Analysis of higher order thinking skills students at junior high school in Surakarta

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Abstract. Higher order thinking skills (HOTS) is high level thinking that many abilities includes inside it. HOTS has 3 dimension, namely: analysis (C4), evaluation (C5) and creating ideas (C6). This research aims to analyze the results of test HOTS of students in 3 school categories, namely high, medium and low category schools. The study is descriptive with quantitative approach using 95 students as a sample from three schools. The sample consists of 32 students in high categories, 32 students in medium categories, and 31 students in low categories. They are selected randomly. The HOTS indicator comes from the revision of Bloom Taxonomy. The dimension of C4 has three indicators, there are differentiating, organizing, and attributing. The dimension of C5 has two indicators, there are checking and critiquing. The dimension of C6 has one indicator, there is producing. The results of this research are: 1) students in high school categories has best result in HOTS problems, 2) in middle and low school categories, students have the highest scores on attributing that is indicators at dimension C4, and 3) students at three school levels are still having difficulty taking a conclusions.

1. Introduction
In recent of the year, the all students are facing the industrial era of 4.0 which is different from before. As the educators, teachers have a very important role to prepare students to face that era. Those who will live in era 4.0 will compete not only against humans but also against technology. The preparation must be extremely good to support the ability of students competent. One of the abilities which are able to support their lives in facing that era is high level thinking skills or what we often recognize as higher order thinking skills (HOTS). This ability not only is required by the students in learning at the classroom but also will have an impact and is useful for them to live their lives as in work or how to solve the problems which occur in everyday life. According to Rajendran [1], HOTS learning will also enhance an individual’s mind; leading to the production of a variety of alternatives, ideas, actions, solutions, and design. This higher order thinking opens the way for systematic and rational thinking.

One of the ways to improve HOTS is through learning, a lot of educational institutions still use an ancient system which is active teachers and passive students. Le and Nguyen [2, 3, 4] said that learning still makes the students passive in class. The students are taught a lot of theories without practice at the class, even the students are difficult and infrequently to ask questions at the class. Good learning that supports HOTS improvement should be an active learning. Brookhart [5] said that learning, besides involving students in retrieving or comprehending knowledge from prior learning, should require students to perform detailed analysis of the contents, reflect on what they are taught, and creatively apply what they have learned to solve the real problems; for example, the students have to think critically, it means that they “apply wise judgment or produced a reasoned critique” while learning.

Nowadays, the discussion about higher order thinking skills has been very widely discussed. Many people say that we need unlimited creativity in facing the industrial era of 4.0. Wheelihan [7] said that creativity and innovation are important keys to be success in any field in this era of rapid development.
Creative is one of ability in higher order thinking skills (HOTS). HOTS are the thinking skills activated when individuals encounter unfamiliar problems, uncertainties, questions, and dilemmas. In such situations, students cannot simply use a memorized solution but a combination of critical, logical, reflective, metacognitive, and creative thinking to develop a creative strategy to solve it [8]. This mental skill was initially determined based on Bloom’s Taxonomy which categorized various levels of thinking, ranging from the lowest to the highest, namely knowledge (C1), understanding (C2), application (C3), analysis (C4), synthesis (C5) and evaluation (C6). The concept of Benjamin S. Bloom et al [6] is actually the learning goals which are divided into three domains. These three domains are cognitive, a mental skill (about knowledge); affective, an emotional side (about attitudes and feelings); and psychomotor which is related to physical abilities (skills). According to Saido [9], based on research of the cognitive domains among secondary school students, the first three categories of Bloom taxonomy, that are knowledge, comprehension, and application measure students’ lower order thinking skills (LOTS), whereas the other three levels, that are analysis, synthesis and evaluation measure the higher order thinking skills or HOTS. Chang said that Bloom’s Taxonomy categorized 3 aspects regarding LOTS and HOTS. On the other hand, Clark in Saido [9] also said under the revised Bloom’s Taxonomy, the three higher levels are analyzing, evaluating and creating. Clark added a revision from Bloom’s Taxonomy regarding HOTS.

Taxonomy for determining the learning goals can be referred to as the ultimate goal of a learning process. After undergoing a certain learning process, students are expected to adopt new skills, knowledge, or attitudes. The order of thinking skills which are divided into low and high levels is the part of one of the domains proposed by Bloom, namely cognitive domain. The other two domains, affective and psychomotor, have their own levels. This cognitive domain was later revised by Lorin Anderson and David Krathwol [10]. The order is changed into (1) remember; (2) understand; (3) apply; (4) analyze; (5) evaluate; and (6) create. Levels 1 to 3, according to the initial concept, are categorized as lower order thinking abilities (LOTS). Meanwhile, levels 4 to 6 are categorized as higher order thinking skills (HOTS). Anderson and Krathwol [10] revised Bloom’s Taxonomy about HOTS. The importance of implementing HOTS became very demanding in the industrial era of 4.0 because learning was not sitting and quietly listening to the teacher deliver the material anymore. Learning becomes very important because it demands an application in the real world. According to Tajularipin [11], from the results of its application, it is stated that the students have a positive view of the implementation of HOTS in teaching and learning because it is beneficial to their real life. Since life has lots of challenges, students could be trained to think critically and creatively. The students have a positive view toward HOTS because they are able to play an active role in learning in real life. Quoted from Kusuma [12], the dimensions of higher order thinking skills delivered by Bloom are as follows:

| The Knowledge Dimension | The Cognitive Process Dimension |
|-------------------------|--------------------------------|
|                         | C4                             |
|                         | Analyze                        |
| Factual Knowledge       | Making structure, classifying   |
| Conceptual Knowledge    | Comparing, correlating          |
| Procedural Knowledge    | Explain, analyze               |
| Metacognitive Knowledge | Distinguish                    |
|                         | Conclude, resume               |
|                         | Arrange formulate              |
|                         | Make assess                    |
|                         | Realization                    |

Based on that dimension, Nugroho [14] has examined and revealed the standard content of HOTS for mathematics. The standard contents of HOTS in mathematics learning are as follows.
| No | Knowledge Dimension | Indicator | Description |
|----|----------------------|-----------|-------------|
| 1  | Analysis (C4)        | Differentiating | Students can differentiate between irrelevant and relevant parts or from important parts to insignificant parts of a given question. |
|    |                      | Organizing | Students can determine how a part of the element is suitable and can function together in determining the solution of a problem. |
|    |                      | Attributing | Students can determine the core of the relationship a question is given with the desired answer. |
| 2  | Evaluate (C5)        | Checking  | Students can track inconsistencies or consistency of a process or result to support decision making on a given problem. |
|    |                      | Critiquing | Students can detect inconsistencies between the results and decisions in accordance with the procedures given problems and provide a description of what is considered true. |
| 3  | Create (C6)          | Producing | Students are given a description of a result and must create a product that matches the description given, student need to built they own ideas. |

2. Method

In this study, the method used was descriptive with quantitative approach to find out the profile of students’ higher order thinking skills at the high, medium and low category schools. The population in this study were all the 8th-grade students at State Junior High School (SMPN) in Surakarta. From the population, three schools had been chosen to represent the population. The selection of three schools was based on National Examination grades which were categorized as low, medium and high category schools. The selection of samples to represent the schools was taken randomly. After being randomly selected, SMPN 9 Surakarta was obtained to represent the high category schools, SMPN 16 Surakarta represented the medium category schools and SMPN 21 Surakarta represented low category schools. The students were used as samples in each school as many as 30 students. The data collection of samples used the questions or the tests. The students were given 6 description questions, each of which represents each indicator, namely differentiating, organizing, attributing, checking, critiquing, and producing. In addition, it was given 60 minutes to complete the test. The topic in the question is a straight line equation in the form of a description that was previously validated and tested by the experts.

3. Result and Discussion

The higher order thinking skills have 6 indicators from 3 dimension of higher order thinking skills. In the high category schools, the highest score was at the C5 or checking indicator, while the lowest indicator was at the C4 or organizing indicator. In the schools with the high category, average ability in each indicators are the same, the indicators with the highest and lowest averages were not too far. It indicates that higher order thinking skills of students in high category schools quite similar at all dimension ranging from C4 to C6. In medium category schools, the highest indicator was at the C4 (attributing indicator), while the lowest indicator was at the C5 (critiquing indicator). In the medium category schools, the average of higher order thinking skills for each indicator was still below 50%. It indicates the students’ higher order thinking skills in the medium category schools is still low. No other than medium category schools, the low categories schools also still have a low average even lower than the medium category school students. The lowest indicator in low category schools was in C6 (producing) and highest was in category C4 (attributing). The value of the highest indicator in low
category schools was still below the lowest indicator in high category schools. Below is a diagram to summarize the students’ higher order thinking skills from the high category schools until the low category schools.

![Figure 1. Summary of higher order thinking skills students result](image)

Based on Figure 1, it was clear that the average HOTS score for SMPN 9 Surakarta as a high category school was quite good. The score they achieved was 60%. It means that half of the students at SMPN 9 had high HOTS especially on the indicator of checking on the level of evaluation (C5). However, the score that we hoped for Indonesian students were more than 60% at all dimension. SMPN 9 had shown a good level of achievement at the initiation stage in order to improve high intelligence thinking in their students. At the SMPN 9, teaching-learning sessions have been student-centered, students have become more active throughout sessions. Perhaps this system is a reason that the students have a better way of thinking compared to the other two schools categories. It was consistent with findings by Heo [13], “Students who were trained to think demonstrated a positive impact on the development of their education.”

In contrast, the highest average score for SMPN 16 as a medium category school achieved 46% on the indicator of attribution, it showed that half of the students in SMPN 16 had not achieved high intelligence thinking yet. Similarly, SMPN 21 as a low category school had an unsatisfactory score. The highest average score was on the indicator of attribution, accounting for 50%. The highest score from low and medium category schools was still lower than the score from a high category school. A high category school, as shown in the figure, had leading scores in all indicators. Whereas between low and medium category schools, they had small differences. There were 4 indicators led by the medium category school, including C4 to differentiate, C4 to organize, C5 to criticize, dan C6 to produce. On the other hand, there were 2 indicators led by students in the low category school. They were an indicator of C4 to attribute and C5 to check.

The high category school had the highest score on indicator C5 checking. This was identified because, in checking, students had to be able to analyze a given statement and to evaluate whether the statement was correct by looking for supportive evidence. After finding an evidence, the student wrote a response concerning the results of checking. The students in the high category school had been used to questioning things and finding evidence. On the one hand, the medium and low category schools had the highest score on indicator C4 to attribute. In this indicator, students should be able to decide the core of the problem. In part, students from low and medium category schools had been able to decide the core of the question and the way to solve it. It was similar to findings by Nguyen [15] who stated that students could almost draw out no conclusions and many of them were quite confused when
the teacher asked them to specify their description. Since we have discussed the overall average score that each category school had achieved, we will now discuss the students who answered perfectly or had the highest score.

Table 3. Percentage of Students With Perfect Answers And Grades

| C4 (differentiating) | SMPN 9 Surakarta | SMPN 16 Surakarta | SMPN 21 Surakarta |
|----------------------|------------------|------------------|------------------|
|                      | 18.75%           | 15.625%          | 19.35%           |
| C4 (organizing)      | 31.25%           | 9.375%           | 0%               |
| C4 (attributing)     | 12.50%           | 18.75%           | 22.58%           |
| C5 (checking)        | 15.625%          | 6.25%            | 0%               |
| C5 (critiquing)      | 15.625%          | 0%               | 0%               |
| C6 (producing)       | 12.5%            | 9.375%           | 0%               |

The indicator of the perfect answer was that students answered correctly and supported their response with logical arguments and evidence. Based on Table 3, we could conclude that students who answered perfectly were very few even in the high category school. Many students did not complete their answers after finding evidence. Students only focused on demonstrating without making conclusions. For students at the medium category school, none of the students answered perfectly on the indicator of criticizing. It indicated that students could not find the mistake in a question. Students could not even find evidence to criticize it. At the low category school, there were 4 indicators that none of the students could answer perfectly. The differences in overall results in the diagram and individual ability to answer perfectly possibly were caused by the differences in the methods of answering the question. Sometimes the different methods led students out of track or unable to find the correct answer. However, it was understandable. Students were still in middle school which was the initial stage of high intelligence thinking. Each individual had different ways of finding and solving problems. It corresponds to statement according to Zang dan Ching [16],[17], “Identifying such relationships can provide instructors and authorities with useful information so that they can apply appropriate methods, based on student’s individual differences, in order for them to be able to develop critical thinking in students.”

Based on that discussion, now we will discuss the different answers from students of low, medium, and high category schools. We should emphasize that the perfect answers also had many alternative answers. Students from the low, medium and high category school had different perfect answers. We will show the example of different student’s answers as follows.

3.1 C4 Differentiating

In the category of differentiating, students were expected to distinguish supporting points in the question order to answer the question. In Figure 2, students from high category school could
differentiate the corresponding one-on-one or also known as one-on-one function. Students in the high category school were able to analyze questions and to conclude that the functional formula stated were one-on-one function correctly. Students from high category school were able to distinguish the one-on-one function with the given evidence in the form of description and an arrow diagram. On the other hand, in Figure 3, students in the medium category school were only able to describe the diagram for evidence. However, they did not look for other supporting evidence. These students were still in the group that can distinguish one-on-one function using the diagram, however, they were not looking deeper for other supporting evidence. In Figure 4, students in the low category school had not been able to distinguish the function yet, but they were still making efforts according to their way of thinking.

3.2 C4 Organizing

In organizing, students were expected to find relevant points in a question or a statement. It was clear from the comparison above that students should be able to find the missing point namely the right \( x \) value to get the correct answer. Look at Figure 5 and Figure 6, high category and medium category school students were able to find \( x \) score correctly and get correct result. The students’ answers of medium category school and high category school had many similarities. The students had been able to determine how to find the relevant thing of this question to look for \( x \) score which was suitable for the expected answer. Look at Figure 7, low category school students had not been able to answer the question perfectly. Not being able to answer it correctly, it was possibly caused by the fact that low category school students had not been able to identify which part was needed to use to be able to solve the given question.

3.3 C4 Attributing

In attributing, students were expected to find relevant points in a question or a statement. It was clear from the comparison above that students should be able to find the missing point namely the right \( x \) value to get the correct answer. Look at Figure 8 and Figure 9, high category and medium category school students were able to find \( x \) score correctly and get correct result. The students’ answers of medium category school and high category school had many similarities. The students had been able to determine how to find the relevant thing of this question to look for \( x \) score which was suitable for the expected answer. Look at Figure 10, low category school students had not been able to answer the question perfectly. Not being able to answer it correctly, it was possibly caused by the fact that low category school students had not been able to identify which part was needed to use to be able to solve the given question.
In the attributing indicator, the students are expected to be able finding the core of the question given and answer it according to the core question. From Figure 8, high category school students had been able to answer the core of the question given correctly. The core of the question was whether the number of mapping from A to B and from B to A was similar or not, the right answers were different. The high category school students answered the core of the question with proof. In the high category school to low category school students (look at Figure 8-10) they had been able to show the proof but they did not answer the core of the question presented. This ability might be based on the fact that students from medium categories had been able to determine the core of the question since the core of the question was included in the legislative thinking ability in which there was no correlation with critical analysis [18].

3.4 C5 Checking

In the checking indicator, students were expected to check the truth from the question given with the support of proof and logical explanation. Look at Figure 11, high category school students had been able to check and prove the statement and followed by complete proof. Look at Figure 12, medium category school students had been able to check the statement with proof as well, but the conclusion had not been written yet. Look at Figure 13, low category school students had not been able to check even they were indicated that they did not understand the question given.

3.5 C5 Critiquing

In this indicator, students were expected to be able to find the incorrect part of a question, in which part the mistake was and how to provide a proof of that mistake. From Figure 14,15,16 high category
school students had been able to determine the mistake and show the correct one of that question supported with proof, while the medium category school students only could state the mistake without any proof, and low category school students could not even determine the mistake.

3.6 C6 Producing

![Figure 17](image1.png) Student’s answer of high school category in C6 producing

![Figure 18](image2.png) Student’s answer of middle school category in C6 producing

![Figure 19](image3.png) Student’s answer of low school category in C6 producing

In this highest level, students were expected to create something different from the others. Seen from Figure 17,18,19 high category school students had been able to create something logic such as function with symbols and mathematics language while the medium and low category school students created something without mathematics symbols only. It was also determined by the ideas that could be made by the students to produce or to create a function. The most interesting part was that the highest level from high order thinking skill was producing which became the indicator of the highest level. It was caused by the fact that idea was the core of creativity. As stated by Heonge [19], the findings indicated that deadlock of ideas was the most important factor in the difficulty in generating ideas among these students.

4. Conclusions

The importance of building higher order thinking skills for students in this day is the absolute important. Higher order thinking skills is one of the thoughts that can support the lives of students not only in school but also to support their thinking in facing the real world. In Indonesia, higher order thinking skills still does not reach the desired target. In this study, there were three different school categories. Students in schools with high categories are good enough in higher order thinking skills but have not reached the desired target. In schools with high categories, students have been able to analyze well what is meant by the problem. Students have been able to read the flow of the questions even though some students still have difficulty in concluding. In high school, students are also able to explore ideas for solving problems in the dimension of creation. Students in medium and low schools category still have not achieved the desired things, middle and low schools are best located in the attributing indicators. In this case they have been able to determine the core of the problem or problem but for indicators on C5 middle and low students still need to be improved. The suggestion for next research following of this research is to give more questions and use more samples. To the researchers, we suggest to study by using sample not only at one junior high school level, but three junior high school level. Using samples with different characters, will enrich the results of the research. If further studies use more sample and more question, maybe we will find something different or we will find something to complete the result of this study.

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