



Impacts of Global Warming in Natural Science: Evaluate Elementary Student's HOTS and PEB in Environmental Education

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Abstract: Global warming is a hot topic in various countries. The impacts of global warming are felt through the decrease in health. Handling the issue requires Higher Order Thinking Skills (HOTS) and Pro-Environmental Behavior (PEB) in environmental education. Elementary school students need to contribute to preventing global warming. The research aims to describe the HOTS and PEB of elementary school students on the topic of the impacts of global warming. The research used a descriptive method. Research instruments are used to measure HOTS and PEB and are disseminated using Google Forms. The research results indicate that the HOTS score of elementary school students is still in a very low category (21.32), whereas their PEB score is in a high category (80.65). Learning media can be developed in future research to improve students' HOTS regarding the impacts of global warming. This research concludes that HOTS and PEB of students in impact of global warming must be improve. The limitation of this study is that the scope of this research is still very limited because it has not yet carried out media development for students at school.

Keywords: Environmental education; Global warming; HOTS; PEB; students

Introduction

The global warming phenomenon is a hot topic in the world. It affects human survival. Earth's temperature is increasingly hot causing changes in life patterns and the human environment. Pollution from motor vehicle fume is one of the causes of global warming (Panno et al., 2017; Pivato et al., 2018; Silva et al., 2015). The use of low-emission vehicles is now mandatory in various developed and developing countries. The obstacle, however, comes from the use of fossil fuels for industry and power plants. The continuous use of fossil energy is due to the substantial cost needed to develop power plants that use alternative energy.

The impacts of global warming are also experienced by communities, especially those who live in urban

areas. Respiratory diseases, such as asthma, respiratory infections, and other disorders are common issues in urban society. This indicates that global warming impacts in urban areas (Alcock et al., 2017; Nzeadibe & Ejike-Alieji, 2020; Wilhelmsen et al., 2017). Additionally, global warming also indirectly affects rural communities. Numerous plantations suffer drought and crop failure that leads to less nutritional food stocks for rural communities. People, including elementary school students, must have critical thinking to contribute to global warming prevention. The role of environmental education becomes crucial to improve skills.

Elementary school students must possess Higher Order Thinking Skills (HOTS) to solve problems. HOTS is someone's skill to solve problems. It consists of several skills, namely analyzing, evaluating, and creating (Anderson et al., 2001). In the context of the topic of

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global warming and its impacts, HOTS becomes a vital skill to contribute to solving the issue. Analytical skills expected to be owned by high-level elementary school students (Grades 5 and 6) include analyzing and evaluating phenomena that occur in everyday life. Further, students need to provide ideas to solve the problems with a doable creative idea although with a simple concept.

HOTS as a concept of student thinking skills becomes crucial to be implemented in the form of Pro-Environmental Behavior (PEB) as an implementation of the concept of the impacts of global warming. PEB consists of several aspects, namely: energy conservation, transportation, waste avoidance, green consumption, recycling, and social behavior (Kaiser & Wilson, 2004). Students must possess PEB as a form to prevent global warming in the world. PEB can be trained and familiarized to students since the elementary school level. The PEB that becomes the focus of the issue of the impacts of global warming is necessary to be applied due to its direct impact on the condition of the surrounding community health. PEB that needs improvement, in this case, is environmental education.

A relevant study is related to the development of Educational models to improve HOTS, such as OIIDE (Husamah et al., 2018a, 2018b). Moreover, there is a strengthening of literacy concepts using a Reading, Mind Mapping, and Sharing (RMS) model that includes the strengthening of student comprehension of natural science concepts (Muhlisin, 2018; Muhlisin et al., 2016). Another relevant study besides those related to model development is associated with the description of community skills in environmental literacy. Based on the previous studies on various topics, the current research is urgent to be done to complete the existing studies, especially on the topic of the impacts of global warming. The research aimed to describe the HOTS and PEB of elementary school students on the topic of the impacts of global warming in environmental education.

Method

The research was conducted using a descriptive method. Data were collected in January 2023 using a survey disseminated to respondents using a Google Form. The respondents that became the research sample were elementary school students in Jakarta, Bekasi, and the surrounding areas. The samples consisted of 108 students randomly selected. The research contained variable measurements comprising Higher Order Thinking Skills (HOTS) and Pro-Environmental Behavior (PEB). The HOTS in the research referred to aspects stated by Anderson et al 2001. The HOTS developed in the research pointed to thinking levels of analyze, evaluate, and create. The thinking levels are the popular HOTS aspects used in various measurements

related to student thinking skills. The instrument grids of the HOTS in the research are presented in Table 1.

Table 1: Indicators and Items of HOTS Instruments

Indicator	Item
Analyze the impact of global warming	1 and 2
Analyze activities that generate a lot of plastic waste	3 and 4
Evaluate environmentally unfriendly habits at school	5 and 6
Evaluate the use of plastic bags	7 and 8
Create creative ideas to prevent global warming	9 and 10
Create creative programs to prevent global warming	11 and 12

The second instrument was related to PEB and its instrument was adapted from Kaiser and Wilson (2004) on environmental behaviors. Aspects developed consisted of energy efficiency, transportation, waste avoidance, green consumption, recycling, and social behaviors. The detailed PEB can be seen in Table 2.

Table 2: Indicators and Items of PEB Instrument

Indicator	Item
Energy Efficiency	1 and 2
Transportation	3 and 4
Waste Avoidance	5 and 6
Daily Consumption	7 and 8
Recycling	9 and 10
Social Behavior Contribution	11 and 12

The collected data along with their instruments would be analyzed using a descriptive analysis technique by comparing the average HOTS scores obtained. The results of the HOTS score would then be categorized using the following measurement standards. The categorization aimed to simplify the measurement of student understanding level and implementation of HOTS and PEB.

Table 3: Categories of Student HOTS and PEB

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	$X \leq 38.72$

Source: (Ichsan et al., 2019)

The analyzed data were interpreted according to Table 3. The interpretation results will indicate whether the elementary students' HOTS and PEB scores were up to the standard. The measurement results would be a base to develop student skills in the future.

Result and Discussion

The research results indicate that the students' HOTS scores were in a very low category (see Table 4). The results of the HOTS measurement in the current

research show that learning on global warming still requires improvement to strengthen elementary school students' comprehension of the topic of the impacts of global warming. Detailed HOTS scores for each item are presented in Table 4.

Table 4. HOTS Scores of Elementary School Students Related to Global Warming Impacts on Public Health

Item	Score
In your opinion, what are the impacts of rising global temperatures on health? Explain	2.29
When global warming occurs, ice at the poles will melt and affecting the rising sea levels. What do you think will happen to the health of the coastal communities? Explain	2.13
When you buy street foods using plastic bags, do you think it will have an impact on global warming? Explain	2.08
Burning trash activity is dangerous for the earth, what can you do to prevent the activity? explain	2.15
What do you think about students' habits at school that could cause global warming? What are the habits and explain!	2.23
What do you think if your friends love to throw away papers when they can still be used to write	1.88
Write down your opinion regarding the ban on using plastic bags in several supermarkets or modern supermarkets. Do you think it will have positive or negative impacts for community?	1.99
Explain your opinion related to efforts that can be done by students to prevent global warming	2.20
Write an idea to invite your friends to recycle garbage into a handicraft	2.23
What ideas can you do to make your home environment apply an energy-saving principle?	2.18
What creative activities you can do to invite your friends to protect the school environment?	2.02
Write a slogan sentence that contains a call to prevent global warming with creative ideas	2.22
Total of score all items (convert to 0-100 scale)	21.32
Category	Very low

In addition to the measurement of the HOTS score for each item, the research also measured the HOTS score of the topic of the impacts of global warming for each indicator. The results indicate that the indicator with the largest score was the first indicator related to analyzing the impacts of global warming, whereas the lowest score was received by the third indicator related to evaluating the students' habits toward global warming. The score for each indicator can be seen in Table 5.

Table 5. Results of HOTS Scores Based on Each Indicator

Indicators	Score
Indicator 1	2.21
Indicator 2	2.11
Indicator 3	2.05
Indicator 4	2.09
Indicator 5	2.20
Indicator 6	2.12

The students' HOTS related to the impacts of global warming were then re-categorized according to thinking levels. The research results show that the highest score was at the C4 and C6 levels, whereas the lowest thinking level was in the C5 aspect as presented in Table 6.

Table 6. Results of HOTS Scores Based on the Thinking Levels

Thinking Level	Score
C4	2.16
C5	2.07
C6	2.16

The research results indicate that the highest PEB score was found in the first item, namely the use of

lamps to save energy. The item indicates that students were used to and very good in saving energy in the use of lamp every day. This is an example of daily behavior that is beneficial to prevent the impacts of global warming. The lowest score was in the tenth item regarding reusing used cans for plant pots. The research results on the PEB score for each item are presented in Table 7.

Table 7. Results of PEB Scores Based on Each Item

Item	Score
I turn off the light when not in use	4.71
I read the information on TV/the internet about energy saving	3.75
I use bicycle or walk to go to foodstalls near my house	4.53
I get used to walking to my neighbor's house which is still in the same area	4.57
I ask my friends to save papers to prevent global warming	3.99
I reuse used papers to reduce waste	3.90
I use my shopping bag to buy foods	4.02
I avoid buying foods that use plastic bags	3.80
I recycle garbage to prevent global warming	3.48
I reuse used cans as plant pots	3.45
I participate in cleaning up the environment around the house	4.00
I participate in cleaning up the school environment and planting trees for greenery in the school	4.19
Total of score all items (convert to 0-100 scale)	80.65
Category	High

Referring to the average score of each PEB indicator, the highest indicator was on the second

indicator related to the use of transportation. The lowest score was found in the fifth indicator, which was recycling. The detailed score for each indicator can be seen in Table 8.

Table 8. Results of PEB Score Based on Each Indicator

Indicators	Score
Indicator 1	4.23
Indicator 2	4.55
Indicator 3	3.94
Indicator 4	3.91
Indicator 5	3.47
Indicator 6	4.09

The research results, as a whole, indicate that the students' HOTS needs improvement. This was due to the very low HOTS measurement result among the students on the topic of the impacts of global warming. Although the PEB score in the research showed a high category score, some aspects need improvement, such as recycling. The research results have impacts on natural science learning topics that must be adjusted to the student's needs, namely global warming topics. Student understanding of the importance of preventing global warming that affects must be socialized early (Lehnert et al., 2020; Maclean & Pavlova, 2017). Moreover, the research results will have an impact if environmental education in elementary schools improves.

The development of media with a theme of the impacts of global warming in elementary school can be a solution. The learning media will help students to understand various topics in school. The topic of the impacts of global warming is intriguing if it explains using different learning media, such as serial books, videos, android applications, websites, and other technologies (Gryczka et al., 2016; Nugraini et al., 2013; Smith & Darvas, 2017). The use of these media will help teachers to convey concepts that are difficult to understand by students. A learning medium such as serial books can be developed to improve students' skills to understand global warming issues in environmental education. Learning media play a vital role in 21st-century education that is modern and rapidly developed in the use of educational technology.

Integration with natural science learning is feasible since environmental education can be discussed with other natural science concepts. Additionally, integrated thematic learning at the elementary school level allows teachers to integrate various topics in the classroom. The integration of various topics of the impacts of global warming will enable students to understand different concepts comprehensively and connect the interrelationships between concepts of environmental education and natural science. The integration of environmental education at the elementary school level is straightforward since the possibility for integration is substantial and unhindered by the curriculum. The topic

integration can be developed in the form of integrated learning media (Liang et al., 2022; Maclean & Pavlova, 2017).

The benefit of the learning media development for the students is to simplify them to understand complicated concepts in daily life. Learning media used in environmental education should be innovative by integrating various learning models. An independent medium is hard to use in integrated learning. The development of media can be based on the existing models, such as problem-based learning, project-based learning, discovery learning, and so on that can be integrated with an environmental learning medium (Buzov, 2014; Maclean & Pavlova, 2017; Shanti et al., 2022; Tsai et al., 2015; Tyabaev et al., 2015). The model-based learning media are expected to improve the HOTS and PEB of elementary school students.

Conclusion

Based on the research, a conclusion can be drawn that Based on the research, a conclusion can be drawn that the HOTS score of the elementary school students regarding the topic of global warming impacts was in a very low category. Their PEB score in the same topic, on the other hand, was in a high category. The student's skills must be continuously improved in the future. One of the efforts to improve the skills is by developing environmental learning media integrated with learning models. The research limitation is related to the limited research area coverage thus it can describe the research results in a limited scope.

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