

# Developing An Assessment Instrument of Higher Order Thinking Skills (HOTS) In Mathematics For Junior High School: "Theoretical Analysis of HOTS According to the Expert"

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**Abstract.** This study aims to describe *Higher Order Thinking Skills (HOTS)* theory according to the expert based on relevant and supportive conceptual studies. This article will contribute knowledge in the field of mathematics education related to the development of *HOTS* assessment instruments based on the theoretical analysis of *HOTS* according to the expert of relevant conceptual studies. *Higher Order Thinking Skills (HOTS)* is a critical and creative thinking skill in solving a problem. *Higher Order Thinking Skills (HOTS)* can be broken down into indicators of critical thinking skills and creative thinking skills. *Critical Thinking* is the process of thinking analyzing by comparing or checking the truth of the information as well as the thinking process of evaluating by judging or selecting the right information from a problem. *Creative Thinking* is the process of creating thinking by constructing, formulating, or summarizing information from a problem.

## INTRODUCTION

The success of education whose primary purpose is to increase human resources is influenced by various factors. One of the factors that influence this success is the ability of teachers to do and utilize the assessment, evaluation process and learning outcomes. Such capability is necessary to know whether or not the learning objectives that have been set in the curriculum have been achieved [1]. Achievement of learning objectives can be seen from student achievement as measured by assessment. Therefore, the position of assessment of learning outcomes is important in the achievement of learning objectives.

According to Nitko and Brookhart (2011) [2], “[a]ssessment is a broad term defined as a process for obtaining information that is used for making decisions about students; curricula, programs, and schools; and educational policy”. Along with this, Van de Walle stated that the principles and standard of assessment emphasize two main ideas: assessment should improve learners' learning and assessment is a valuable tool for making teaching decisions [1]. Furthermore, according to McMillan (2000) [3] suggests that “[a]ssessment is inherently a process of professional judgment.” Further, Cecil (2009: 3) [2] explicitly says that “assessment is any systematic procedure for collecting information that can be used to make inferences....” In line with that,

*[a]ssessment is an important aspect and should be the main concern in determining the direction of a programme or national education system. Thus, HOTS elements in the subject of mathematics assessment need to be emphasized since it can measure teachers understanding on the implementation of HOTS in mathematics classroom [4].*

It is in line that:

*[t]he quality of learning outcomes assessment instruments will influence directly in achievement of student learning outcomes. Therefore, the position of learning outcomes assessment instrument is strategic for teachers and schools in decision making related to learning outcomes achievement including high order thinking skills [5].*

Furthermore, the characteristics of HOTS are as follows: “*characteristics of higher-order thinking skills: higher-order thinking skills encompass both critical thinking and creative thinking*” [6]. Associated with higher order thinking skills, including *logic and reasoning, analysis, evaluation, and creation, problem solving, and judgement* [7]. It is in line that “*the next five Standar address the proses of problem solving, reasoning and proof, connections, communication, and representation*” [8].

This proves that HOT is closely related to problem-solving ability, but the problem-solving ability of Indonesian students is low [9]. The findings are in line with the results of the international survey of The Third International Mathematics and Science Study (TIMSS) that the ability of Indonesian VIII Junior High School students in solving non-routine problems (mathematical problems) is very weak but relatively good in solving problems about facts and procedure. This proves that to the mathematical problems that demand high-level thinking, Indonesian VIII junior high school students are far below the international average, even with some neighbouring countries such as Malaysia, Singapore and Thailand [10]. This is in line with previous research findings shown by Cronbach's Alpha value on the problem of packet C is not reliable that is equal to 0.488. The results of the test instrument can be concluded that the ability of higher order thinking (HOT) mathematics students less good. This can be seen from the average value of test results of 26.38 on a scale of 100. In line with that, the ability of high-level thinking among learners is still low [1].

Problem HOTS with indicators to analyze, evaluate and create contained in the book support is still limited [11]. Furthermore, in accessing HOT instruments is still limited and not easy, as well as cost is not cheap. Also, “[*t*]he common belief among teachers is that tasks requiring HOT are appropriate only for high achieving students, whereas low achieving students, who can barely master the basic facts, are regarded as unable to deal with such tasks” [12].

The results of research related to the ability of teachers in developing HOTS assessment instruments are still lacking [1]. In line with that, in the case of packet B, the item received is 37.50%, the item is revised 18.75%, and the rejected item is 43.75%. This proves that the ability of teachers in preparing the problem of HOTS is still lacking [13]. Further, “[*r*]esults indicate that mathematics teachers have difficulty interpreting the thinking skills in Bloom's Taxonomy and creating test items for higher-order thinking” [14].

In a study conducted by [1] where the quality analysis of HOTS related tests was conducted with a classical test theory in which the students' ability influenced the results of the analysis and in the study, the development of the HOTS assessment instrument was used Bloom's taxonomy revision which included *analyzing, evaluating, and creating* [15]. Furthermore, HOTS instruments are readily available, but in accessing these instruments is not easy and the cost is not cheap, so it is necessary to develop a well qualified HOTS assessment instrument on mathematics class VIII SMP.

Higher order thinking skills are a thinking skill that requires not only remembering skills but requires other higher skills, such as creative and critical thinking skills [16]. Furthermore, The Australian Council for Educational Research (ACER) [17] suggests that higher-order thinking is the process: analyzing, reflecting, arguing, applying concepts to different situations, composing, creating. In line with that opinion, “*HOTS (Higher Order Thinking Skill) is the ability to make judgments, analyze contents and synthesize information into coherent forms of communication and present such information to others*” [18]. Based on some opinions about HOTS, it can be concluded that HOTS is a critical and creative thinking skills in solving a problem. Operationally Higher Order Thinking Skills (HOTS) or higher-order thinking can be translated into indicators based on aspects of critical thinking and creative thinking skills.

Huitt (1998) defines critical thinking as follows: “[*c*]ritical thinking is the disciplined mental activity of evaluating arguments or propositions and making judgments that can guide the development of beliefs and taking action.” [18]. In line with this,

*Critical Thinking - using basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations; develop cohesive, logical reasoning patterns and understand assumptions and biases underlying particular positions; attain a credible, concise, and convincing style of presentation* [19].

*Creative Thinking - using basic thinking processes to develop or invent novel, aesthetic, constructive ideas or products, related to percepts as well as concepts, and stressing the intuitive aspects of thinking as much as the rational. Emphasis is on using known information or material to generate the possible, as well as to elaborate on the thinker's original perspective* [19].

In line with that opinion, “*HOTS (Higher Order Thinking Skill) is the ability to make judgments, analyze contents and synthesize information into coherent forms of communication and present such information to others*” [18].

Problem formulation in this article, how the analysis of theoretical HOTS according experts based research conceptual relevant? So that the purpose of writing this article is to describe the analysis of

theoretical *HOTS* according expert based research conceptual relevant. Benefit from writing this article is expected to help the development of knowledge and can provide direct experience for authhors.

## DISCUSSION

### A. Conceptual Definition

*Higher Order Thinking Skill (HOTS)* was a skill think that is not only need skills in view of course, but need skills other higher as thinking skills creative and critical [16]. Next, *The Australian Council for Educational Research (ACER)* states that *HOTS* a process: analyze, reflect, give arguments (reasons), apply, concepts to different situations, compose, create [17]. In line with that opinion, that "*HOTS (Higher Order Thinking Skill) is the ability to make judgments, analyze contents and synthesize information into coherent forms of communication and present such information to others*" [18].

Thomas and Thorne (2005) states that "*Higher Order Thinking is thinking on higher level that memorizing facts or telling something back to someone exactly the way the it was told to you*" [16]. Furthermore Thomas and Thorne (2009) states that *HOTS* requires a person to do something about facts, that is to understand, to conclude, to connect with other facts and concepts, to categorize, to manipulate, put facts together in new ways and to apply in finding solutions to problems [20]. Next,

*[a]nalyze is breaking material into its constituent parts and determining how the parts are related to one another as well as to an overall structure or purpose. Evaluate means making judgments based on criteria and/ or standards. Finally, Create is putting elements together to form a novel, coherent whole or to make an original product* [15].

On a revised Bloom Taxonomy that is *analysing, evaluate, create* included in the *Higher Order Thinking (HOT)* category.

Furthermore, Stein and Lane define higher order thinking as complex thinking, no algorithm to accomplish a task, some unpredictable, using different approaches to existing tasks and different from the examples given [11]. Then, "*characteristics of higher-order thinking skills: higher-order thinking skills encompass both critical thinking and creative thinking*" [6]. In addition, the characteristics of the *HOTS* problem include: measuring higher order thinking skills, contextual-based problems, and using diverse questions, where higher order thinking skills include problem solving skills, critical thinking skills, creative thinking, reasoning, and decision making [17].

In line with that, "*[h]igher order thinking skills include critical, logical, reflective, metacognitive, and creative thinking* [21]. In addition, Resnick states that: "*higher order thinking is nonalgorithmic; that is, the path of action is not fully specified in advance*" [11]. Meanwhile, Krulik and Rudrick formulated four levels of thinking categorized as follows [22]:

- 1) *recall*. This is the lowest thinking skill that includes near-automatic skills or reflexes.
- 2) *basic*. These skills include understanding concepts such as addition and subtraction, including the application in the questions.
- 3) *critical thinking* to test, connect, and evaluate all aspects of the situation or problem. This includes collecting, organizing, remembering, and analyzing information. In other words, critical thinking is analytical and reflexive. *creative thinking* is thinking that is original and reflective that produces something complex. Activities undertaken include combining ideas, creating new ideas, and determining their effectiveness. Creative thinking also includes the ability to draw conclusions that usually produce new ends.

The last two levels of thinking are critical thinking and creative thinking called higher order thinking skills that must be developed in the learning of mathematics.

Based on some expert opinions above can be summed up as in the following table.

Level Thinking	Rosnawati	ACER	Narayanan and Adithan	Thomas and Thorne	Bloom revision	Conklin	Widana	King, Goodson, and Rohani	Krulik and Rudrick
HOTS	1. Critical thinking	1. Analyze 2. Reflect 3. Reason 4. Apply	1. Analyze 2. Evaluate/Judgments	1. Understand 2. Connec 3. Categorize 4. Manipulate	1. Analyze 2. Compare 3. Check 4. Criticize 5. Test 6. Evaluate 7. Rate 8. Refute 9. Decide 10. Choose 11. Support	1. Critical thinking	1. Problem solving 2. Critical thinking 3. Reasoning 4. Decision making	1. Critical thinking 2. Logical 3. Reflective 4. Metacognitive	1. Critical thinking
	2. Creative thinking	5. Compile 6. Create	3. Synthesis 4. Presents	5. Conclude 6. Apply	10. Create 11. Construct 12. Designing 13. Creation 14. Develop 15. Write 16. Formulate	2. Creative thinking	5. Creative thinking	5. Creative thinking	2. Creative thinking
LOTS	3. Remember			7. Remember 8. Recounted	17. Remember 18. Understand 19. Apply				3. Recall 4. Basic
	<b>Conclusion</b> Higher Order Thinking Skills (HOTS) is a critical and creative thinking skill in solving a problem.								

## B. Operational Definition

*Higher Order Thinking Skills (HOTS)* can be described in the indicator of critical thinking skills and creative thinking skills as follows.

### 1) Critical Thinking

Huitt (1998) defines critical thinking as follows: “[c]ritical thinking is the disciplined mental activity of evaluating arguments or propositions and making judgments that can guide the development of beliefs and taking action.” [18]. Furthermore,

*Critical Thinking - using basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations; develop cohesive, logical reasoning patterns and understand assumptions and biases underlying particular positions; attain a credible, concise, and convincing style of presentation* [19].

Next,

*[a]nalyze is breaking material into its constituent parts and determining how the parts are related to one another as well as to an overall structure or purpose. Evaluate means making judgments based on criteria and/ or standards* [15].

Furthermore, Anderson and Krathwohl (2001) states that the *HOTS* is skills analyze include compare, check out, critical, test: and skills evaluate include evaluation, assess, denied, decided, choose, support [17].

Crowl et al., 1997; Lewis and Smith, 1993 states “[c]ritical thinking” as a part of the process of evaluating the evidence collected in problem solving or the results produced by thinking creatively” [21]. Furthermore, Wijaya states that critical thinking leads to the activity of analyzing ideas in a more specific direction, distinguishing things sharply, choosing, identifying, studying and developing in a more perfect direction [23]. Furthermore, John Chaffee defines critical thinking as thinking which is used to systematically investigate one's thinking process in using evidence and logic to the thinking process [23]. According to Ennis (1985: 54) critical thinking is one of the higher order thinking processes that can be used in the formation of student conceptual systems [16]. Critical thinking is a reasonable, or reasonably-based, reflective thinking way of determining what to believe and do. Wade (1995) identifies eight critical thinking characteristics, including [16]:

- a) Formulate questions,
- b) Limiting the problem,
- c) Testing the data,

- d) Analyze various information,
- e) Avoiding very emotional considerations,
- f) Avoid oversimplification,
- g) Consider various interpretations, and
- h) Tolerate the ambiguity.

Based on some expert opinions about critical thinking above can be summed up as in the following table.

<i>Critical Thinking</i>			
Huitt	Presseisen	Bloom revision	Wijaya
	1. Analyze	1. Analyze	1. Analyze
	2. Change	2. Compare	2. Distinguish
	3. Interpretation	3. Check	3. Identify
		4. Criticize	4. Review
		5. Test	
1. Evaluate		6. Evaluate	5. Choose
2. Judgments		7. Rate	6. Develop
3. Develop		8. Refute	
		9. Decide	
		10. Choose	
		11. Support	

*Critical Thinking* is the process of thinking analyzing by comparing or checking the truth of the information as well as the thinking process of evaluating by judging or selecting the right information from a problem.

## 2) *Creative Thinking*

*Creative Thinking - using basic thinking processes to develop or invent novel, aesthetic, constructive ideas or products, related to percepts as well as concepts, and stressing the intuitive aspects of thinking as much as the rational. Emphasis is on using known information or material to generate the possible, as well as to elaborate on the thinker's original perspective* [19].

In line with that opinion, "*HOTS (Higher Order Thinking Skill) is the ability to make judgments, analyze contents and synthesize information into coherent forms of communication and present such information to others*" (Narayanan & Adithan, 2015: 7). Next, Thomas and Thorne (2005) state that "*Higher Order Thinking is thinking on higher level that memorizing facts or telling something back to someone exactly the way the it was told to you*" [16]. Furthermore Thomas and Thorne (2009) states that *HOTS* requires a person to do something about facts, that is to understand, to conclude, to connect with other facts and concepts, to categorize, to manipulate, put facts together in new ways and to apply in finding solutions to problems [20]. Next, "*[c]reate is putting elements together to form a novel, coherent whole or to make an original product*" [15]. Furthermore, Anderson and Krathwohl (2001) states that *HOTS* is a creative skills that includes constructing, designing, creating, developing, writing, and formulating [17]. Similarly, Huitt (1998) stated creative thinking as follows:

*[c]reative thinking requires an individual to look at parts and relationships (analysis) and then to put these together in a new and novel way, as well as looking at the elements and the whole in a new perspective altogether* [18].

Furthermore, Crowl et al. (1997) states that:

*[t]he very act of generating solutions to problems requires the creative process of going beyond previously learned concepts and rules. Creativity involves divergent and convergent thinking to produce new ideas* [21].

In addition, creative thinking is a mental activity that produces something new that results from development. This is in line with Coleman and Hammen's opinion that "Creative thinking is a mental activity to improve the purity and sharpness of understanding in developing something" [23]. The ability to think creatively with regard to the ability to produce or develop something new, something unusual that is different from the ideas generated by most people. There are four stages in creative thinking, namely; (1) Exploring, identifying what things are to be done under current conditions; (2) Inventing, viewing or reviewing the tools, techniques and methods already possessed that may be

helpful in eliminating traditional thinking; (3) Choosing, identifying and selecting ideas that are most likely to be implemented; (4) Implementing, how to make an idea can be implemented.

Based on some expert opinions about creative thinking above can be summed up as in the following table.

<i>Creative Thinking</i>			
Presseisen	Narayanan and Adithan	Thomas and Thorne	Bloom revisi
1. Develop	1. Synthesis	1. Conclude	1. Create (Produce)
2. Create	2. Presents	2. Apply	2. Construct
3. Construct			3. Designing
4. Produce			4. Creation
5. Elaborate			5. Develop
			6. Write
			7. Formulate

*Creative Thinking* is the process of creating thinking by constructing, formulating, or summarizing information from a problem.

### CONCLUSION

Based exposure above, that the *Higher Order Thinking Skills (HOTS)* is a critical and creative thinking skill in solving a problem. *Higher Order Thinking Skills (HOTS)* can be broken down into indicators of critical thinking skills and creative thinking skills. *Critical Thinking* is the process of thinking analyzing by comparing or checking the truth of the information as well as the thinking process of evaluating by judging or selecting the right information from a problem. *Creative Thinking* is the process of creating thinking by constructing, formulating, or summarizing information from a problem.

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