Hits of the HOTS

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Abstract: *To enhance his ability to solve problems, a student must acquire critical thinking skills. This article establishes the results of 5 higher order thinking skills (HOTS) problems tested to 24, 'alumni' of the 2013 Curriculum, students of the higher educational institution. The identification of critical thinking frameworks and the description of the critical thinking skills were based on the answers of 5 random samples. In general, students were characterized as critical thinking agents able to evaluate problems; HOTS were implemented by manufacturing information to determine choices; employing experience and transforming knowledge when working on solving problems resulted in 65.60% critical thinking skills representing the logic approvals of 56% information, 60% meaning, 96% model, 60% choice, and 56% reason through questionnaires and interviews.*

Keywords: *Critical thinking; HOTS; Bloom's Taxonomy.*

INTRODUCTION

Students of the higher educational institutions should acquire critical thinking skills to confidently meet the 4.0 challenges of 21ˢᵗ Century learning. These skills have been practiced to be a desired standard of Indonesian students through the 2013 Curriculum to improve the quality of Indonesian human resources (Ministry of National Education, 2009). Accordingly, the developed test problems shall include critical, creative, communicative, and collaborative thinking skills known as higher order thinking skills (HOTS).

HOTS are intended to prepare students to meet the real world of millennial era in debt to the extent of complexity, competitiveness, knowledge-base, information, and utilization of technology. Thus, teachers shall train the students to find, interpret, and use information to make capital of critical thinking skills in meeting the global competition.

This article aimed to identify the students' critical thinking frameworks and describe their critical thinking skills in answering HOTS problems.

Revised Bloom's Taxonomy

The Bloom's taxonomy comprises 3 domains: cognitive, affective, and psychomotor. Krathwohl (2002) has revised the domain of cognitive taxonomy into a knowledge dimension and a cognitive process dimension. The categories of knowledge dimension represent factual, conceptual, procedural, and metacognitive knowledge. Krathwohl ranks the ability of the cognitive domain into 6 dimensions of systematic thinking process from the lower to a higher organisation.

The hierarchy of the six cognitive systems consist of remembering, understanding, applying, analysing, evaluating, and creating dimensions. First, a person's ability to remember information that he experienced is said to be the lowest dimension. Second is the ability to understand a fact why something occurs. Next, the third is the ability to apply facts, rules, concepts, or opinions that he understands. Fourth is the ability to analyse information into interrelated parts. Following, the fifth, is the ability to determine the worth of the

information or idea. Sixth, the highest dimension, is the ability to put the interrelated parts together to create something.

The dimensions of remembering and understanding process include lower-order thinking skills (LOTS). Anggraini cited Schmalz (1973) "LOTS tasks require the students remember facts, carry out simple operation, or solve problems that already familiar to the students. It does not require the students to work outside of their comfort zone".

Krathwohl (2002) has a view that the dimensions of Bloom's cognitive process start from remembering—taking relevant knowledge from memory. Further, someone will learn to understand by determining the meaning of instructional messages, including oral, written, and graphic communication. Then he will apply his understanding by carrying out a procedure in a given situation.

The dimensions of carrying out a procedure include middle order thinking skills (MOTS) or intermediate levels. Meanwhile, the dimensions of analysing, evaluating, and creating a procedure include higher-order thinking skills called HOTS—the extent to which millennial students are required to acquire critical thinking.

Critical Thinking

Critical thinking is the ability to analyse, interpret, evaluate, summarize, and synthesize all this information—and apply the results to solve an urgent problem (Trilling & Fadel, 2009). People react differently from each other. It all depends on how each critically processes information with reference to his abilities and attitude of curiosity that leads to critical thinking.

As cited by Rahaju (2017), Krulik & Rudnik promote critical and creative thinking to the level of the HOTS thinking process. According to them, the taxonomy of thinking process consists of 4 levels: recalling in the lowest position, basic in the second position, critical in the third position, and creative in the highest position.

In their article, Debela & Fang considered critical thinking as a 'process' which can be more efficient and effective when guided; and 'skill' which can be more developed with exposure and practice. This is an interesting view as it is a chance for a teacher to guide his students to be more actively use their question and answer skills in an instructional environment. So, they can develop their critical thinking skill through exposures and practices in a student-centred atmosphere.

Critical thinking is the art of analysing and evaluating processes (Elder & Paul, 2020). A critical thinking agent has a curiosity to examine and learn something as well as a willingness to actively use critical questions. When he gets a finding, he is able to determine a decision and belief. In addition, Elder & Paul define critical thinking as self-directed, self-disciplined, self-monitored, and self-corrective thinking.

Higher Order Thinking Skills (HOTS)

HOTS or higher-level thinking skills are more than the ability to recall, restate, and recite or refer without processing (Anggraini, 2019). It means that at this level someone has to acquire ability to understand and reason to the obtained information in addition to the ability to recall (Rahaju, 2017).

Hence, the ability to recall is minimized and students are exposed to an assessment that measures more on the ability to (1) transfer one concept to another, (2) process and apply information, (3) search for connections from various different information, (4) use information to solve problems, and (5) critically examine ideas and information.

HOTS is the ability to connect, utilize, and adapt both existing knowledge and experience to think critically and creatively in an effort to make decisions and solve problems in unconditioned situations

(Rahaju, 2017). In line with that, a research by Iswahyuni (2018) concluded that students with high intelligence were able to pass all problem solving indicators; students with medium intelligence had little difficulty; and students with low intelligence took longer time.
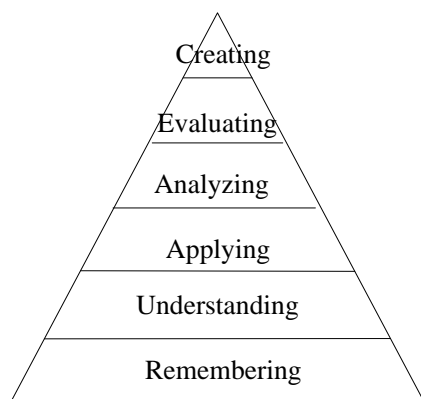

Figure: Revised Bloom's Taxonomy

HOTS Domain

As cited by Anggraini, according to Kruger (2013) HOTS includes concept formation, critical thinking, creativity/brainstorming, problem solving, mental representation, rule use, reasoning, and logical thinking. When a high-level thinking agent works on or finds a problem, he begins to make some plans related to some specified information found in the problem and what the problem is. In other words, he understands the problem.

He thinks critically in order to plan some solutions and connect what is in his mind with the problem; by this time, he has had a creativity or a model to solve the problem. As a mental representation, he proceeds to carry out his plan by implementing the steps according to the rule use. At last, he examines the result if the rule use is in accordance with reasoning and logical thinking.

A higher-order thinking agent, as described by Iswahyuni, will go through a thinking process of (1) understanding problem: understanding the terms use, formulating what is understood and asked, meeting the desired requirements; (2) planning a solution: recalling some solutions of similar problems once he resolved, then compiling an implementation procedure; (3) carrying out the plan: carrying out what has been carefully planned to solve the problem; and (4) examining: analysing and evaluating if the measures use and the results are proper, and a generalization can be obtained. To sum up, critical thinking is structurally thinking to solve a new problem intelligently with reference to knowledge, logic, and experience.

HOTS Instruments

Before thinking critically to work on HOTS problems, one must pass LOTS cognitive levels as stated by Krathwohl. The dimensions of knowledge are tiered from factual i.e. understanding the existing facts of an object or event; conceptual i.e. understanding the ideas or thoughts; procedural i.e. having knowledge to understand the sequence of a work or an event; and metacognitive i.e. understanding something beyond the existing facts.

Table 1. HOTS Criteria

Dimensions of Cognitive Process			
Knowledge Dimension	Analyzing	Evaluating	Creating
Factual	x	x	x
Conceptual	√	√	√
Procedural	√	√	√
Metacognitive	√	√	√

Neither is factual knowledge able to be analysed, evaluated, nor created as it is recalled, understood, and applied in contrast to conceptual, procedural, and metacognitive knowledge. Hence, the

factual knowledge does not meet the HOTS criteria.

The specifications of a HOTS developed problem is based on a construct of understanding basic concepts or key elements of the field of study and constructs of applicable, analytic, evaluated, and synthetic thinking skills related to basic concepts or key elements of the field of study (Hidayat, 2017).

METHOD

The Data

Some vocational students of 2013 Curriculum 'alumni' got a pre-test in 5 HOTS problems within 10 minutes before taking Technical English Course during the 4th semester. A qualitative description of the frameworks and critical thinking skills were resulted from 5 random samples. Each answered a questionnaire to assess information, meaning, and model; completed with an interview of difficulty level and attitude towards the problem solving, choice, and reasoning. Having collected some data, they were analysed, identified, organized, and clarified. Conclusions were drawn after describing phenomena. Here are the 5 problems.

No. 1

> A gentle, easy to rinse foam with the power of pure lemon extract to intensively cleanse and visibly brighten skin. Gently massage on wet face. Avoid eye area.

Random steps:
1. Wet your face.
2. Avoid eye area.
3. Rinse your face.
4. Take the product.
5. Massage the product on your face.

1. To get the result, here are the correct steps to follow:

    (A) 5 – 2 – 4 – 3 – 1
    (B) 4 – 5 – 3 – 1 – 2
    (C) 2 – 1 – 5 – 3 – 4
    (D) 1 – 4 – 5 – 2 – 3
    (E) 3 – 2 – 1 – 4 – 5

Of conceptual knowledge dimension, information on the use of facial foam is not entirely stated; problem in procedural knowledge dimension, question in a statement of metacognitive knowledge dimension in order to determine the implied steps of using the foam.

Table 2. Understanding No. 1

Sample	Information	Meaning	Model
1	how to use facial foam	to put the correct steps of using facial foam in order	rearranging the sentences into the order
2	the advantages of a 'lemon' facial cleanser product & steps of using the product	to find the steps of cleansing using the product	finding 1st sentence & forwarding by paying attention to the number of the sentence
3	1. the content, usage & how to use the product 2. the random steps of using the product	to put the orderly steps of cleansing in order	rearranging the random steps into the orderly ones
4	how to use facial soap	to put the sentences in order	understanding the product from the description & translating the beginning to the end of cleansing steps
5	how to cleanse the face by the correct order	to put the random numbers according to the orderly steps to wash face	translating then putting the steps according to the orderly ones

The meaning is derived from information on the product, its properties, its functions, and how to use it. An evaluation is made to understand the problem's instruction of putting the random steps into orderly ones. A created model is

by employing the how-to-use instructions '*Gently massage on wet face. Avoid eye area.*'

No. 2

> **Instructions:**
> Fill the cell in such a way that all rows, columns, and every 3-by-3 sub-square contains every digit from 1 to 9, with no repetition of each digit.

2. The medium is a … containing ….
   (A) cell – 3 rows
   (B) row – 6 squares
   (C) column – 1 digit
   (D) sub-square – 9 digits
   (E) square – 9 sub-squares

Of conceptual knowledge dimension, information on cell, rows, columns, 3x3 sub-squares, and digits 1 – 9 are compounded in one instruction; question in a statement of metacognitive knowledge dimension in order to find the medium and the content.

Table 3. Understanding No. 2

Sample	Information	Meaning	Model
1	information on the numbers of column & row, naming the square	to look for the name of the square & the numbers of column & row	imagining or drawing the problem to understand
2	the shape of a square consisting of 9 sub-squares, composed from 3 sub-columns & 3 sub-rows	to find the kinds of a square formed from some squares	drawing sub-square 3x3
3	3 columns & 3 rows. Each sub-square has a digit 1-9, without repeating each digit	to ask the existing medium & its content	drawing
4	3x3 sub-square column & row into which number 1-9 will be put	to look for the medium & find the number that will be put into the 3x3 sub-square	imagining the shape based on the description & drawing it to be clear
5	a square divided into 3x3 sub-square, each has numbers 1-9 without repetition	to describe shape & proper meaning towards the information found in the problem	drawing the medium according to the information provided in the problem

The information is about the cells in which digits 1 – 9 should be filled in without repetition. The meaning of the problem is to determine the medium's shape and the numbers of its content. The evaluation results in the medium shape and its content. Model is made by employing '*rows, columns, and every 3-by-3 sub-squares.*'

No. 3

> **Men in pictures:**
> GIA president stands right, independent director left, one director second left, another director center, and the other director next.

3. Where is the position of the last director?

   (A) far left
   (B) far right
   (C) next to the president
   (D) between two directors
   (E) next to the independent director

Of conceptual knowledge dimension, information on the position of the board of directors; problem in conceptual knowledge dimension, question in metacognitive dimension in order to determine the last-mentioned director's position.

Table 4. Understanding No. 3

Sample	Information	Meaning	Model
1	positions	to determine information on where the position of the leader and the stand	drawing the position of the desired
2	the positions of the president and 4 directors, started from the president on the right and 4 directors left of the president, forming a stand	to be able to imagine from the described position of the last director	placing the director, president and independent directors in position then looking for the vacant position for the last director
3	the position of President GIA on the right, independent on the left, another director next, the other one in the middle and the next director.	to find where the position of the last director	understanding the text and imagining
4	about the position of director, independent director and president	to find the position of the last director	imagining the president's position and directors from the description, and drawing the positions
5	a stand of some men from one side to the other side	to state the position of the last director	drawing the order according to the information

The information is on the position of 5 men standing from right to left. The evaluation is about determining the position of the last director. The created model can be drawing the president's position in the right and the independent director in the left. The positions of the other directors can be put in order according to the information.

No. 4

Men in pictures:
GIA president stands right, independent director left, one director second left, another director center, and the other director next.

4. The men stand….
(A) in a queue
(B) in some rows
(C) on the left side
(D) on different lines
(E) in a parallel direction

Proceed from No.3, question in a statement of metacognitive dimension: imagining the direction of standing in a queue, in some rows, on the left side, on different lines, or in a parallel direction.

Table 5. Understanding No. 4

Sample	Information	Meaning	Model
1	information on a stand	to find where the men are standing or what stand they form	imagining the positions of the directors
2	the standing president & directors to form a stand	to describe the formation of the stand	putting in order and positioning the director
3	idem	to find the positions of the men	understanding the text and imagining
4	idem	to determine the pattern of the directors' position	guessing the stand pattern of the president and the directors
5	idem	to conclude the stand	concluding the stand according to the problem's meaning

Of the similar information and model to No.3, the evaluation results in how the men stand. The employment of key words 'right' and 'left' will lead to the omission of two distractors using pluralization and another illogical option 'on the left side'.

No. 5

A semi-circular piece of paper is folded diagonally on both ends touching each other. Then open out the fold.

5. You will get … and … shapes.
   (A) 4 circular – 1 square
   (B) 2 semi-circular – 1 triangular
   (C) 2 triangular – 1 semi-circular
   (D) 1 semi-circular – 1 triangular
   (E) 4 semi-circular – 1 rectangular

Of conceptual knowledge dimension, information on a paper object in the form of its shape; question in a statement of metacognitive dimension in order to determine the shapes of the paper after being folded then unfolded.

Table 6. Understanding No. 5

Sample	Information	Meaning	Model
1	the results of paper folding	to find the shapes of the unfolded	imagining & drawing
2	the result of folding circular paper and two semi-circular shapes as the results	to find the shapes of folded paper	imagining semi-circular folded paper and unfolded
3	semi-circular paper diagonally folded on both ends	to find the results of folding the paper	drawing
4	forms of folded-semi-circular paper	to describe the shapes resulted from the folding of circular paper folded in the middle	imagining the shapes resulted from folding the circular-shaped paper
5	semi-circular paper folded into 2 and seen the shapes	to determine the shapes after folding the paper	drawing the medium according to the problem's meaning then determining the resulted shapes

No.5 informs an object of a semi-circular piece of paper, diagonally folded on both ends touching each other. Following is the evaluation which results in the instruction to open up the fold to find the shapes and their numbers. The model is drawing.

FINDINGS AND DISCUSSION

Findings

Table 7. The Test Results

Sample	Problem 1	Problem 2	Problem 3	Problem 4	Problem 5	Correct
1	V	V	V	X	V	4
2	V	V	X	X	X	2
3	V	X	V	X	X	2
4	V	X	V	X	V	3
5	V	V	V	X	V	4

v = True
x = False

The difficulty level was said to be 56% fair, 32% easy, and 12% difficult. Eighty-four per cent answers were done confidently and the 16% remaining in doubt. The findings show 100% correct experience-based answers to No.1 was confidently done and stated 40% very easy, 40% easy, and 20% fair. It seems that events or activities which have given someone experiences work away in his decision making. In contrast, all confidently done No.4 resulted in 100% incorrect

answer (option B: in some rows) that was stated 80% fair and 20% easy. Seemingly, grammar knowledge will not do due to mistaken imagination i.e. '*in some rows*' (plural) instead of '*in a parallel direction*' (singular).

Discussions

The critical thinking frameworks are seen through some steps taken by a test taker in working on a HOTS problem:
a) analysing information in the problem;
b) evaluating the meaning of the instruction based on the results of the analysis; c) creating a problem solving model; d) knowing how to implement the model; e) understanding how to complete the model; f) executing the solution model to determine the choice (Anggraini, 2019).

Out of 25 statements each, 56% (14) information; 60% (15) meaning; 96% (24) model; 60% (15) choice; and 56% (14) reason had logic approval.

In addition to logic, a total of 64% utilized information, experience and general knowledge; keywords; the meaning of the question; and understanding vocabulary in order to create a problem solving model. This diversity shows that the students think critically in planning problem solving and have creativity to solve problems (Kruger in Anggraini). Indeed, each person's reactions, abilities, and attitudes are different when processing information critically (Trilling & Fadel).

Fifty-two per cent took logical reasoning, followed by applying experience and knowledge, employing keywords, and drawing/imagining. Twenty-four acceptable models showed skills to process, utilize, and manufacture information to solve problems (Rahaju). The students used knowledge and intelligence to take appropriate action to solve problems (Haskins, 2012).

Most problems were solved by drawing and imagining—the students built on the learning process from written communication to graphic

(Krathwohl). Some tried to understand the used terms by translating, utilizing vocabulary and keywords as well as those who took advantage of the experience (Iswahyuni).

Another finding was the lack of reasoning skill. Seventeen (68%) reasons as '*according to the description, logic*', or '*that's the most appropriate step*', or '*based on the elaboration*', and so on were without further explanation of what they meant. These mean that the students referred their reason to something without processing (Anggraini), not representing HOTS. Supposedly, a check is kept to see if the rule use is in accordance with reasoning (Kruger in Anggraini). '*Based on the experience*' is a HOTS process (Iswahyuni), though, reasoning is in need to prove the critical thinking.

Nevertheless, '*according to the logic of 3-by-3 sub-squares*' and '*the other director next means next to the president*' indicated that the rule use is in accordance with logical thinking (Kruger).

CONCLUSION

The students have acquired critical thinking character with their ability to identify problems and focus on topics and issues which can be evidenced from the information that they obtained. They are also able to assess and evaluate statements from the problems. HOTS were shown by processing the information to solve problems or determine choices. Besides, they employed experience and transformed knowledge to work on the problems. The overall measurements of framework and critical thinking skills is of 60.56% or moderate.

However, the students should be equipped with reasoning ability. They felt confident of their choices, however, they were lack of giving reasonable reasons as the results of critical thinking. Last but not least, grammar knowledge still plays an important role in understanding and

'guessing' to determine the choice. For example, when vocabulary knowledge does not work to choose the correct option, the student should rely on his grammar knowledge as the result of critical thinking.

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