix and  $AX = B$ . finding the matrix  $X$  (C3)
- 

Instruction of Question 1 is finding the value of polynomials where factors, roots and remainder are unknown. It can be solved directly by factor theorem. Based on the table 1, competence tested is the application of mathematics concept already familiar for students. It is definition of *execution* and include cognitive domain C3 (application aspect).

Instruction of question 2 is determine the sums and product the of roots polynomial. It can be solved with recall the formula of sums and product of roots polynomial. Recall verb is included in cognitive domain C1 (knowledge aspect). Then interpreting polynomial is done by corresponding the constant of variable. It is definition of interpreted and include cognitive domain C2 (comprehension aspect). So, the cognitive domain peak in this question is C2 (comprehension aspect).

Instruction of question 3 is determine factors and roots of polynomial. It can be solved by applying Horner's theorem. Based on the table 1, competence tested is the application of mathematics concept already familiar for students. It is definition of *execution* and include cognitive domain C3 (application aspect).

Instruction of question 4 is determine remainder of  $f(x)$  is divide by  $x^2 - 9$  when remainder and divider are unknown. It can be solved with recall the concept of "when  $f(x) : (x - a)$  then the remainder is  $f(a)$ " where  $a$  is root of polynomial  $f(x)$ . Recall verb is include cognitive domain C1 (knowledge aspect). Then applying the result on the remainder theorem which is already familiar for students. Based on the table 1, competence tested is the application of mathematics concept already familiar for students and use the result to a new situation. It is definition of *implement* and include cognitive domain C3 (application aspect). So, the cognitive domain peak in this question is C3 (application aspect). So, the cognitive domain peak in this question is C3 (aplying aspect).

Instruction of question 5a is finding the value of  $a$ ,  $b$  and  $c$  of matrix equation and matrix transpose. It can be solved by recall the concept of matrix transpose first. Recall verb is include cognitive domain C1 (knowledge aspect). Then, the result of both matrix can be substitute into equation unknown. Based on the table 1, competence tested is the application of mathematics concept already familiar for students and use the result to a new situation. It is definition of *implement* and is included in cognitive domain C3 (application aspect). So, the cognitive domain peak in this question is C3 (application aspect). So, the cognitive domain peak in this question is C3 (application aspect).

Instruction of question 5b is finding the value of  $x$  and  $y$  of sums and product matrix. It can be solved by recall the concept of sums and product matrix first. Recall verb is included in cognitive domain C1 (knowledge aspect). Then, the result of both matrix can be substitute into equation unknown. Based on the table 1, competence tested is the application of mathematics concept already familiar for students and use the result to a new situation. It is definition of *implement* and include cognitive domain C3 (application aspect). So, the cognitive domain peak in this question is C3 (application aspect). So, the cognitive domain peak in this question is C3 (application aspect).

Instruction of question 6 is draw an area graph. It can be solved by applying concept of linear system inequality with two variables. Based on the table 1, competence tested is the application of mathematics concept already familiar for students and use the result to a new situation. It is definition of *implement* and is

included in cognitive domain C3 (application aspect). Then, the result of set solution can be used to draw an area graph. Interpreting information unknown to other information more meaningful is definition of represent and is included cognitive domain C2 (comprehension aspect). So, the cognitive domain peak in this question is C3 (application aspect). So, the cognitive domain peak in this question is C3 (application aspect).

Instruction of question 7a and 7b are finding the inverse of a matrix. It can be solved by recalling the concept of matrix inverse first. Recall verb is included cognitive domain C1 (knowledge aspect). Then, the result of both matrix can be substitute into equation unknown. Based on the Table 1, competence tested is the application of mathematics concept already familiar for students and use the result to a new situation. It is definition of implement and include cognitive domain C3 (application aspect). So, the cognitive domain peak in this question is C3 (application aspect). So, the cognitive domain peak in this question is C3 (applying aspect).

Mapping the Cognitive Domain of Beginner Subject

C1	C2	C3	C4	C5	C6	C7
	<b>Interpreting</b>	<b>Execution</b>	<b>Implementation</b>			
	2	1, 3, 5b, 7	4, 5a, 6			

Based on Table 5, question arranged by beginner subject consist of comprehension aspect (C2) and application aspect (C3). In comprehension aspect, operational verb used is represented. Question tested only about understanding concept of sums and product the of roots polynomial. In application aspect, operational verb used are execution and implementation. Execution verb on the Table 4 is about applying concept of matrix into an equation and finding polynomial with unknown remainder and divider. Implement verb on the Table 4 is about substitution the value for solution set in equation directly. Students can immediately solve problems without having to interpret the intent of the question first.

### Conclusions

The result on the study showed that the most common middle school semester 1 exam question used by all subjects was application aspect whereas analysis aspect was least used. Even, in beginner subjects, analysis aspect was not used at all. The quality of both question arranged by two subjects was different. Question arranged by senior subject could not be resolved directly. Students must interpret the question to other form. Even, the question arranged by beginner subject could be resolved directly without interpreting the intent of question first. Question of comprehension aspect arranged by senior subject was demanding skills of students to change the question to other form. Even in beginner subject, question can be solved simply by applying the formula. Question of analysis aspect was only used by senior subject. In this aspect, question was around of conclusion of logarithm.

### References

- Budiyono. (2015). *Pengantar Penilaian Hasil Belajar*. Surakarta: UNS Press.
- Giani, Zulkardi, & Hiltrimartin, C. (2015). Analisis Tingkat Kognitif Soal-Soal Buku Teks Matematika Kelas VII Berdasarkan Taksonomi Bloom (Versi Elektronik). *Jurnal Pendidikan Matematika (JPM)*, 9 (2), 1-20.

- Heng, C. S., & Ziguang, Y. (2015). Framework of Assessment for the Evaluation of Thinking Skills of Tertiary Level Student. *Advances in Language and Literary Studies*, 6 (5), 67 - 72.
- Micklich, D. L. (2011). Examining the Cognitive, Affective, and Psychomotor Dimension in Management Skill Development Through Experiential Learning: Developing a Framework. *Developments in Business Simulation and Experiential Learning*, 38, 261-266.
- National Council of Teachers of Mathematics (NCTM). (2000). *Principles and Standards for School Mathematics*. USA: NCTM.
- Rufiana, I. S. (2015). Level Kognitif Soal pada Buku Teks Matematika Kurikulum 2013 Kelas VII untuk Pendidikan Menengah. *Jurnal Dimensi Pendidikan dan Pembelajaran*, 3(2), 13-22.