

Prospective teachers and secondary students' ideas on global environmental issues: Contradictions or similarities

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Abstract

The present study aims to investigate prospective teachers' (PTs') and secondary students' (SSs') ideas related to environmental issues. A case study design was adopted in this study. SSs ($n = 100$) who received instruction on environmental issues and PTs ($n = 150$) who attended courses concerning environmental education were participated in this study. An open-ended questionnaire was designed and used as a data collection tool. Written answers of the participants were analysed in ideographic terms. The results of the study showed that the PTs held a range of alternative ideas similar to SSs. They both linked environmental problems which were irrelevant with cause-effect chain. Yet, PTs provided a more scientific definitions regarding greenhouse effect, global warming and ozone layer depletion as compared to SSs.

Keywords: Global environmental issues, prospective teachers, secondary students, environmental education, greenhouse effect, global warming, ozone layer depletion.

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1. Introduction

Environmental issues have become a major problem that our world faces, and it threatens not only the world but also the individuals' health. Therefore, it needs decisions to be taken both at world-wide level and in individuals' life styles. There is a need for individuals who have knowledge about the causes, consequences and cures of this serious problem. The way to do that is to raise environmentally literate people, and this is the reason behind the emphasis for environmental education programmes. The education programmes help students gain knowledge about environmental issues, possible cures and consequences of the problems. They also target to donateprovide learners with skills that will lead them to make the right choices about environment. Yet, empirical studies indicate that students' ideas are severely limited and their understandings are embedded with a range of alternative conceptions (Boyes & Stanisstreet, 1993; 1994; 1997; 1998; Khalid, 2001). For instance, students usually confuse some major environmental issues with each other such as greenhouse effect -- global dimate change, global climate change -- ozone layer depletion or radioactive contamination -- acid-rain. They also hold different erroneous models for cause and effect relationship between environmental phenomena such as destruction of the ozone layer resulting from increased greenhouse effect (Boyes & Stanisstreet, 1993), global climate change resulting from increased UV radiation, and ozone layer depletion resulting from air pollutants (CO₂ and NO₂) (Hansen, 2009).

In an attempt to find out the sources of students' alternative conceptions, researchers have concentrated their efforts on finding out teachers' understanding of environmental issues. The results of these studies showed that teachers also have inadequate and alternative ideas of the same environmental problems (Dove, 1996; Groves & Pugh, 1999; Michail, Stamou & Stamou, 2007). For instance, in Cordero's (2001) study, discussions with teachers showed that environmental topics were often found confusing and difficult to explain. Therefore, some researchers focused on prospective teachers' (PTs') ideas about environmental problems (Dove, 1996; Hillman, Stanisstreet & Boyes, 1996). These studies indicated that PTsprospective teachers hold alternative ideas that are similar to those of students and in- service teachers. On examination of these studies, it becomes clear that some major points related to greenhouse effect, global dimate change, ozone layer depletion, acid rain and pollution have not been studied. For a fuller picture, PTs'prospective teachers' understanding about all these major environmental problems need to be investigated in depth to uncover the reasoning behind each and the relationship between them, so as to compare their understanding with those of secondary students (SSs). In this way, overlapping on their altemative ideas could be pinpointed and taken into account in designing PTs' courses related to environmental education.

2. Purpose of the study

The present study aimed to investigate PTs' and SSs'secondary students' ideas concerning the causes, consequences and possible cures of the environmental problems listed above. In this respect, the research questions can be stated as;

- What are participants' ideas related to the nature and the causes of greenhouse effect, global climate change and ozone layer depletion?
- What are participants' ideas concerning the consequences of greenhouse effect, global dimate change and ozone layer depletion?
- Do PTs' ideas differ from that of SSs'secondary students' ideas on greenhouse effect, global warming, ozone layer, and ozone layer depletion?
- What are participants' mental models of ozone layer depletion? Do they think ozone layer depletion as a fracture, hole or decrease in gas concentration?

3. Methodology

The study was constructed in the light of constructivist / interpretive paradigm. The case study as a qualitative research design is benefited to enlighten the research questions in a detailed way. According to Yin (2003, p. 13), the case study 'investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident'.

3.1. Participants

Prospective teachers from the departments of science, biology and chemistry education ($n = 150$) as well as secondary students from different state schools ($n = 100$) have participated in the study voluntarily. Prospective teachers attended courses related to environmental education during their undergraduate training programme. Secondary students also received teaching on global climate change, greenhouse effect, ozone layer depletion and acid rain.

3.2. Data collection

In other related studies, students' ideas were mostly determined via a 3- or 5-point Likert-type scale questionnaire consisted of some statements (Boyes, Chuckran & Stannisstreet, 1993). In this study, an open-ended questionnaire was developed by the authors. In this way, it became possible to uncover participants' individual ideas and reasoning rather than determining his/her tendency to agree or disagree with statements provided. The questionnaire contains 12 questions of which nine is open-ended, three is multiple choice. In the questionnaire, some of the questions asked the participants to explain a range of concepts such as greenhouse effect, global climate change, ozone layer, ozone layer depletion, whereas some of the questions asked them to explain the relationship between different environmental problems. In these questions, the participants were required to explain the causes and the consequences of global climate change, ozone layer depletion and acid rain. Additional questions were also asked for possible solutions for each of the environmental problem. In the questionnaire, one of the questions was as in the form of drawing. This question aimed to find out participants' visualizations of the ozone layer depletion and to explain their drawings verbally. Therefore, it became possible to see their mental models for ozone layer depletion. After piloting the questions, the questionnaire was distributed to the participants of the study. In addition to the questionnaire, face-to-face interviews were conducted so as to investigate the mental models of the participants thoroughly.

3.3. Data analysis

The data gathered from the questionnaire and the interviews were analyzed ideographically. Participants' answers were coded separately by the authors and an expert from the department of science education to establish inter-rater reliability. In order to determine the agreement between the codifications of the authors and the expert, the percentages of agreement between codifications were calculated for each question on the questionnaire. According to Miles and Huberman (1994), the analysis is considered to be reliable when there is 80% or over coherence between two codings. The aforesaid analysis in the study was considered reliable, because the coherence between the researchers was found to be 92% on the basis of questions.

4. Results

The results of analysis were organized so as to reply the research questions. Thus, findings related to participants' ideas about the nature and the causes of greenhouse effect, global warming and ozone layer depletion, their ideas about the consequences of greenhouse effect and global warming, and their mental models of ozone layer depletion are presented respectively.

4.1. The nature and cause of greenhouse effect

In the questionnaire, participants were asked 'Which of the gases listed is NOT a greenhouse gas?'. Their answers to this question can be seen in Table 1.

Table 1. The prospective teachers' (PTs/PT) and the secondary students' (SSs') ideas about the compounds which of them is not a greenhouse gas

	Prospective teachers' answers Frequency (percent)	Secondary students' answers Frequency (percent)
NO ₂	35 (23)	18 (18)
SO ₂	15 (10)	17 (17)
CH ₄	57 (38)	22 (22)
CFCs	37 (25)	40 (40)
No answer	6 (4)	3 (3)

The major greenhouse gases are water vapour, carbon dioxide (CO₂), methane (CH₄), chlorofluorocarbons (CFCs) and hydrogenated chlorofluorocarbons (HCFCs), tropospheric ozone (O₃), and nitrous oxide (N₂O). But, sulfur dioxide SO₂ is not a greenhouse gas. Only 10% ($n = 15$) of PTs and 17% ($n = 17$) of SSs correctly answered as 'sulfur dioxide' but many of PTs could name other greenhouse gases such as CH₄ (38%, $n = 57$), CFCs (25%, $n = 37$), or NO₂ (23%, $n = 35$). Similarly many of SSs thought that CFCs (40%, $n = 40$), CH₄ (22%, $n = 22$) and NO₂ (18%, $n = 18$) are not greenhouse gases.

In the questionnaire, participants were asked to define greenhouse effect. Their responses can be seen in Table 2.

Table 2. The PTs' and the SSs' definitions of greenhouse effect

	Prospective teachers' answers Frequency (percent)	Secondary students' answers Frequency (percent)
Correct definition	78 (52)	7 (7)
Inadequate definition	–	21 (21)
False definition	42 (28)	18 (18)
Instead of definition, writing the causes and/or consequences	19 (13)	38 (38)
Uncodable/No answer	11 (7)	6 (6)

A correct definition of greenhouse effect is accepted as a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases and is re-radiated in all directions. According to the Table 2, half of the PTs (52%, $n = 78$) out of 150 could stated the correct definition. On the other hand, only a small percentage of the SSs (7%, $n = 7$) could define the term in a correct way. Many of them provided explanations related to causes and consequences of greenhouse effect instead of defining it (38%, $n = 38$).

Another question appear on the questionnaire was about whether greenhouse effect is good or bad for our world. Participants' answers to this question can be seen in Table 3.

Table 3. The PTs' and the SSs'' ideas whether greenhouse effect is good or bad for our world

	Prospective teachers' answers Frequency (percent)	Secondary students' answers Frequency (percent)
Good	10 (7)	27 (27)
Bad	131 (87)	73 (73)
No answer	9 (6)	–

Examining Table 3 reveals that majority of PTs and SSs regarded greenhouse effect as bad. They thought that due to greenhouse effect poisonous gases are produced; plants and animals suffer and they can become extinct and there might be draught. Yet, SSs seems to be more informed as compared to their counterparts (PTs) as only 7% of PTs stated that greenhouse effect makes the temperature on Earth habitable for people, whereas this ratio is 27% for SSs.

4.2. The nature and cause of global warming

In the questionnaire, the PTs and the SSs were required to define global warming. Their answers to this question can be seen in Table 4.

Table 4. The PTs' and the SSs'' definitions of global warming

	Prospective teachers' answers - Frequency (percent)	Secondary students' answers - Frequency (percent)
Correct definition	85 (57)	10 (10)
Inadequate definition	1 (1)	17 (17)
False definition	38 (26)	7 (7)
Instead of definition, writing the causes and/or consequences	25 (17)	63 (63)
Uncodeable/No answer	1 (1)	3 (3)

Table 4 reveals that nearly half of the 85 (%57%) PTs out of 150 could stated the correct definition of global warming, whereas majority of SSs (63%) could not provide a correct definition. Rather they explain causes or consequences of global warming. Only 10 SSs could define the term in an acceptable way.

Another question appears on the questionnaire asked for explaining the relationship between greenhouse effect and global warming. Their answers can be seen in Table 5.

Table 5. The PTs' and the SSs'' ideas about relationship between the greenhouse effect and global warming

If greenhouse effect increases the global warming	PTs' answers Frequency (percent)	SSs' answers Frequency (percent)	Reasons
Increases	138 (92)	95 (95)	Temperature rises Ray of light stays on earth Air pollution increases
Decreases	2 (1)	–	Ray of light cannot reach the earth
Stays the same	6 (4)	5 (5)	The increasing amount of CO ₂ affects G.E.
No answer	4 (3)	–	–

Nearly all participants thought that if greenhouse effect increases global warming increases too. They explained their reasoning as temperature rises, ray of light stays on Earth, and hence, air pollution increases. Thus, greenhouse effect increases and earth warms up. Only a small number of PTs (4%, $n = 6$) and SSs secondary students' (5%, $n = 5$) aired that if greenhouse effect increases, global warming stays the same.

4.3. The nature of ozone layer and depletion

One of the questions required participants to select the gases that made up the ozone layer. Participants' selections of gases can be seen in Table 6.

Table 6. The PTs' and the SSs' ideas about the gases that form the ozone layer

	Prospective teachers' answers Frequency (percent)	Secondary students' answers Frequency (percent)
O ₃ -N ₂	11 (7)	10 (10)
O ₂ -O ₃	40 (27)	14 (14)
O ₂ -O ₃ -N ₂	26 (17)	43 (43)
O ₃	73 (48)	31 (31)
No answer	–	2 (2)

Nearly half of the PTs (48%) described the ozone layer consisting of ozone molecules (O₃), whereas only one-third of the SSs described the ozone layer in a correct way. Majority of SSs thought that ozone layer consists of a mixture of gases such as O₂-O₃-N₂ (43%, $n = 43$). Even though 48% of PTs picked up the correct gas, the rest half selected mixtures of gases such as oxygen and ozone (27%), oxygen, ozone and nitrogen (17%) and ozone and nitrogen (7%). Interviews revealed that all PTs verbalized physical state of the ozone layer as gaseous even though some failed to describe its content in scientific terms. However, some SSs imagined the ozone layer as solid. One of the questions was about ozone layer depletion. Participants were expected to explain what ozone layer depletion is. Their responses are presented in Table 7.

Table 7. The PTs' and the SSs' definitions of ozone layer depletion

	PTs' answers Frequency (percent)	SSs' answers Frequency (percent)
Decreasing ozone gas concentration	42 (28)	5 (5)
Thinning of the ozone layer	10 (7)	10 (10)
Hole, fracture of the ozone layer	50 (33)	48 (48)
Instead of definition, writing the causes and/or consequences	42 (28)	35 (35)
Uncodable/No answer	6 (4)	2 (2)

Only 42 (28%) PTs out of 150 could state the correct definition of ozone layer depletion, whereas 5 (5%) of SSs aired the same definition as decreasing ozone gas concentration. Majority of participants in both groups defined ozone layer depletion as a hole in the layer or fracture of the ozone layer. During the interviews, participants verbalized that ozone layer depletion is bad for our environment. They supported their idea by stating that when temperature will rise, UV radiation will diffuse through the hole, causing harm to living organisms, acid rain increases and global warming increases.

4.4. Mental models of ozone layer depletion

In the questionnaire, the PTs and the SSs were asked to explain how the ozone depletion occurs. Their answers to these questions included: gases react with ozone gas making them into other

chemicals, objects come from the space collide and make a hole in the layer, heat resulting from global warming crush the ozone layer, acid rain erodes the ozone layer, gases make pressure and break down the ozone layer and radiation that come from the sun make a hole in.

PTs were asked to make a drawing to show how they imagine ozone layer depletion. Analysis of their drawings indicated that the most of them imagined ozone layer depletion as a hole, thinning or fracture, instead of decreasing of ozone gas concentration. Yet, some PTs who draw a hole in the layer explained the hole as decrease in the concentration of the ozone gases. Some of the drawings which show the PTs' mental images of ozone layer depletion are presented below with their corresponding explanations.

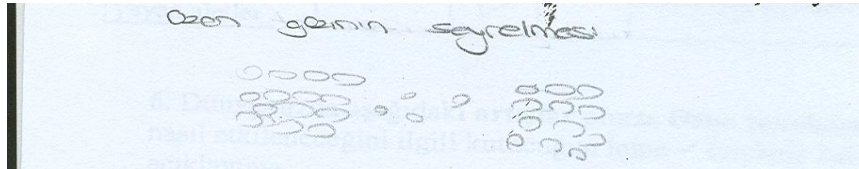


Figure 1. Explanation: Hole in the ozone layer

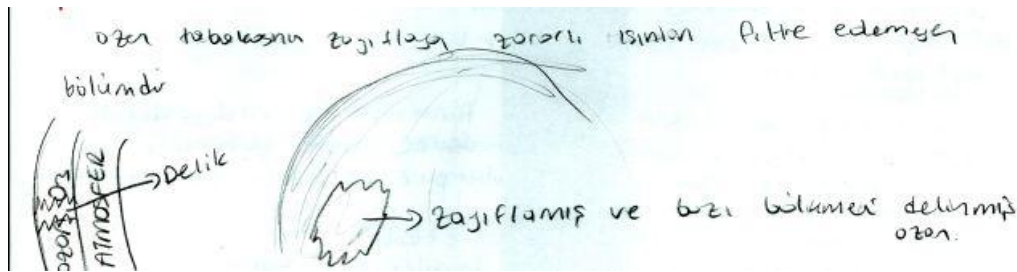


Figure 2. Explanation: Decrease in ozone gas concentration

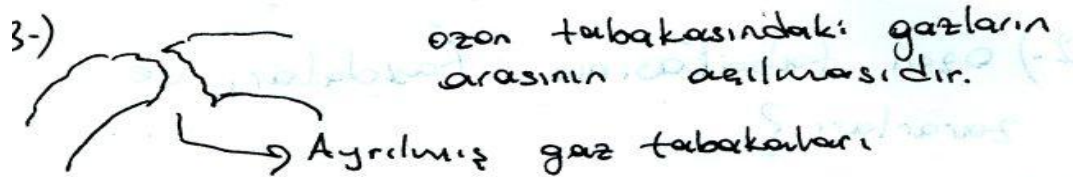


Figure 3. Explanation: Decrease in ozone gas concentration due to harmful factory waste

4.5. The relationship between the global warming and ozone layer depletion

In the questionnaire, participants were asked if there is relationship between global warming and ozone layer depletion. Majority of PTs (65%) and SSs (70%) thought that if ozone layer depletion increases, then the global warming also increases. These participants seem to imagine that when the ozone layer depletion occurs, more sun light reach to the earth, and hence, global warming increases. Some of the participants believed that if global warming increases, ozone depletion will also increase. They appear to think that due to increased greenhouse effect and global warming, the ozone layer will be crushed and depletion increases. Only a small proportion of the participants in both groups stated that there is no relationship between the two environmental problems, which is scientifically acceptable way of thinking.

5. Discussion

The results of the study showed that both PTsprospective teachers and SSssecondary students have similar misconceptions about greenhouse effect, global warming, ozone layer depletion and acid rain,

since they had difficulty in even defining these environmental issues. The PTsprospective teachers and SSsecondary students were asked to distinguish between greenhouse gases and non- greenhouse gases. Results indicated that limited number of PTsprospective teachers and students answered the question correctly. Both of the groups also appear to hold a range of alternative ideas concerning the aforementioned environmental issues. They seem to link environmental problems which were irrelevant with cause—effect chain. For instance, majority seem to relate global warming and ozone layer depletion in a scientifically unacceptable way.

The results indicated that PTsprospective teachers and SSsecondary students possess different conceptual models for ozone layer depletion. Majority of them thought that ozone layer had a hole or fracture in the ozone layer. However, some of the participants (especially the PTsprospective teachers) gave correct explanations by saying there was a decrease in ozone gas concentration. In the study, it was found that PTsprospective teachers don't differ much from SSsecondary students in conceptual understandings of the environmental issues even though they attended courses related to environment education.

6. Implications

The PTsprospective teachers seem to possess alternative ideas that are common among SSs,secondary students as can be seen from this study. They might pass these erroneous ideas onto their students in the future. Therefore, teacher education programmes need immediate revision by which PTs'prospective teachers' alternative ideas are pinpointed as required by the constructivist view. Considering the aforementioned problems in environmental education, teachers need activities and sources specifically designed to teach environmental issues. Directing teachers to the reliable sources and supporting them with teaching activities specifically designed to teach environmental issues should be a priority for teacher education programmes.

References

- Boyes, E., & Stanisstreet, M. (1993). The greenhouse effect: Children's perception of causes, consequences and cures. *International Journal of Science Education*, 15(5), 531–552.
- Boyes, E., & Stanisstreet, M. (1994). The idea of secondary school children concerning ozone layer damage. *Global Environmental Change*, 4(4), 331–324.
- Boyes, E., & Stanisstreet, M. (1997). Children's models of understanding of two major global environmental issues (ozone layer and greenhouse effect). *Research in Science & Technological Education*, 15(1), 19–28.
- Boyes, E., & Stanisstreet, M. (1998). High school students' perceptions of how major global environmental effects might causeskin cancer. *Journal of Environmental Education*, 29(2), 31–36.
- Cordero, E. C. (2001). Misconceptions in Australian students' understanding of ozone depletion. *Melbourne Studies in Education*, 41, 85–97.
- Dove, J. (1996). Student teacher understanding of the greenhouse effect, ozone layer depletion and acid rain. *Environmental Education Research*, 2(1), 89–100.
- Groves, F. H., & Pugh, A. F. (1999). Elementary pre-service teacher perceptions of the greenhouse effect. *Journal of Science Education and Technology*, 8(1), 75–81.
- Hansen, P. J. K. (2010). Knowledge about the greenhouse effect and the effects of the ozone layer among Norwegian Pupils Finishing Compulsory Education in 1989, 1993, and 2005 - what now? *International Journal of Science Education*, 32(3), 397–419.

- Kabapinar, F., Cengiz, C. & Aglarci, O. (2018). Prospective teachers and secondary students' ideas on global environmental issues: Contradictions or similarities. *International Journal of Learning and Teaching*, 10(1), 13-21.
- Hillman, M., Stanisstreet, M., & Boyes, E. (1996). Enhancing understanding in student teachers: The case of auto-pollution. *Journal of Education for Teaching*, 22, 311–325.
- Khalid, T. (2001). Pre-service teachers' misconceptions regarding three environmental issues. *Canadian Journal of Environmental Education*, 6, 102–120.
- Michail, S., Stamou, A. G., & Stamou, G. P. (2007). Greek primary school teachers' understanding of current environmental issues: an exploration of their environmental knowledge and images of nature. *Science Education*, 91(2), 244–259.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage Publications.
- Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.