

Analysis of Senior High School Students' Higher Order Thinking Skills in Physics Learning

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Abstract. Higher-order thinking skills is thinking activity that involves bloom's taxonomy revised on analyze level, evaluate level and create level. The aim of this research is to find out students' higher-order thinking skills in physics learning. This research is descriptive research with subjects of the research is 92 students of XI MIPA grade in Surakarta from high, medium and low categorized school. The selection of school category was based on physics score in national examination. Students' higher-order thinking skills are measured using essay test of HOTS item that include C4, C5 dan C6. Based on the result of the research and analysis obtained percentage of students' higher-order thinking skills were gain results as follows, analyze skills is 94,5%; evaluate skills is 44,6%; and create skills is 8,7%. From this research, teachers know that students' HOTS still dominated analyze skills while evaluate skills and create skills needs to be empowered again, so teachers must choose the suitable learning method and giving HOTS instrument in physics learning to improve students' higher-order thinking skills.

Keywords: Analysis, Higher Order Thinking Skills, Physics Learning

INTRODUCTION

In globalization era that many challenges and uncertainties, so needed education that can develop students' thinking skills. The role of government in improving the quality education is doing structuring curriculum. The 2013 curriculum is expected to help students to improve students' thinking skills. Thinking skills is crucial in order to support solve problems. Idea generation thus is a crucial part of resolving a problem [1]. Beyer categorized the generation of ideas as a higher-order thinking skills activities that require high-level creative thinking and action [2]. To meet demands of the 21st century, students required not only have lower-order thinking skills, but must have higher-order thinking skills. So, schools in Indonesia must begin to empower higher-order thinking skills. This is accordance with characteristics of 21st-century societal skills, according to the partnership of 21st-century skills which identifies that students in the 21st-century must be able to develop competitive skills that focused on developing higher-order thinking skills [3].

The thinking skills that an individual possesses is not directly owned but acquired through practice. Lopez and Wittington believed that higher-order thinking skills appeared when an individual receives new information and the information mixed such that it generates a new arrangement and extend the individual knowledge [4]. Brookhart explains that higher-order thinking skills as students' skills to apply the knowledge and skills that they will develop during a learning process on a concept that has not been previously thought, but the concept has been taught previously [5]. With higher-order thinking skills, an individual will be able to use the new information or prior knowledge and manipulate information to obtain a reasonable response to new situations [6]. Consequently, application of knowledge learned in daily lives, creative ideas can only be generated through higher-order thinking, instead of the lower-order thinking too.

Barnett and Francis argues that higher-order thinking questions can encourage students to think deeply about subject material, so it can be said that higher-order thinking skills can stimulate students to improve higher-order thinking skills [7]. Brookhart states that higher-order thinking conceived of as the top end of the Bloom's cognitive taxonomy. The teaching goal behind any of the cognitive taxonomies is equipping students to be able to do transfer. "Being able to think" means students can apply the knowledge and skills they developed during their learning to new contexts [8]. "New" here means applications that the student has not thought of before, not necessarily something universally new. Higher-order thinking is the skills of students to connect their learning with other elements beyond those they were taught on everyday life.

Schraw *et al*, classifies bloom's thinking skill into two categories that is Lower-order thinking skills which consists of knowledge, understanding and application. Higher-order thinking skills which consists of analysis, synthetic and evaluation [9]. Description and key word of each category can be seen in table 1.

Table 1. Description and Key Word of Bloom's Taxonomy Revision

Category	Key Words	Thinking Skills
Remembering: can the student recall or remember the information?	Mention the definition, imitate the pronunciation, state the structure, pronounce, repeat, state	LOTS Lower-Order Thinking Skills
Understanding: can the students explain the concept, principle, law or procedure?	Classify, describe, explain the identification, placed, report, explain, translate, paraphrased.	
Applying: can the students apply their understanding in new situation?	Choosing, demonstrating, acting, using, illustrating, interpreting, arranging schedule, making sketch, solving problem, writing	
Analyzing: can the students classify the sections based on their difference and similarity?	Examining, comparing, contrasting, distinguish, doing discrimination, separating, test, doing experiment, asking	HOTS Higher-Order Thinking Skills
Evaluating: can the students state either good or bad towards a phenomenon or certain object?	Giving argumentation, defending, stating, choosing, giving support, giving assessment, doing evaluation	
Creating: can the students create a thing or opinion?	Assemble, change, build, create, design, establish, formulate, write	

Based on the above description, knew the students' higher-order thinking skills is important, so teachers can choose the suitable learning method in physics learning to improve students' higher-order thinking skills. Assessment of higher-order thinking skills use to measure the students' higher-order thinking skills, besides that assessment of higher-order thinking skills also expected to be a means of train higher-order thinking skills, improve creativity and build student self-reliance in solving problems.

METHODS

The method used in this research is descriptive, to analysis students' higher-order thinking skills in physics learning. The selection of school category was based on physics score in national examination. Research subjects were 11th-grade students in the academic year of 2017/2018. There are 92 students from high, medium and low categorized school in Surakarta. The number of samples used is one class for each school with the number of students shown in table 2.

Table 2. The number of students used in the research

Category School	Number of Students
High	31
Medium	30
Low	31

Data of the research was obtained from the result of students' test using assessment instrument higher-order thinking skills with temperature and heat material. This test were adapted from Lindawati, *et al* [10]. Data that consists of 3 essay tests is used to analyze the achievement of each indicator of higher-order thinking skills. The indicators are analyze skills, evaluate skills and create skills. The instrumen higher-order thinking skills can be seen in Figure 1.

1. Dina ingin melakukan pengukuran suhu pada tubuh adiknya menggunakan termometer X. Termometer X memiliki titik beku air 50°X dan titik didik air 250°X . Jika suhu tubuh adiknya diukur dengan termometer X menunjukkan angka 126°X .
 - a. Berapakah suhu tubuh adik dina jika diukur dengan termometer Celcius?
 - b. Gambarkan perbandingan titik didih air dan titik beku air pada kedua termometer!
2. Tukang pandai besi memiliki baja bersuhu 20°C yang panjangnya 40 cm dengan koefisien muai panjang baja $10^{-5}/^{\circ}\text{C}$. Jika baja dipanaskan,
 - a. Bagaimana perubahan panjang setelah dilakukan penambahan suhu pada interval 70°C , 120°C dan 170°C ?
 - b. Proyeksikan interval suhu menggunakan grafik!
3. Pecahnya kaca jendela, bengkoknya rel kereta api merupakan contoh dari suatu benda yang dapat menyusut atau memuai yang disebabkan oleh perubahan suhu, menyusut maupun memuai tentu memiliki kerugian dan keuntungan. Buatlah resume mengenai kerugian dan keuntungan menyusut maupun memuai dengan menghubungkannya dalam kehidupan sehari-hari!

Figure 1. Question of Instrument Higher-Order Thinking Skills

Data that consists of a result of students' test is used to analysis the achievement of each indicator of higher-order thinking skills. The indicators are analyze, evaluate and create. Based on three indicators of higher-order thinking skills, the total value of indicator is converted. Students can be categorized based on their higher-order thinking skills. HOTS categories are shown in table 3 [11].

Table 3. Category Level of Higher-Order Thinking Skills

Students' mark	Level of students' higher-order thinking
100-76	Excellent
75-51	Good
50-26	Enough
25-1	Poor

RESULTS AND DISCUSSION

HOTS analysis at high school category

Higher-order thinking skills measurements in the high school category were conducted in 31 students. The result of measurement is shown in figure 2.

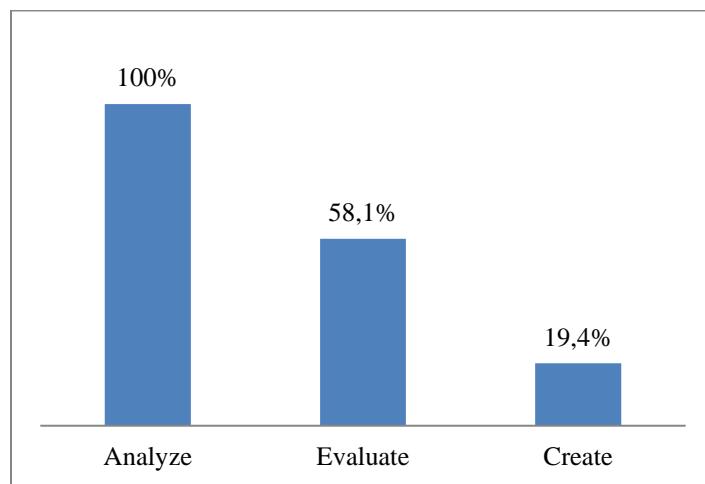


Figure 1. Higher-order thinking skills analysis at high school category

Based on Figure 1 which is a high school category, shown that all students have analyze skills, while in evaluate skills 18 students already have evaluate skills and only 19,4% of the 31 students who can true to answer the question of create skills.

HOTS analysis at medium school category

Higher-order thinking skills measurements in the medium school category were conducted in 30 students. The result of measurement is shown in figure 3.

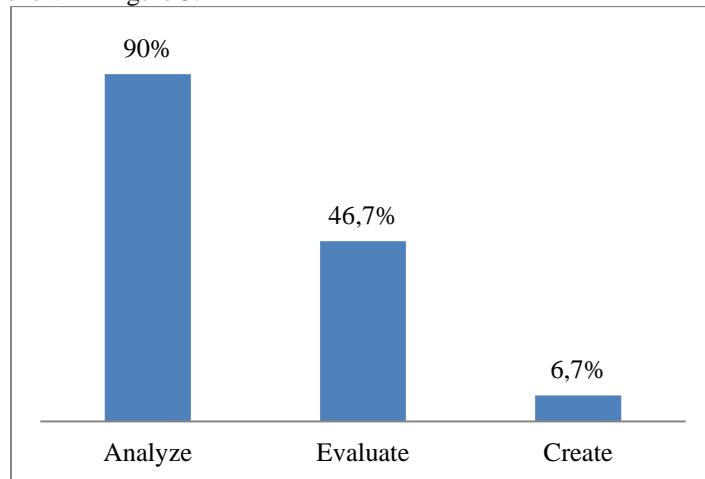


Figure 2. Higher-order thinking skills analysis at medium school category

On Figure 3 can be seen that the percentage of each category of higher order thinking skills for Analyze skills, Evaluate skills, and Create skills at medium school category is 90%; 46,7% and 6,7%. This indicates that the higher the level of higher-order thinking skills, the fewer students can answer the question with true.

HOTS analysis at low school category

Higher-order thinking skills measurements in the low school category were conducted in 31 students. The result of measurement is shown in figure 4.

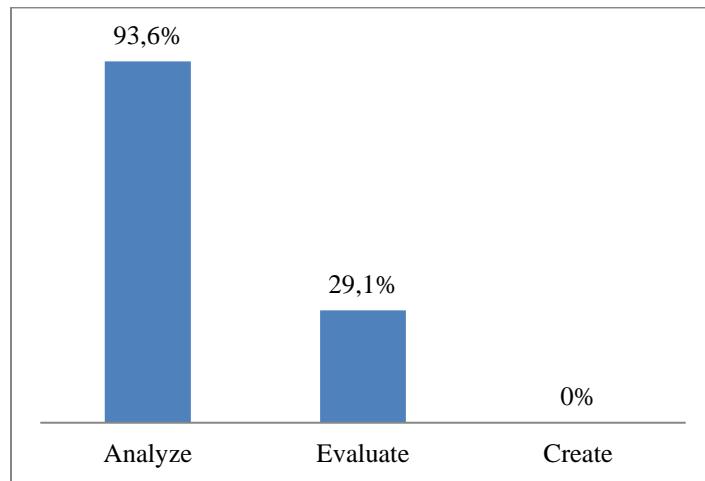


Figure 4. Higher-order thinking skills analysis at low school category

The Figure 4 shows that students in low school category only have Analyze skills and Evaluate skills. On the category of create skills no students can answer the question with true.

Summary of that result for each component and its convert was presenting as follows:

Table 4. Average of students' higher-order thinking skills

Higher-Order Thinking Skills Level	Percentage (%)	Category
Analyze	94,5	Excellent
Evaluate	44,6	Enough
Create	8,7	Poor

Based on Table 4, it can be seen that the level create which is the highest level of higher-order thinking skills shows average is poor because just 8,7%, it shows that only 8 students reach creative skills and percentage at evaluation level not reach 100%, this indicates that 55,4% of students had not achieved evaluation skills. Table 3 also shows that most students already had analyze skills, only 5 students who had not reached the analyze skills.

CONCLUSION

Based on the result and the data analysis, students' higher-order thinking skills of XI grade students is as follows analyze skills is 94,5% with excellent category; evaluate skills including enough category with percentage 44,6%; and create skills is a poor category because it only gets percentage of 8,7%. The research showed that students' HOTS still dominated analyze skills while evaluate skills and create skills needs to be empowered again by giving HOTS instrument, so that students' higher-order thinking skills can improve.

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