Research Article doi: 10.12973/eu-jer.8.4.935

European Journal of Educational Research
Volume 8, Issue 4, 935 - 942.
ISSN: 2165-8714
http://www.eu-jer.com/

# HOTS-AEP: Higher Order Thinking Skills from Elementary to Master Students in Environmental Learning

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*Received: June 6, 2019 ▪ Revised: July 24, 2019 ▪ Accepted: September 22, 2019*

**Abstract:** Environmental learning in the 21st century requires students to have Higher Order Thinking Skills (HOTS). The purpose of this study was to measure HOTS students using Higher Order Thinking Skills Assessment based on Environmental Problem (HOTS-AEP). The research method used in this study was descriptive method with a total sample of 248 students consisting of Elementary School (ES), Junior High School (JHS), Bachelor Program (BP), and Master Program (MP). The results showed that students overall have a very low HOTS category. HOTS scores scale of 0-100 on ES (22.3) are still higher than JHS (20.2). Whereas at the university level, BP scores (19.9) are lower than MP (21.4). This showed that learning must be oriented towards increasing HOTS through various media development learning, learning materials, learning models, and strategies. This study concludes that the HOTS score of students was still very low and needs to be improved.

**Keywords:** *Environmental learning, higher order thinking skills, HOTS-AEP, students.*

**To cite this article:** Ichsan, I. Z, Sigit, D. V., Miarsyah, M., Ali, A., Arif, W. P., & Prayitno, T. A. (2019). HOTS-AEP: Higher order thinking skills from elementary to master students in environmental learning. *European Journal of Educational Research, 8*(4), 935-942. https://doi.org/10.12973/eu-jer.8.4.935

## Introduction

Environmental learning had various changes over the past few years, certainly due to demands on 21st century learning that change various aspects of learning. 21st century environmental learning at various levels has changed the habits of the teacher center to become a student center (Quieng, Lim, & Lucas, 2015; Sharif & Cho, 2015). The competencies required by students in 21st century learning also change. Previously students were only required to memorize concepts and understand them. Students are only taught to memorize various concepts that can be learned on their own and are not contextual to learn in class. In 21st century learning, students are required to analyze environmental problems around them and more than just memorize concepts (Chalkiadaki, 2018; Saputri, Sajidan, Rinanto, Afandi, & Prasetyanti, 2018).

As for environmental problems such as green consumerism, recycling, waste avoidance, eco-labeling, climate change, global warming and other environmental problems that are often found in students' daily lives (Blanco & Lozano, 2015; Gu, Chhajed, Petruzzi, & Yalabik, 2015; Karpudewan, Roth, & Abdullah, 2015). In solving these problems, analytical skills are needed. For example, when students want to solve recycling problems, students must be able to analyze the factor make people lazy for recycling. Then students make an action such as an event for recycling. So that other students want to participate in the recycling activities. The ability not only to analyze but also to evaluate and create. The ability to analyze, evaluate, and create is often referred to as Higher Order Thinking Skills (Aisyah, Salehuddin, Aman, Yasin, & Mimiko, 2018; Anderson et al., 2001; Garcia, 2015).

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Higher Order Thinking Skills (HOTS) is a student's ability to think at a higher level. Students who have HOTS will be able to analyze, evaluate, and create innovation in solving environmental problems. HOTS need in science and environmental learning. That is because many environmental problems can be solved using HOTS capabilities. For example, the case of green consumerism, students must have good HOTS skill in analytical (C4) so they can provide an evaluation (C5) of the policy on the use of plastics. After they can provide an evaluation, the next step is to create a solution. The create (C6) level on HOTS is the highest ability students must have in the 21st century (Chalkiadaki, 2018; Saputri et al., 2018; Talmi, Hazzan & Katz, 2018). Basically the ability of HOTS can be improved by various learning media, teaching materials based on HOTS. Therefore it is necessary to develop the learning of Science and environment.

Students in the level of Elementary School (ES), students usually begin to be taught to identify problems and solve simple problems while the level of Junior High School (JHS) students begin to be required to be able to identify problems that are a bit complicated. For the Bachelor Program (BP) and Master Program (MP) level, students must be able to solve complex problems. In principle, all levels of education require students to have a high score of HOTS (Baris, 2015; Copley, 2013; Heong et al., 2012; Lile & Bran, 2014; Saltan & Divarci, 2017).

The problem that arises is the absence of a complete students HOTS profile from various levels of education that illustrates the HOTS ability of students in solving environmental problems. Most research is usually only comparing HOTS at the same level of education (Afflerbach, Cho & Kim, 2015; Zohar & Alboher Agmon, 2018). Besides, there is also much developments of learning media in the HOTS field, and so on (Husamah, Fatmawati & Setyawan, 2018; Saputri et al., 2018). But no one has discussed the overall profile of HOTS students at various levels. Therefore, this study shows the novelty of a student's HOTS profile measured at various levels of education.

Measurements about HOTS must certainly use instruments that are understood by students in all levels of education. One of the instruments that are suitable was Higher-order Thinking Skills Assessment based on Environmental Problem (HOTS-AEP). So based on the description of the above problems, it is necessary to investigate students HOTS profiles. So this study aimed to measure students HOTS at various levels of education using HOTS-AEP.

## Methodology

*Research Goal*

This research was a descriptive research. This study conducted with instruments that are distributed to students. The purpose of this study was to measure the HOTS of students at various levels of education using HOT-AEP. This research is a descriptive study conducted in May-June 2019.

*Sample and Data Collection*

The sample in this study were students and university students in several schools and university in Indonesia. Samples were taken at State Elementary School 2 Jatimulya, State Junior High School 1 South Tambun, State University of Jakarta (Universitas Negeri Jakarta), Alauddin State Islamic University of Makassar (UIN Alauddin Makassar), and Teacher and Education Institute of Budi Utomo (IKIP Budi Utomo). The sample used in this study was selected by simple random sampling with 248 students consisting of 32 students at Elementary school (ES), 100 students at Junior High School (JHS), 100 students at Bachelor Program (BP), 16 students at the Master Program (MP). Simple random sampling is used so that the sample chosen is representative.

*Analyzing of Data*

Data were analyzed descriptively by comparing average HOTS scores of students from various levels. Also, comparison of HOTS scores from each indicator and aspect was also carried out. The software used in conducting data analysis in Microsoft Excel and the Statistical Package for Social Sciences (SPSS).The categories of HOTS are presented in table 1.

*Table 1. HOTS categories of students*

| Category | Interval Score |
|---|---|
| Very High | $X > 81{,}28$ |
| High | $70{,}64 < X \leq 81{,}28$ |
| Moderate | $49{,}36 < X \leq 70{,}64$ |
| Low | $38{,}72 < X \leq 49{,}36$ |
| Very Low | $X \leq 38{,}72$ |

*Instrument*

The research instrument used was the Higher Order Thinking Skills Assessment based on Environmental Problem (HOTS-AEP) that had been developed (Ichsan, Hasanah, Aini, Ristanto & Miarsyah, 2019). This instrument is an

instrument consisting of 12 items. Each item developed has a score of 0-10. The HOTS-AEP indicators used in this instrument can be seen in table 2.

*Table 2. HOTS-AEP Indicators*

| Aspect | Indicator | Item |
|---|---|---|
| C4 (Analyze) | Students can be analyzing the causes of water and air pollution | 1,7 |
| C4 (Analyze) | Students can be analyzing water and air pollution factors based on a case | 2,8 |
| C5 (Evaluate) | Students can be evaluating water and air pollution that occurs in their environment | 3,9 |
| C5 (Evaluate) | Students can be criticizing the components of society that cause water and air pollution | 4,10 |
| C6 (Create) | Students can be making a hypothesis about the effects of water and air pollution on the survival of living things | 5,11 |
| C6 (Create) | Students can be designing simple tools for purifying water and a poster or paragraph about the negative effects of air pollution | 6,12 |

Source: Ichsan et al. (2019)

*Validity and Reliability*

HOTS-AEP has been declared valid and reliable by the developer. However, in this study the validity and reliability were tested again to ensure that the items valid and suitable with the characteristics of students measured as a sample. The validity test used Pearson Product Moment (PPM). In this study, the method used to measure reliability was the split half method (Spearman-Brown). The significance level used is 0.05 for the validity and reliability tests. After all items are declared valid and reliable in this study, then the HOTS-AEP instrument is given to students. In the validity test the results can be said to be valid if the Pearson correlation > r table. Meanwhile for reliability, the reliability category can be seen in table 3.

*Table 3. Reliability Category*

| Value of Reliability | Category |
|---|---|
| $0,80 \leq r_{11}$ | High reliability |
| $0,4 \leq r_{11} < 0,80$ | Medium reliability |
| $r_{11} < 0,4$ | Low reliability |

Source: Ratumanan & Laurens (2006)

## Results

The results of the validity test showed that all HOTS-AEP items have a valid category. While the reliability calculation performed showed that this instrument has a reliability of 0.78 with a medium reliability category. More information can be seen in table 4.

*Table 4. Results of testing the validity of HOTS-AEP items at all levels of education*

| No item | Pearson correlation | r table (n=59/sig level=0.05) | Category |
|---|---|---|---|
| 1 | .606 | .250 | Valid |
| 2 | .858 | .250 | Valid |
| 3 | .671 | .250 | Valid |
| 4 | .641 | .250 | Valid |
| 5 | .680 | .250 | Valid |
| 6 | .518 | .250 | Valid |
| 7 | .731 | .250 | Valid |
| 8 | .696 | .250 | Valid |
| 9 | .731 | .250 | Valid |
| 10 | .705 | .250 | Valid |
| 11 | .765 | .250 | Valid |
| 12 | .459 | .250 | Valid |

In tables 5 and 6 are the results of HOTS-AEP measurements from various levels of education. Elementary School (ES) level students get the highest score on the fourth indicator. Junior High School (JHS) students get the highest score on the first indicator. Students Bachelor Degree Program / undergraduate students (BP) get the highest score on the sixth indicator. While for the Master Program (MP) level, students get the highest score on the first indicator. Overall, the highest score is in the sixth indicator, see table 5. Meanwhile, for HOTS scores per aspect can be seen in table 6.

*Table 5. Students Average Score HOTS at all levels based on each indicator*

| | Indicators | ES | JHS | BP | MP | Average |
|---|---|---|---|---|---|---|
| 1 | Students can be analyzing the causes of water and air pollution | 2.27 | 2.29 | 1.95 | 2.38 | 2.22 |
| 2 | Students can be analyzing water and air pollution factors based on a case | 2.25 | 1.92 | 2.02 | 2.03 | 2.06 |
| 3 | Students can be evaluating water and air pollution that occurs in their environment | 2.00 | 1.89 | 1.77 | 1.91 | 1.89 |
| 4 | Students can be criticizing the components of society that cause water and air pollution | 2.42 | 2.13 | 2.06 | 2.06 | 2.17 |
| 5 | Students can be making a hypothesis about the effects of water and air pollution on the survival of living things | 2.17 | 1.83 | 1.87 | 2.13 | 2.00 |
| 6 | Students can be designing simple tools for purifying water and a poster or paragraph about the negative effects of air pollution | 2.27 | 2.03 | 2.26 | 2.34 | 2.23 |

Note: each indicator has a score range from 0 to 10; ES (Elementary School), JHS (Junior High School), BP (Bachelor Program/undergraduate students), MP (Master Program)

*Table 6. HOTS scores of students of various levels seen from each aspect*

| | ES | JHS | BP | MP |
|---|---|---|---|---|
| C4 (*Analyze*) | 2.26 | 2.11 | 1.99 | 2.20 |
| C5 (*Evaluate*) | 2.21 | 2.01 | 1.91 | 1.98 |
| C6 (*Create*) | 2.22 | 1.93 | 2.06 | 2.23 |
| Average score | 2.23 | 2.02 | 1.99 | 2.14 |
| Average score (scale 0-100) | 22.3 | 20.2 | 19.9 | 21.4 |
| Category | Very Low | Very Low | Very Low | Very Low |

In table 7, it can be seen that the lowest item in ES, BP, and MP students are on item 9. While for JHS students, the lowest item is on item 8. While the highest item is obtained on item 4 in ES students, while for JHS students on item 1, for BP and MP students, the highest item is on item 6. More details can be seen in table 7.

*Table 7. HOTS scores of students of various levels seen from each item*

| | Item | ES | JHS | BP | MP |
|---|---|---|---|---|---|
| 1 | Analyzing the causes of river pollution | 2.44 | 2.48 | 1.97 | 2.31 |
| 2 | Analyzing the causes of dead fish in a polluted lake | 2.53 | 2.17 | 2.27 | 2.00 |
| 3 | Evaluating the impact of lake pollution on human life | 2.22 | 2.04 | 1.89 | 2.13 |
| 4 | criticizing the behavior of people who are unable to protect the environment | 2.88 | 2.19 | 2.19 | 2.06 |
| 5 | Making the hypothesis the impact of consuming polluted water | 2.41 | 1.94 | 2.02 | 2.31 |
| 6 | Making a simple water purifier design | 2.03 | 2.28 | 2.35 | 2.56 |
| 7 | Analyzing the impact of car-free day activities | 2.09 | 2.10 | 1.93 | 2.44 |
| 8 | Analyzing various factors of air pollution in addition to forest fires | 1.97 | 1.67 | 1.77 | 2.06 |
| 9 | Evaluating people's behavior in preventing air pollution | 1.78 | 1.74 | 1.65 | 1.69 |
| 10 | Criticizing the behavior of the community to the problem of forest fires | 1.97 | 2.06 | 1.92 | 2.06 |
| 11 | Making Hypothesis the impact of forest fires | 1.94 | 1.72 | 1.72 | 1.94 |
| 12 | Making a paragraph or picture to prevent forest fires | 2.50 | 1.78 | 2.16 | 2.13 |

Note: each item has a score range from 0 to 10; ES (Elementary School), JHS (Junior High School), BP (Bachelor Program/undergraduate students), MP (Master Program)

The measurements presented in table 7 allow us to know which sides are already good and which are not yet good at HOTS students in more detail. So that the only focus on learning is to improve points that are still considered lacking. It also can make time more efficient in learning because the teacher can make the right strategy to overcome the low HOTS problem.

## Discussion and Conclusion

The results of HOTS scores of students in table 6 as a whole showed that the scores of students at the ES level are still higher than the JHS level. While the JHS level is still higher than the BP level. This is due to changes in the curriculum that was implemented several years ago. Indonesia Curriculum in 2013 (*Kurtilas*) is a new curriculum that changes the educational outlook from teacher center to the student center. This seems to affect HOTS of students. It is seen that in BP, students who were students who at the time of 10 years ago were still using Indonesian curriculum in 2006 (*KTSP*), had a low HOTS score. That is because the use of *KTSP* is dominant based on the teacher center. The teacher center

approach is difficult to stimulate HOTS students (Gunduz, Alemdag, Yasar, & Erdem, 2016; Kinay & Bagceci, 2016; Mahoney & Harris-Reeves, 2019; Tyabaev, Sedelnikova, & Voytovich, 2015; Xia, 2017; Yee et al., 2015). Therefore teachers must be able to change their habits in using the teacher center. This can be done if the lesson plan is made with a more constructive approach.

The use of teacher center approach in *KTSP* makes students more passive in learning. It is evident in the results of this study that if see back at table 7 it can be seen that in the ninth item it is clear that BP students have the lowest score compared to ES, JHS, and MP. This is because BP students who used to learn with *KTSP* (several years ago in elementary school) are passive, so students will find it difficult to evaluate an attitude or behavior of someone who is not environmentally friendly. At the ES level, it is clear that they can begin to learn to evaluate a person's attitude towards the environment. This is certainly a positive thing considering the ability to evaluate is one part of HOTS that needs to be trained (Gunduz et al., 2016; Madhuri, Kantamreddi, & Goteti, 2012; Walsh, Bowes, & Sweller, 2017). In Table 5, it is clear that on the 5th indicator about making a hypothesis, ES students have the highest score compared to the other levels. This further reinforces the argument that the use of *Kurtilas* as a curriculum has an impact on HOTS Students. However, there are different results if we look at table 6, it is clear that all students at various levels have a very low HOTS category. However, if we look further, MP students have the highest C6 (create) aspect compared to others. In this study, MP students respondent have indeed been directed to be able to create innovation, even though the highest still has a very low HOTS category.

Learning needs to be improved so that students have high HOTS. In this study, it was seen that fundamental changes in the curriculum and technological advances played an important role in HOTS. Students in the technology era like now are very easy to find various information on the internet, but they must filter and use only good information. This will make them open their knowledge. However, technology also has a detrimental effect that is, the information is not necessarily valid. Steps to ensure that the information received by the student is valid, then teacher must clarify the concepts in learning (Fitriani, Adisyahputra, & Komala, 2018; Meyer, 2016; Nordin & Alias, 2013; Okur Berberoglu, Ozdilek & Yalcin Ozdilek, 2014).

Improvement of HOTS on aspects of C4 (analyze) can be done by applying various methods, strategies, learning materials, and learning media that can stimulate the power of student analysis. In HOTS-AEP, students are stimulated to carry out analysis in terms of environmental pollution that occurs around them. Students are asked to answer using various sources of information they get and then become a new sentence, which is an analysis. This needs to be trained, in learning for example students are accustomed to discussing problems with their group friends to solve problems (Istiana & Awaludin, 2018; Puran, Behzadi, Shahvarani & Lotfi, 2017; Yang, 2018).

While the aspects of C5 (evaluate) can be improved by giving various cases, then students are asked to comment on the case. In this case, of course, students do not only give comments without foundation but must be based on the facts. For example, on HOTS-AEP, students are asked to provide criticism on the behavior and attitudes of people who do not care about the environment. After giving an evaluation and criticism, students should give conclusions about the attitudes and behavior of the community that should be done. In this activity students are trained to dare to make comments based on existing data, so that students are trained in their ability to argue (Fauzi & Fariantika, 2018; Hidayat, Wahyudin & Prabawanto, 2018; Khan, Khan, Zia-Ul-Islam, & Khan, 2017; Mercer-Mapstone & Kuchel, 2017; Vincent-Ruz & Schunn, 2017).

The last aspect, namely the C6 (create) aspect, is an aspect that has different characteristics from C4 and C5. C6 can be improved by practical learning, such as project-based learning. Learning to use project-based will stimulate students to make innovation from the project. However, the disadvantage is that this learning is difficult because it requires a lot of time and energy. The teacher can look for alternatives by doing a demonstration, but later the students continue to make the product too. Also, the products made must be in the form of goods that are environmentally friendly, such as waste recycled bags, etc. (Ertz, Karakas & Sarigollu, 2016; Genc, Genc & Rasgele, 2018; Goldman, Yavetz & Pe'er, 2014; Suhendar & Wahyuni, 2018).

While at the university level, it needs a formal program in the classroom. Besides that, they can use outdoor learning. They can go directly to areas where the environment is polluted, then do simple research. Solving problems in do simple research at the ES, JHS, SHS, BP, and MP levels the difference is their depth in analysis. One and the same problem can be solved by students at all levels, but the analysis is different, in MP deeper than in BP. Moreover, they can create an innovation that is beneficial to society. This will train their logic for analysis, and of course, HOTS will increase (Bahtiar & Dukomalamo, 2019; Fajarianingtyas, Akbar & Herowati, 2019; Kose, Savran Gencer, Gezer, Erol & Bilen, 2011; Sener, Turk & Tas, 2015; Yu, Yu & Chao, 2017).

The conclusion of this study is that HOTS students are still in the category very low at all levels of education. Various ways must be done to increase HOTS students so they can increase. Development and use of various learning models, learning methods, learning material, teaching materials, student worksheet, and learning media can improve students HOTS.

## Suggestions and Limitation

Suggestions that can be given based on the results of this study are for researchers to continue to develop learning models, learning methods, learning materials, teaching materials, student worksheets, and learning media to increase HOTS students at various levels. The development of various learning tools will make HOTS-based learning increase. This will potentially have an impact on increasing HOTS students. The limitation of this study is that the number of samples which is still very small is only 248 students. So it can't yet represent the entire territory in Indonesia that is wide. In addition, this study only focuses on looking at students' HOTS profiles. so the factors that influence HOTS are not examined further in this study.

**Acknowledgements**

Thank you to all those who have helped this research. Thank you to Mrs. Enin Iriani (teacher) for gathering data on this research at Elementary School 2 Jatimulya. Thank you to Mrs. Aryani Kadarwati Dewi (teacher) for gathering data on this research at State Junior High School 1 South Tambun, Bekasi.

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