

# Logical-Mathematical Ability's Description to Solve HOT Problem for Students Grade X Senior High School 01 Salatiga

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**Abstract.** This research is a qualitative descriptive research which purpose is to describe the logical mathematical capacity to solve High Order Thinking (HOT) Problem for Students Grade X Senior High School 01 Salatiga. Subjects in this research are 5 students. The data collection method used observation, HOT problems/questions, and depth interview. The data analysis method are data reduction, data display, and conclusion. The result of this research are 1) In analyze questions of HOT, 33% subjects use basic skills level and 67% subjects use complex skills level; 2) In evaluate questions of HOT, 20% subject use basic skills level, 50% subject use complex skills level, and 30% subject use coherence skills level; and then 3) In create questions of HOT, 30% subject use basic skills level, 50% subject use complex skills level, and 20% subject use coherence skills level. The data shows that in order to solve HOT Problems, students use 3 levels of logical-mathematical ability, which are basic skills level, complex skills level, and coherence skills level.

## INTRODUCTION

Mathematic is a subject which consist of knowledges and skills. As knowledge, math has some simple elements which can be learnt such as definition, terms, symbols, axiom, dalil, and theorem. On the other hand, skill in math require learner to accomplish skills such as addition, subtraction, multiplication, and division. If someone learns math, he or she will develop logical and quantitative way of thinking [1]. Logical thinking is a way of thinking which are logic, sequence and objective [2]. Thinking logically or orderly defined as a process to achieve a conclusion with consistent reasoning, think cause and effect, think based on certain pattern or logic inference rule or logic principle to achieve a conclusion, and think which include induction, deduction, analysis, and synthetic [3].

High Order Thinking Skill (HOTS) is a thinking process with include mental activity in an effort to explore complex experience, reflective and creative which is done consciously to achieve knowledge including analytical thinking level, synthetic and evaluatif [4]. HOTS is a thinking ability which is not only require their memory skill, but also higher skill such as logical, rational, critical, imaginal, and creative thinking [5]. Basically, Higher Order Thinking (HOT) is a thinking ability which is on highest level in a cogniive process. The ability is a highest thinking ability in Bloom Taxonomy in a newest Anderson and Karthwohl's revision. HOTS have the climax within the Bloom cognitive taxonomy which are analyze, evaluate, and create. Analyze, include the ability of breakdown a material or concept to pieces, determine how the pieces is related one to another which consist of differetiating, organizing, and attributting ability. Evaluate, include the ability to assess based on criteria and standart that passed through checking and criticize step which consist of checking and critiquing ability. Create, include the ability to put elements in one as a whole thorough allowing one shape that is coherent or functional which consist of generating, planning, and producing [6], [7]. One o HOTS is logical thinking.

The ability to think logically is one of the ability in logical-mathematical that is found by Howard Gardner and Hoekstra-de Roos where this ability could be used to improve logical-mathematic smart ability. The ability in logical-mathematical involve some components such as mathematical calculation, logical thinking, problem solving ability, deductive and inductive reasoning, also pattern acuity [8]. Logical-mathematic smart is one kind of abilities to create a mathematical calculation, deductive and inductive reasoning, create a logical connection,

generalize hypothesis, problem solving, critical thinking and understand numbers, geometry forms and abstract symbols [9]. The logical-mathematical ability consist of the competence tp analyze problem logically, to use the mathematic operations and examine problems in scientific way [10]. There are 3 indicators to assess logical thinking ability 1) relation between facts; 2) giving reasons; 3) ability to conclude. Further, there are 3 levels of logical-mathematical which based on a research from Howard Gardner, Thomas Armstrong, Linda Campbell, and David Lazear, which are 1) Basic Skills Level, is a logical-mathematical level which involve improvement on simple concrete objects manipulation, recognition of concrete pattern and ability to show the simple abstract mindset; 2) Complex Skills Level, is a logical-mathematical level which involve problem solving learning process, effective mindset, and standard mathematic calculation and operation ability; Also 3) Coherence Skills Level, is a logical-mathematical level which involve the improvement on continued mathematic process followed by the operations, integrated, ideas which oriented to the application including learning transfer. Indicators from each levels in logical-mathematical ability [11] is as mention below

**TABLE 1.** Logical-Mathematical Ability Indicator

<b>Basic Skills Level</b>	<b>Complex Skills Level</b>	<b>Coherence Skills Level</b>
1. Capacity to perform concrete object manipulations based on specific criteria	1. Ability to perform a range of standard mathematical operations and calculations	1. Competence in linking various mathematical operations for complex problem solving
2. Ability to count and perform basic sequencing tasks (for example, putting things in an order)	2. Grasp of a variety of problem-solving skills and possible approaches	2. Knowledge of how to find unknown quantities in a problem-solving situation
3. Recognition of numbers and being able to relate number symbols to concrete objects	3. Development of a variety of thinking patterns and knowing how to use them	3. Understanding and utilizing a variety of metacognitive processes and behaviours
4. Competence to engage in simple abstraction involving concrete objects	4. Ability to engage in abstract thinking based on conceptual information	4. Performance of logical thinking and standard math proofs
5. Recognition of simple, concrete cause-and-effect relationships	5. Understanding of various mathematical processes and logic patterns	5. Ability to engage in both inductive and deductive reasoning processes

Logical thinking is very useful to solve mathematic problems. This ability is needed to solve questions in story form. One of the story form questions in mathematic is Linear Equation System of Two Variables. To solve this question, abilities to understand, create the mathematic form and apply the form to solve the problem given is needed. Based on this background, the aim from this research is describe logical-mathematical thinking process in solving HOT questions on Senior High School 1 Salatiga students.

## **RESEARCH METHODS**

The type of this research is qualitative descriptive research. The subject in this research is decided with the purposive random sampling mehod so that 5 subjects are chosen and are students grade X. This research is done by giving the student tests about HOT questions and then an interview is also conducted so that more information obtained about students ability to solve HOT questions. The method in this data collection is observation, HOT question test and deep interview. The data analysis method here is data reduction, data presentation and inference.

## **RESULT AND DISCUSSION**

HOT's questions are categorized into 3 steps which are analysis, evaluation, and create question. In this research, there are 7 questions which are contain of 3 analysis questions, 2 evaluation questions, and 3 create questions.

**The first analyze question analysis**

Subject  
1

Berapa tinggi tower yang paling pendek tersebut?

$x + 2y = ?$

Jawab :

$$\begin{array}{r} 3x + 3y = 21 \text{ m} \\ 3x + 2y = 19 \text{ m} \\ \hline y = 2 \text{ m} \end{array}$$

$$\begin{array}{r} 3x + 2y = 19 \text{ m} \\ 3x + 2(2) = 19 \text{ m} \\ 3x + 4 = 19 \text{ m} \\ 3x = 15 \text{ m} \\ x = 5 \text{ m} \end{array}$$

$$\begin{array}{r} x + 2y = 5 + 2(2) \\ = 5 + 4 \\ = 9 \text{ m} \end{array}$$

FIGURE 1. Subject S1 Test Result of Question 1

Based on subject S1 test result, the subject did question number 1 can do mathematic form of hexagonal shape and rectangle with presupposes as  $x$  and  $y$ . Subject S1 wrote the equation from the first and second tower directly with consecutive linear equation  $3x + 3y = 21m$  and  $3x + 2y = 19m$ . After making the equation from both towers, S1 operate 2 linear equations with a combined method. Subject S1 understand the question given and make the mathematic form within it.

Subject  
2

Berapa tinggi tower yang paling pendek tersebut?

Jawab :

$$\begin{array}{r} 3x + 3y = 21 \\ 3x + 2y = 19 \\ \hline y = 2 \\ 3x + 4 = 19 \\ 3x = 15 \\ x = 5 \\ 2y + x = 2(2) + 5 \\ = 9 \end{array}$$

FIGURE 2. Subject S2 Test Result of Question 1

From the subject S2 test result, it shown how S2 write the presupposes beside the first tower to hexagon ( $x$  symbol) and rectangle ( $y$  symbol) shape. Subject S2 wrote the equation from both towers with a consecutive linear equation  $3x + 3y = 21$  and  $3x + 2y = 19$ . After making the equation, S1 operate those linear equations with a combined method. From the explanation, subject S2 is categorized in complex skills level.

Subject  
3

1. Di bawah ini adalah 3 tower yang memiliki tinggi berbeda dan terapan dari dua bentuk yaitu bentuk segi-enam dan persegi panjang.

Berapa tinggi tower yang paling pendek tersebut?

Jawab :

a)  $3x + 3y = 21$

b)  $3x + 2y = 19$

c)  $x + 2y = ?$

$$\begin{array}{r} 3x + 3y = 21 \\ 3x + 2y = 19 \\ \hline y = 2 \\ 3x + 4 = 19 \\ 3x = 15 \\ x = 5 \\ x + 2y = 5 + 2(2) \\ = 9 \text{ m} \end{array}$$

FIGURE 3. Subject S3 Test Result of Question 1

From the subject S3 test result, it shown how S3 wrote the presupposes beside the third tower by drawing the hexagon ( $x$ ) and rectangle ( $y$ ). Subject S3 wrote the equation from these three towers with a consecutive linear equation  $3x + 3y = 21m$ ,  $3x + 2y = 19m$  and  $x + 2y = ?$ . After making the equation from these three towers, S3 operate the first and second linear equations using the combined method. From the explanation, subject S3 is categorized in complex skill level.

Subject  
4

Jawab :

1.  $3x + 3y = 21$

2.  $3x + 2y = 19$

3.  $x + 2y = ?$

$$\begin{array}{r} 3x + 3y = 21 \\ 3x + 2y = 19 \\ \hline y = 2 \\ 3x + 4 = 19 \\ 3x = 15 \\ x = 5 \\ x + 2y = 5 + 2(2) \\ = 9 \text{ m} \end{array}$$

FIGURE 4. Subject S4 Test Result of Question 1

Based on the subject S4 test result, in doing the question number 1, subject can do the mathematic form. S4 presupposed hexagonal shape as  $x$  and rectangle shape as  $y$ . Subject S4 wrote the equation from the first and second tower with a consecutive linear equation  $3x + 3y = 21m$  and  $3x + 2y = 19m$ . After the equation, S1 operate the equation with a combined method. From the explanation, subject S4 is categorized in complex skills level.

Subject  
5

Jawab:  
Dumuk matematika  
misal segi enam = x  
persegi panjang = y

$$\begin{aligned} 1) & 3x + 3y = 21 \\ \Leftrightarrow x + y &= 7 \\ x &= 7 - y \end{aligned}$$

2)  $3x + 2y = 19$  substitusi

$$\begin{aligned} 3(7-y) + 2y &= 19 \\ 21 - 3y + 2y &= 19 \\ 21 - y &= 19 \\ -y &= -2 \\ y &= 2 \end{aligned}$$

3)  $x = 7 - y$

$$\begin{aligned} &= 7 - 2 \\ &= 5 \end{aligned}$$

4) Tinggi tower paling pendek =  $x + 2y$

$$\begin{aligned} &= 5 + 2 \cdot 2 \\ &= 5 + 4 \\ &= 9 \text{ meter.} \end{aligned}$$

FIGURE 5. Subject S5 Test Result of Question 1

Based on the subject S5 test result, the subject did the first question with the mathematic form. It shown that S5 presupposes hexagon as  $x$  and rectangle as  $y$ . Subject S5 wrote the equations from the first tower which is  $3x + 3y = 21m$  and then simplified into  $x = 7 - y$ . After making the equation from the first tower, S5 create the equation from the second tower which is  $3x + 2y = 19$ . The subject use the substitution method to solve the question. From the explanation, subject S5 is categorized in complex skills level.

## 2nd Question Analysis

Subject  
1

Jawab:

$$\begin{aligned} a. & \text{Rp } 3.750.000 + \text{Rp } 5000x \\ b. & \text{Rp } 2.500.000 + \text{Rp } 7500x \\ c. & \text{Rp } 5500.000 + \text{Rp } 10.200x \end{aligned}$$

10.200 → tambahan > 200 km

tambahan:  $10.200 \times 200$   
= 2.040.000  
membayar Rp 5.750.000

FIGURE 6. Subject S1 Test Result of Question 2

Based on the subject S1 test and interview result, it shown that subject S1 is unable to do the mathematic form. It shown on the subject's answer which could only make a consecutive presupposes on equation A and B which are  $= \text{Rp}3.750.000 + \text{Rp}5.000x$  and  $B = \text{Rp}2.500.000 + \text{Rp}7.500x$  but is unable to do the equation C because the subject only write

$\text{Rp}3.500.000 \rightarrow \text{max } 200\text{km}$  and  $\text{Rp}10.200 \rightarrow \text{tambahan} > 200\text{km}$ . In a calculation in equation A and B, the subject is unable to solve the question because the subject think that the companies do not have maximum distance, while in company C calculation, the subject did the multiplication  $10.200 \times 200$  and the result is  $2.400.000$ . The calculation is not correct because the result should be  $\text{Rp}2.040.000$ . It makes the final result is also incorrect. From the explanation, subject S1 is categorized in basic skills level.

Subject  
2

Jawab:

$$\begin{aligned} A \rightarrow 3.750 + 5000x &= 3.750 + 5000 \cdot 400 \\ &= 3.750 + 2000000 \\ &= 2.003.750 \\ B \rightarrow 2500 + 7500x &= 2.500 + 400 \cdot 7500 \\ &= 7500 + 3000000 \\ &= 3.002.500 \\ C \rightarrow 10.200x &= 10.200 \cdot 400 \\ &= 4080000 \end{aligned}$$

Jadi yang sebaiknya disewa yaitu perusahaan B karena harganya lebih murah

FIGURE 7. Subject S2 Test Result of Question 2

Based on subject S2 test result, the subject is not really able to make mathematic form for the second question towards bus A, B and C's rents because subject omit 3 digits of number 0 on the first equation which is  $3.750 + 5000x$  which is supposed to be  $3.750.000 + 5.000x$  and on the second equation  $2500 + 7500x$  is supposed to be  $2.500.000 + 7.500x$ . The subject is also really able to do mathematic form t the third equation  $10.200x$  which is supposed to be  $3.500.000 + (x - 200)10.2000$ . Because of the

omission of the 3 digits of 0 on the first and second equation, it leads to the errors of the calculatio after the equation. Moreover, the third equation is also done incorrectly because the presupposes is incorrect. Subject S2 use the substitution method even though in the presupposes and calculation the subject is not thorough. However, the final result is correct because the calculation the subject did shown that company B's rents is less than other companies.

Subject  
3

dikunjungi 400 kilometer, bis dari perusahaan manakah yang sebaiknya disewa?

Jawab:

Perusahaan A	Perusahaan B	Perusahaan C
$P_0 = 3.750.000$	$P_0 = 2.500.000$	$P_0 = 3.500.000$
$P_0 = 5000/\text{km}$	$P_0 = 7500/\text{km}$	$P_0 = 10.200/\text{km}$
$3.750.000$	$2.500.000$	$3.500.000$
	$+ 30.000.000$	$+ 3096.000$
		$75.596.000$

FIGURE 8. Subject S3 Test Result of Question 2

Based on the test and interview result of subject S3, the subject wrote the rens of companies A, B, and C consecutively in doing the second question which are  $P_0 = \text{Rp}3.750.000$  and  $P_0 = 5000/\text{km}$ , also  $P_0 = \text{Rp}2.500.000$  and  $P_0 = 7500/\text{km}$ , also  $P_0 = \text{Rp}3.500.000$  and  $P_0 = 10.200/\text{km}$ . The subject later wrote the total rents on company A which is  $\text{Rp}3.750.000$  and company B which is  $\text{Rp}2.500.000$  without adding up the multilication result of every km

and 400km. It happens because the subject is already understand that the actual cost is including the rents with the distance of 400. On the company C, subject S3 wrote the sum of the rents which is Rp5.540.000 by doing some calculations caused in the correct final result. At the end of the interview, subject S3 realized that the final completion is less correct, and even though the subject understand the question, the subject cannot make the mahematic form. Based on the explanation, subject S3 is categorized in basic skills level.

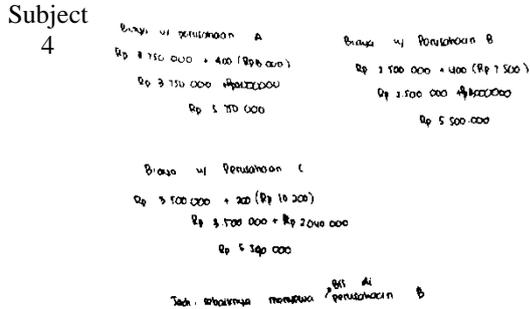


FIGURE 9. Subject S4 Test Result of Question 2

Based on subject S4 test result, S4 is able to make the mathematic form of company A, B, and C's rents however the subject substitute the questioned price which is 400km into the form in each equations. After that, the subject did calculation to each A, B, and C equations and as the result, the rents on each companies (in order) are Rp 5.750.000, Rp 5.500.000, and Rp 5.540.000. At the end of the completion, subject S4 wrote a conclusion clearly that company B is recommended. Based on the explanation, subject S4 is categorized in complex skills level.

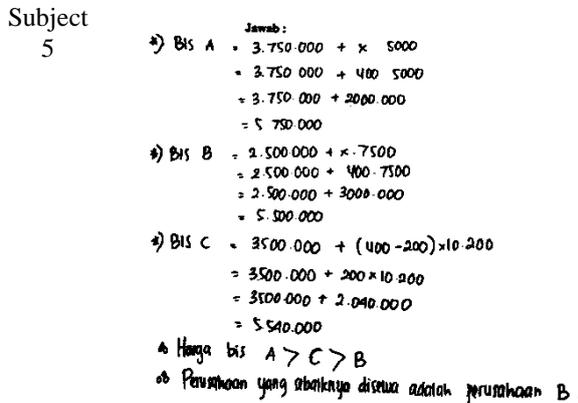


FIGURE 10. Subject S5 Test Result of Question 2

Based on the test result of subject S5, S5 is able to do the mathematic form of the second question about bus A, B, and C consecutively  $3.750.000 + x \cdot 5.000$ ,  $2.500.000 + x \cdot 7500$ , dan  $3.500.000 + (400 - 200)x10.200$ . However, the presupposes towards bus C equation is quite incorrect because there are no variable as a presupposes caused the subject change the presupposed variable (x) into 400km. Subject S5 use substitution method so that the result is collected as the rents of each company A, B, and C (in order) are 5.750.000, 5.500.000 and 5.540.000. At the end of the completion steps, S5 wrote a clear conclusion by writing that the rents of bus A > C > B and recommend the company B. Based on the explanation, subject S5 is categorized in complex skills level.

### 3rd Question Analysis

Subject S1

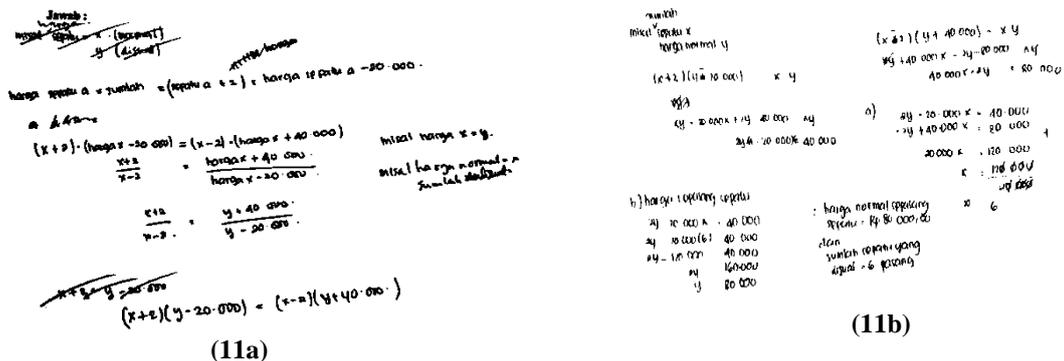


FIGURE 11. Subject S1 Test Result of Question 2 before and after interview

Based on the test and interview result of subject S1, S1 did the mathematic form for the first question. Before the interview, the subject is able to to make the first equation which is shoes' price × the amount = (shoes a + 2) (shoes price a - 20.000) even though the transcript is not clear. However, after the interview conducted, the subject fix their own answer and the subject is able to make 2 equations which are shoes' amount as x and normal price as y. The subject then make the first and second equations onsecutively which are  $(x + 2)(y - 20000) = x \cdot y$  dan  $(x - 2)(y + 40000) = x \cdot y$  and simplified it into  $2y - 20000x = 40000$  dan  $40000x - 2y = 80000$ . The next step is eliminate y to both equations so that they got  $x = 6$ . Subject then substitute  $x = 6$  into the

first equation so that they got  $y = 80.000$ . In the completion, subject make a conclusion that the shoes' normal price is Rp 80.000 and the sold shoes' amount is 6 pairs. Based on the explanation, subject S1 is categorized in complex skills level.

Subject S2

Jawab:

$$\begin{aligned} 1) (n-20000) + 2(n+80000) &= y \\ 2) (n-40000) + 2(n+40000) &= y \end{aligned}$$

$$\begin{aligned} n - 20.000 + 2n + 160.000 &= y \\ 3n + 140.000 &= y \\ n - 40.000 + 2n + 80.000 &= y \\ 3n + 40.000 &= y \\ n - 120.000 &= y \end{aligned}$$

$$\begin{aligned} 3n + 20.000 &= y \\ n - 120.000 &= y \end{aligned}$$

$$\begin{aligned} 4n &= -140.000 \\ n &= -35.000 \end{aligned}$$

$$4n = 140.000 \Rightarrow n = 35.000$$

$$4n = 140.000 \Rightarrow n = 35.000$$

FIGURE 12. Subject S2 Test Result of Question 3

Based on the test and interview result of subject S2, the subject is able to finish the third question with a mathematic form. However, the subject is unable to make the correct form, instead they write presupposes on the first and second equations which are  $(n - 20000) + 2(n + 20000) = y$  and  $(n - 40000) - 2(n + 40000) = y$  so that the final result is also incorrect because the formula is incorrect. Based on the explanation, it shown how S2 solve the third question so that is categorized in basic skills level.

Subject S3

b. Berapa harga normal sepasang sepatu itu?

$$\begin{aligned} x + 2(y - 20000) &= 40000 \\ x + 2(y + 40000) &= 80000 \end{aligned}$$

Jawab:

$$\begin{aligned} x + 2y - 40000 &= 40000 \\ x + 2y + 80000 &= 80000 \end{aligned}$$

$$\begin{aligned} x &= 40000 - 2y \\ x + 2y + 80000 &= 80000 \end{aligned}$$

$$40000 - 2y + 2y + 80000 = 80000$$

$$120000 - 2y = 80000$$

$$-2y = 80000 - 120000$$

$$-2y = -40000$$

$$y = 20000$$

FIGURE 13. Subject S3 Test Result of Question 3

Based on the test and interview results of subject S3, the subject complete the question with a mathematic form. However, the subject is unable to make the mathematic form correctly. Instead, the subject make 3 pairs of equations which are  $P = Pn - 20000$  and  $P = Pn + 20000$ ,  $x + 2(Pn - 20000)$  and  $x - 2(Pn + 40000)$ , also  $x = Pn - 20000$  and  $y = Pn + 40000$ . The subject is also unable to finish their work

because the subject realized later that they could not make a mathematic form according to the question. Based on the explanation, it shown how S3 solve the third question so that is categorized in basic skills level.

Subject S4

Jawab:

$$\begin{aligned} (x+2)(y-20000) &= 40000 \\ (x-2)(y+40000) &= 80000 \end{aligned}$$

$$\begin{aligned} xy - 20000x + 2y - 40000 &= 40000 \\ xy + 40000x - 2y + 80000 &= 80000 \end{aligned}$$

$$\begin{aligned} xy - 20000x + 2y - 40000 &= 40000 \\ xy + 40000x - 2y + 80000 &= 80000 \end{aligned}$$

$$\begin{aligned} -20000x + 2y - 40000 &= 40000 - xy \\ 40000x - 2y + 80000 &= 80000 - xy \end{aligned}$$

$$\begin{aligned} -20000x + 2y - 40000 &= 40000 - xy \\ 40000x - 2y + 80000 &= 80000 - xy \end{aligned}$$

$$\begin{aligned} -20000x + 2y - 40000 &= 40000 - xy \\ 40000x - 2y + 80000 &= 80000 - xy \end{aligned}$$

$$\begin{aligned} -20000x + 2y - 40000 &= 40000 - xy \\ 40000x - 2y + 80000 &= 80000 - xy \end{aligned}$$

$$\begin{aligned} -20000x + 2y - 40000 &= 40000 - xy \\ 40000x - 2y + 80000 &= 80000 - xy \end{aligned}$$

$$\begin{aligned} -20000x + 2y - 40000 &= 40000 - xy \\ 40000x - 2y + 80000 &= 80000 - xy \end{aligned}$$

FIGURE 14. Subject S4 Test Result of Question 3

Based on subject S4, subject is able to make presupposes shoes' amount as  $x$ , shoes' price as  $y$ , total sold amount as  $xy$  towards the third question. The next step is subject wrote the first equation  $(x + 2)(y - 20000) = xy$  and then is simplified into  $2y - 20000x = 40000$  and also the second equation  $(x - 2)(y + 40000) = xy$  and is simplified into  $-2y + 40000x = 80000$ . Subject then do elimination towards  $y$  and got  $x = 6$  as a result. The next step is subject substitute  $x = 6$  into the first equation and obtained  $y$  which is 80.000. As the completion, subject S4's result is that Ina sell 6 pairs of shoes and the normal price = 80.000 Based on the explanation, it shown how S4 solve the third question so that is categorized in complex skills level.

Subject S5

Jawab:

$$\begin{aligned} 1) (n-20000) + 2(n-20000) &= y \\ 2) (40000+n) - 2(n+40000) &= y \end{aligned}$$

$$\begin{aligned} n - 20.000 + 2n - 40.000 &= y \\ 3n - 60.000 &= y \\ 40.000 + n - 2n - 80.000 &= y \\ 40.000 - n - 40.000 &= y \\ -n &= y \end{aligned}$$

$$\begin{aligned} 3n - 60.000 &= y \\ -n &= y \end{aligned}$$

$$\begin{aligned} 3n - 60.000 &= y \\ -n &= y \end{aligned}$$

$$\begin{aligned} 3n - 60.000 &= y \\ -n &= y \end{aligned}$$

$$\begin{aligned} 3n - 60.000 &= y \\ -n &= y \end{aligned}$$

$$\begin{aligned} 3n - 60.000 &= y \\ -n &= y \end{aligned}$$

FIGURE 15. Subject S5 Test Result of Question 3

Based on the subject S5 test and interview result, the subject did the third question by making the mathematic form, but the subject is unable to do the correct mathematic form. Instead, the subject wrote the presupposes which are  $(n - 20000) + 2(n - 20000) = y$  and  $(40000 + n) - 2(n + 40000) = y$  make the final result is incorrect because the previous form is also incorrect. Based on the explanation, it shown how S5 solve the third question so that is categorized in basic skills level.

Evaluate Question: 4th Question Analysis

Subject  
1

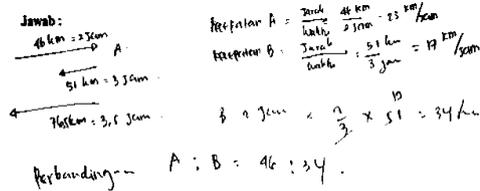


FIGURE 16. Subject S1 Test Result of Question 4

Based on test result of subject S1, subject is looking for the boat's speed in line with the river's current which is presupposes as speed B. Subject S1 is able to find speed A and B with a formula distance divided by times so that the subject get a correct result. The next step is calculate, 2 is obtained from 2 hours travel time in speed A, 3 is obtained from 3 hours travel time in speed B and 51 is the distance

with the speed B. The calculation caused to a correct result, however the concept is incorrect caused the final result is also incorrect because the subject find the comparison between speed A : B which is 46:34 that is not related to the questioned answer. Based on the explanation, it shown how S1 solve the fourth question so that is categorized in basic skills level.

Subject  
2

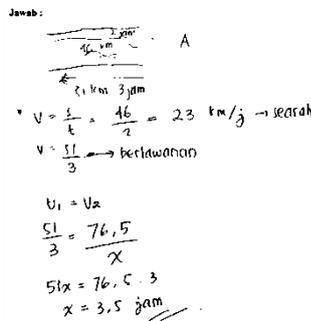


FIGURE 17. Subject S2 Test Result of Question 4

Based on the subject S2 test result, the subject draw what they know on the first place and give a note 46 km and 2 hours on the top right and 51 km and 3 hours on the bottom right. The next step is to search the speed when the boat is reversed or in line with the river's current consecutively which is then simplified. The subject then do comparison between the distance and the travel time which are  $\frac{46}{2}$  that simplified into 23 km/hour and  $\frac{51}{3}$ . Then Subject do comparison between  $\frac{51}{3}$  and  $\frac{76,5}{x}$  when the boat is

reversed with the river's current. Steps done by S2 is correct, however, S2 is not thorough on the calculation so that the final result is incorrect because S2 answered 3,5 hours instead of 4,5 hours. Based on the explanation, it shown how S2 solve the fourth question so that is categorized in basic skills level.

Subject  
3

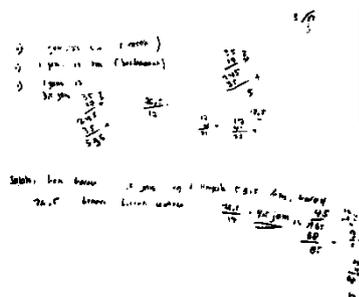


FIGURE 18. Subject S3 Test Result of Question 4

Based on the subject S3 test result, S3 was looking for the speed when the boat is in line or reversed the current, but subject directly wrote the final result which are 1 hour = 23 km (in line) dan 1 hour = 17 km (reverse) without showing he ssteps clearly. Subject also did not wrote the completion clearly, only the calculation. On the completion, subject wrote a conclusion that the statement in the question is incorrect because 3,5 hours is needed to travel 59,5km far and 4,5 hours is needed to travel 76,5km far. Based on the explanation, it shown how S3 solve the fourth question so that is categorized in coherence skills level.

Subject  
4

Jawab:

searah ↓  
46 km = 23 jam  
1 jam = 23 km

berlawanan  
51 km = 3 jam  
1 jam = 17 km

Waktu 3,5 jam maka =  $3,5 \times 17$   
= 59,5 km

Pernyataan tersebut salah karena dalam 3,5 jam kapal tersebut dapat menempuh 59,5 km.

FIGURE 19. Subject S4 Test Result of Question 4

because 3,5 hours is needed to travel 59,5km far. Based on the explanation, it shown how S4 solve the fourth question so that is categorized in coherence skills level.

Subject  
5

Jawab: SALAH

1) Vsearah arus sungai =  $46 \text{ km} / 2 \text{ jam} = 23 \text{ km/jam}$

2) Vberlawanan arus sungai =  $51 / 3 \text{ jam} = 17 \text{ km/jam}$

Jika  $S = 76,5 \text{ km}$ , dengan Vberlawanan arus sungai  
maka  $t = \frac{S}{V} = \frac{76,5 \text{ km}}{17 \text{ km/jam}}$   
= 4,5 jam

& Pernyataan di atas salah

FIGURE 20. Subject S5 Test Result of Question 4

distance which is 76,5 km with 17 km/hours because the boat reverse the current so that the travel time needed is 4,5 hours. On the completion, subject wrote a conclusion that the statement in the question is incorrect caused subject S5 could answer correctly. Based on the explanation, it shown how S5 solve the fourth question so that is categorized in coherence skills level.

Based on the subject S4 test result, S4 wrote the distance and times needed by a boat to travel in line and reverse with the current, but on the answer sheet S4 wrote the final result of boat's speed which are  $1 \text{ jam} = 23 \text{ km}$  (in line) and  $1 \text{ jam} = 17 \text{ km}$  (reverse) without showed the calculation of that answer. The next step is to find the travel distance if the time needed is 3,5 hours which is obtained by multiply 3,5 hours with 17 and got 59,5km as a result. On the completion, subject wrote the result clearly that the statement in the question is incorrect

Based on subject S5 test result, S5 try to find the boat's speed when it is in line or reverse the current on the first place. Subject then got the boat's speed when it is in line with the current is  $\frac{46 \text{ km}}{2 \text{ jam}} = 23 \text{ km/jam}$  and boat's speed when it reverse he current is  $\frac{51 \text{ km}}{3 \text{ jam}} = 17 \text{ km/jam}$ . The next step is subject try o find time needed by divide travel

### 5th Question Analysis

Subject  
1

Jawab:

100 m  
50 m  
misal  $1 \text{ m} \times 1 \text{ m} = 4 \text{ orang}$   
 $100 \times 50 = 5000 \times 4$   
= 20.000 orang (C)

FIGURE 21. Subject S1 Test Result of Question 5

the result is 20.000 people. Based on the explanation, it shown how S1 solve the fifth question so that is categorized in complex skills level.

Based on subject S1 test result, subject draw a rectangle with informations known. The next step is the subject assume that every.. can be fulfilled by 4 people. Subject then multiply the width and length to know how broad is the yard. The next step is to multiply the wide of the yard which is 5000 with 4 and

Subject  
2

Jawab:

100 m  
50 m  
 $L = 100 \times 50 = 5000 \text{ m}^2$   
Kira2 1 pengunjung, 'd, 25 m<sup>2</sup>  
Banyak pengunjung  $\frac{5000}{0,25} = 20.000$

FIGURE 22. Subject S2 Test Result of Question 5

Based on the subject S2 test result, S2 draw a rectangle with information known. The next step is to find the yard's wide by multiply width and length  $100 \times 50$  so, they got  $5000 \text{ m}^2$ . Subject then assume that "kira2 pengunjung = 0,25 m". Next, subject find the amount of the visitor by divide yard's wide is  $\frac{5000}{0,25}$  so the correct final result is 20.000 people. Based on the explanation, it shown how S2 solve the fifth question so that is categorized in complex skills level.

Subject  
3

A. 2000    B. 5000    C. 20.000    D. 50.000    E. 100.000

Jawab:

100    50    L = 5000  
25

FIGURE 23. Subject S3 Test Result of Question 5

Based on subject S3 test and inerview result, S3 draw a square ad write the length on both side. Subject also add an information  $5000 \text{ m}^2$ . The next step is, at first subject chose option A but after the interview, subject's calculation is by divide the yard's wide with the amount of the visitors and recfity the result into C which is 20.000 people. Based on the explanation, it shown how S3 solve the fifth question so that is categorized in complex skills level.

Subject  
4

A. 2000 B. 5000  C. 20.000  D. 50.000 E. 100.000

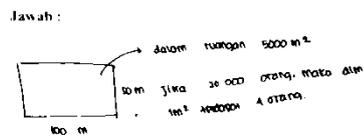


FIGURE 24. Subject S4 Test Result of Question 5

on the explanation, it shown how S4 solve the fifth question so that is categorized in complex skills level.

Subject  
5

A. 2000 B. 5000  C. 20.000 D. 50.000 E. 100.000

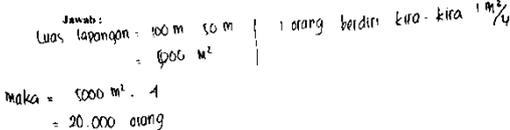


FIGURE 25. Subject S5 Test Result of Question 5

people. Based on the explanation, it shown how S5 solve the fifth question so that is categorized in complex skills level.

Create Question: 6th Question Analysis

Subject  
1

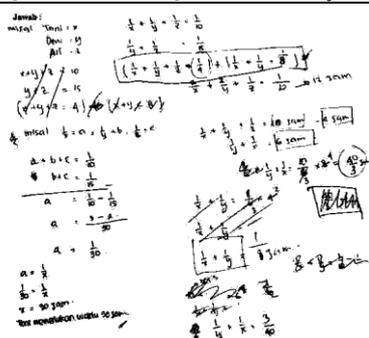


FIGURE 26. Subject S1 Test Result of Question 6

create the third equation caused the completion is just the time Toni need which is 30 hours. Based on the explanation, it shown how S1 solve the sixth question so that is categorized in basic skills level.

Subject  
2

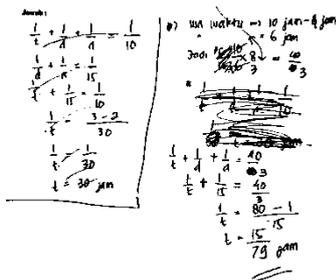


FIGURE 27. Subject S2 Test Result of Question 6

Subject  
3

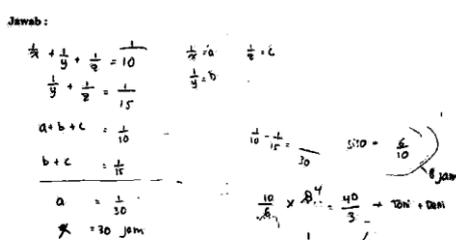


FIGURE 28. Subject S3 Test Result of Question 6

Based on subject S1 test result, subject draw a square and wrote the length on both side. Subject also add an information  $5000\text{ m}^2$ . Subject also assume that every  $1\text{ m}^2$  can be fulfilled by 4 people with the help of floor or ceiling. Subject then multiply wide of the yard obtained which is 4 and got a correct result which is 20.000 people. Based

Based on subject S5 test result, S5 search the yard's wide by multiply the length and width is  $100\text{ m} \times 50\text{ m}$ , so S5 got the result is  $5000\text{ m}^2$ . Subject then assume that each visitors need  $\frac{1\text{ m}^2}{4}$ . The next step is that the subject multiply the yard's wide obtained which is 4 and the correct result obtained is 20.000

Based on the subject S1 test result, S1 make a simple presupposes towards informations known. However, subject presupposes Toni = x, Deni = y, Ari = z whereas the proper one is 1 task could be done by Toni within =  $\frac{1}{x}$ , 1 task could be done by Deni within =  $\frac{1}{y}$ , and 1 task could be done by Ari within =  $\frac{1}{z}$ . After the presupposes, S1 eliminate the first equation  $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = \frac{1}{10}$  with the second equation  $\frac{1}{y} + \frac{1}{z} = \frac{1}{15}$  then S1 got  $\frac{1}{x} = \frac{1}{30}$ , so  $x = 30\text{ jam}$ . On the next step, subject is unable to

Based on subject S2 test result, subject is not really able to do the presupposes. At first, subject is able to find that the time needed by Toni is 30 hours, but subject cross the answer because S2 is unsure. Next, S2 calculate the remaining time needed  $10\text{ jam} - 4\text{ jam} = 6\text{ jam}$ , but then subject is unable to do presupposes caused the result is only one items and is incorrect. Based on the explanation, it shown how S2 solve the sixth question so that is categorized in basic skills level.

Based on subject S3 test result, S3 solve the question by presupposes the first equation  $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = \frac{1}{10}$  and the second equation  $\frac{1}{y} + \frac{1}{z} = \frac{1}{15}$  even though x, y and z is not explained, what are they represent of. Next, subject presuppose  $\frac{1}{x} = a$ ,  $\frac{1}{y} = b$ , dan  $\frac{1}{z} = c$  then subject eliminate first and second equations to get a. After got the number, S3 forgot that a need to be substitute to the previous equation

$\frac{1}{x} = a$ , subject just directly wrote if  $a = 30$ . The next step is that subject is trying to calculate the remaining time needed but subject is unable to do that. Based on the explanation, it shown how S3 solve the sixth question so that is categorized in basic skills level.

Subject  
4

Handwritten work for Subject S4. It shows several equations and calculations. At the top, there are equations involving  $\frac{1}{t}$ ,  $\frac{1}{d}$ , and  $\frac{1}{a}$ . Below these, there are more complex equations and calculations, including a final result for  $a = 40$ . The work is somewhat messy and includes some corrections.

FIGURE 29. Subject S4 Test Result of Question 6

completion, subject wrote the correct final result which are Toni = 30 jam, Deni = 24 jam, and Ari = 40 jam. Based on the explanation, it shown how S4 solve the sixth question so that is categorized in coherence skills level.

Based on subject S4 test result, S4 directly wrote presupposes which are first equation i.e  $\frac{1}{T} + \frac{1}{D} + \frac{1}{A} = \frac{1}{10}$  and the second equation  $\frac{1}{D} + \frac{1}{A} = \frac{1}{15}$  to obtained  $T$  using elimination. Subject do the calculation correctly but S4 do not finish the writing and only write the completion  $\frac{1}{T} = \frac{1}{30}$ . The next step is the subject calculate the remaining time needed is  $\frac{6}{10}$  hour based on  $\frac{1}{T} + \frac{1}{D} + \frac{1}{A} = \frac{4}{10}$  equation, then subject calculates time needed by Toni and Deni is  $\frac{40}{3}$  hours. S4 then found a new equation that is  $\frac{1}{t} + \frac{1}{d} = \frac{1}{8} = \frac{3}{40}$  so, S4 got the  $d$  equal 24 hours correctly. After obtained the  $d$ , subject substitute the number into the second equation to got  $a$  caused the subject got a correct result of  $a$  which is 40 hours. On the

Subject 5

Handwritten work for Subject S5 (30a). It shows equations and calculations for variables  $t$ ,  $d$ , and  $a$ . The work is organized and includes a final result for  $a = 40$ . There are some annotations and corrections.

(30a)

Handwritten work for Subject S5 (30b). It shows equations and calculations for variables  $t$ ,  $d$ , and  $a$ . The work is organized and includes a final result for  $a = 40$ . There are some annotations and corrections.

(30b)

FIGURE 30. Subject S5 Test Result of Question 6

Based on the subject S5 test result, the subject do presupposes by wrote the first equation which is  $\frac{1}{t} + \frac{1}{d} + \frac{1}{a} = \frac{1}{10}$  and second equation which is  $\frac{1}{d} + \frac{1}{a} = \frac{1}{15}$  and than do elimination to got  $t$ . Subject did a correct calculation so that  $t$  obtained is 30 hours. The next step done is calculate the remained time which is 6 hours, then subject recalculate times needed by Toni and Doni to do the house work. Subject than found a new equation which is  $\frac{1}{t} + \frac{1}{d} = \frac{3}{40}$  so that  $d$  is obtained correctly which is 24 hours. After obtained the  $d$ , subject substitute the number into the two equations to get  $a$  caused the correct result which is 40 hours. Based on the explanation, it shown how S5 solve the sixth question so that is categorized in coherence skills level.



Subject  
S5

$$\begin{array}{r}
 \text{Jumlah} \\
 \text{d) } 97.500 - 67.500 \quad \left( \begin{array}{l} 9 \text{ mie ayam} \\ 2500 \\ 15.000 \end{array} \right) \\
 \hline
 30.000 \\
 \text{ sisa uang = 15.000} \\
 \text{maka yang harus dipesan Andi dan 4 orang lainnya adalah} \\
 1 \text{ es teler dan 4 es/tel hangat}
 \end{array}$$

FIGURE 35. Subject S5 Test Result of Question 7

Based on the subject S5 test and interview result, the subject calculate the initial outcome and got a total Rp 85.000 so the remaining money on Andy is Rp 15.000. The subject wrote that the drink ordered by Andy and 4 of his friends are 4 ice tea and 1 ice teler while in the interview, the subject is unable to find another completion remaind the result unclear. Based on the explanation, it shown how S5 solve the seventh question so that is categorized in complex skills level.

### Logical-Mathematical Analysis on Each Subject

The research is done through test and interview for each subject. Based on the test and interview result, we could know subjects' logical-mathematical ability to finish HOT questions. Afterward, the result is analyzed to collect the information about their logical-mathematical ability. The logical-mathematical ability analysis result is below

TABLE 2. Result Logical-Mathematical Analysis on Each Subjects

Subject	Analyze Question			Evaluate Question		Create Question	
	Number 1	Number 2	Number 3	Number 4	Number 5	Number 6	Number 7
S1	CM	BS	CM	BS	CM	BS	CM
S2	CM	BS	BS	BS	CM	BS	CM
S3	CM	CM	BS	CH	CM	BS	CM
S4	CM	CM	CM	CH	CM	CH	CM
S5	CM	CM	BS	CH	CM	CH	CM

Notes :

BS : Basic Skills Level

CM : Complex Skills Level

CH : Coherence Skills Level

Based on the data, analyze questions are solved 33% by basic skills level and 67% by complex skills level. The evaluate questions are solved 20% by basic skills level, 50% by complex skills level, and 30% by coherence skills level. The create questions are solved 20% by basic skills level, 50% by complex skills level, and 30% by coherence skills level. It means that in solving HOT questions, subjects use 3 levels in logical-amthematical ability which are basic skills level, complex skills level, and coherence skills level. There is no previous studies which are describe about logical-mathematical capacity but there is a research by Distariana which the result is to solve HOT problem students use 2 type of different thinking, they are functional and predictive thinking. The implication of the research is to improve the teacher's ability to create or design HOT problem or question to improve the students' capacity of logical-mathematical.

## CONCLUSION

Based on the written test result and interview result analysis, we come to the conclusion that students' logical-mathematical ability to solve HOT questions are

1. In solving the analyze, evaluate and create questions, subject S1 use basic skills level and complex skill level.
2. In solving the analyze, evaluate and create questions, subject S2 use basic skills level and complex skill level.
3. Subject S3 use basic skill level and complex skill level to solve analyze questions, complex skills level and coherence skills level on evaluate questions, and use basic skills level and complex skills level on create questions.
4. Subject S4 use complex skill level to solve analyze questions, complex skills level and coherence skills level on evaluate questions, and use basic skills level and coherence skills level on create questions.
5. Subject S5 use basic skill level and complex skill level to solve analyze questions, complex skills level and coherence skills level on evaluate questions, and use basic skills level and coherence skills level on create questions.

So, to solve HOT problem in analyze question, student should use complex skill level, in evaluate question

should use complex skill level or coherence skill level, and in create question should use coherence skill level. Beside that, the subject of this research was limited only for students grade X of Senior High School 01 Salatiga, so the result is specific for the 5 subjects and cannot be generalized in any populations. The further research is needed in order to obtain the result which will valid for wider area, so we recommend for the future researcher to increase the amount of the subject.

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