

PROFILING PROSPECTIVE SCIENCE TEACHERS' UNDERSTANDINGS OF GLOBAL ECOLOGICAL CONCERNS

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Abstract

This study focuses on teacher knowledge with the purpose of profiling future science teachers' understandings of current environmental problems. The research questions were: (a) what do prospective science teachers know about biodiversity, carbon cycle, global warming, and ozone layer depletion? (b) What kind of misconceptions do prospective science teachers have about aforementioned environmental issues compared to other international studies? 360 participants gave their view of 20 different statements on each ecological concern by indicating whether they were right or wrong. The statements concerned the reasons that cause the problems, the consequences of the problems and what can be done to help the solutions. Study was undertaken in six universities and conducted by means of a closed-form questionnaire. Analysis involved simple counting of the numbers of responses in each response category, finding frequencies and percentages, and comparing means for students majoring in elementary and secondary science teaching. Analysis of variance for differences among universities, majors, and responses to different issues are also included. Ozone layer depletion was the least understood topic among the four issues as it had the lowest mean score ($M=7,8$). An eighty four percent of participants erroneously associated ozone layer depletion with global warming and only nineteen percent of them knew that ozone is found both in the upper atmosphere and on ground level. Commonly held and seen four misconceptions, reported in all previous studies from other countries, were held by significant proportion of the participants, particularly holes in the ozone layer as the cause of global warming (%84), the certainty that our activities causes the global warming (%80), role of carbon dioxide in global warming (%63). The results of this study confirm those conducted in other countries.

Keywords: Global ecological concerns, Environmental Education, ozone layer, global warming

Introduction

Environmental education is a part of formal educational system and teachers play a key role in developing environmental literacy in future generations, therefore adequate preparation of science teachers is required for their ability to implement effective environmental education. The integration of environmental education in elementary and secondary teacher preparation programs receives an important emphasis in both developed and developing countries. Knapp (2000) have identified insufficient teacher preparation as one of the major challenges of environmental education. Many teachers and students appear to have misconceptions of certain environmental issues as they lack insight into the complexity of the environment and the underlying theoretical and scientific views (Van Petegem, et al., 2007).

This study focuses on teacher knowledge with the purpose of profiling future science teachers' understandings of current environmental problems. As a part of more comprehensive research program findings of study will inform program developers and teacher educators and could be used in designing new courses to improve concept of sustainability in science teacher education. The research questions were: (a) what do prospective science teachers know about biodiversity, carbon cycle, global warming, and ozone layer depletion? (b) What kind of misconceptions do prospective science teachers have about aforementioned environmental issues compared to other international studies?

United Nations Educational, Scientific, and Cultural Organization (UNESCO) have identified the teacher education for sustainable development as 'the priority of priorities' (UNESCO-UNEP, 1990). In particular, science teacher education, which provides a strategic opportunity for ensuring that all students learn sustainability, is recognized as a key strategy in achieving a sustainable society (Ferreira, et al., 2007). The concept of sustainable development within environmental literacy is now many years old (Redclift, 1994). Debate about the nature and purpose of an education for sustainable development have been discussed in many nations (Tilbury, 1995; Huckle & Sterling, 1996). Science teachers has an important role related to education for sustainable development and developing

environmental literacy by helping students to understand the concepts and identify unifying principles for the concepts so that they can make reasoned value judgments. Several studies have been carried out on the greenhouse effect (Boyes & Stanisstreet, 1993; Dove, 1996; Khalid, 2003; Michail, et al., 2007), the ozone layer depletion (Dove, 1996; Summers et al., 2001), and acid rain (Khalid, 2003). Dove (1996) studied 60 prospective teachers' understanding of the greenhouse effect and the depletion of the ozone layer. Boyes et al. (1995) studied understanding of the ozone layer with a questionnaire survey of 453 prospective teachers. Both studies reported misconceptions, for instance, emissions from motor vehicles were responsible for ozone depletion and that holes in the ozone layer are a direct cause of global warming.

This study deals with prospective science teachers' concepts related to the biodiversity, global warming, carbon cycle, and the depletion of the ozone layer. In the study participants gave their view of 20 different statements on each issue by indicating whether they were right or wrong. The statements concerned the reasons that cause the problems, the consequences of the problems and what can be done to help the solutions.

Method and Data Collection

Research exploring teachers' ideas about environmental concepts has used both quantitative (Boyes et al., 1995; Dove, 1996) and qualitative (Summers et al., 2000) approaches. We used both methodologies in different stages of the study. At the beginning, in order to adapt questionnaires to the current context, interviews were employed and questionnaires were later used. The objective was to identify whether participants' ideas were similar to those detected by previous research in other countries and to make more generalized claims about their understandings.

Context and Sampling

This investigation was undertaken in a total of six universities and conducted by means of a closed-form questionnaire. Both prospective secondary science teachers and prospective elementary science teachers participated. The choice of participating universities was not random, but made to ensure a geographical spread, and to involve big universities, universities of average size and smaller universities. The final questionnaire was administered to 360 participants in 6 universities nationwide.

Data sources and the questionnaires

Data were gathered from six universities that are in different regions of the country. Analysis involved simple counting of the numbers of responses in each response category, finding frequencies and percentages, and comparing means for students majoring in elementary and secondary science teaching. Analysis of variance (ANOVA) for differences among universities, majors, and responses to different issues are also included. After interviewing prospective teachers Summer et. all. (2001) developed questionnaire surveys that were designed to test knowledge in these four areas. We adapted their questionnaires and modified them according to our context. Two researchers and two graduate students translated the questionnaire items individually and then a panel of experts revised the items. Draft questionnaires were applied to a small group of prospective science teachers with follow up interviews to ensure that respondents understood the questions in the way intended. The interview sample for the draft survey consisted of 7 prospective science teachers enrolled in authors' university. Items were constantly revised until desirable understandings occurred. Questionnaires were administered online and participants were asked to respond whether number of statements on each issue was true or false via Internet. A choice of "I am not sure" was included to diminish the disadvantage of closed-form questionnaire, which is the selection of the right answer by chance. Each university were provided with a username and a password for logging in to the survey.

Findings and Discussion

Initially, we looked at the descriptive statistics of four questionnaires. We identified problematic items as well as well responded items and common misconceptions. We present means and standard deviation of four questionnaires in table 1.

Table 1: Mean Scores for Environmental Issues (N=360)

Environmental Issues	<i>M</i>	<i>SD</i>
Biodiversity	11,5	1,37
Carbon Cycle	11,6	1,19
Global Warming	11,7	1,26
Ozone Layer	7,8	0,92

Note. Mean scores ranged from 0 to 20.

Understandings of ozone layer depletion

Ozone layer depletion was the least understood topic among the four issues as it had the lowest mean score ($M=7,8$). An eighty four percent of participants erroneously associated ozone layer depletion with global warming and only nineteen percent of them knew that ozone is found both in the upper atmosphere and on ground level. Just like previous studies from other countries we also found that participants hold on to misconception that pollution from fossil fuels is destroying the ozone layer, ninety-one percent of participants had this misconception. The sample items are shown in table 2.

Table 2: Sample frequencies for ozone depletion items (N= 360)

Statements	Correct (%)	Wrong (%)	Not sure (%)
Lots of ozone is only found in the atmosphere at a high altitude.	19	47	34
Holes in the ozone layer let too much heat from the Sun get through to Earth.	8	85	7
Pollution from burning fossil fuels, e.g. in car engines, is destroying the ozone layer.	9	82	9
Car engines emit lots of ozone directly into the air.	24	59	17
Industrial processes in factories emit lots of ozone directly into the air.	20	63	17

Understandings of global warming

Global warming questionnaire findings largely supported trends seen in the literature from the other countries, like Greece, UK and USA (Table 3). Some dimensions of global warming, including the role of carbon dioxide as the greenhouse gas; the natural greenhouse effect; and the Earth's balance of incoming and outgoing solar energy were well understood.

Commonly held and seen four misconceptions, reported in all previous studies from other countries, were held by significant proportion of the participants, particularly holes in the ozone layer as the cause of global warming (%84), the certainty that our activities causes the global warming (%80), role of carbon dioxide in global warming (%63).

Table 3: Sample frequencies for Global Warming items (N= 360)

Statements	Correct (%)	Wrong (%)	Not sure (%)
Man-made pollution traps heat entering through holes in the ozone layer to cause global warming.	10	84	6
Global warming is caused by the ozone layer trapping the extra heat entering through its holes.	20	70	10
Global warming is caused by a layer of high altitude CO ₂ .	16	63	21
It is certain that present global warming is caused by Man's activities.	7	80	13
Man's burning of fossil fuels has increased the amount of carbon dioxide in Earth's atmosphere.	92	3	5

Understandings of biodiversity and carbon cycle

Because of the lack of space we are not able to present our analysis and show the results properly, thus, we give sample of items on each issue in table 4 and table 5. Participants were well aware of loss in biodiversity and the effect of human action in this process. They had difficulties with the loss of diversity within species and the role of variation within a species in adapting to change in environment. Incorrect views about genetic variation in modern crops and considerable uncertainty about Lamarckian statements indicated difficulty with ideas about evolution.

Table 4: Sample frequencies for biodiversity items (N= 360)

Statements	Correct (%)	Wrong (%)	Not sure (%)
Total number of species on Earth is getting less.	93	3	4
Modern types of crops such as wheat are more genetically varied than their ancestors.	16	53	31
Most species' flexibility about living requirements enables them to tolerate a change in the habitat.	10	85	5
A species adapts to changed conditions because its members are all a bit different.	76	10	14

Although prospective science teachers had a good understanding of the effects of fossil fuels on greenhouse effect, they were not aware that it is the absence of the decay that results in fossil fuel formation. Also the relationship between decay, CO₂ production and fossil fuel formation was not well understood.

Table 5: Sample frequencies for carbon cycle items (N= 360)

Statements	Correct (%)	Wrong (%)	Not sure (%)
When leaves take in carbon dioxide, some of the carbon eventually forms the body of the tree.	79	8	13
Fossil fuels are formed from the decay of things that were once alive.	11	81	8
Burning coal produces carbon dioxide.	82	13	5
The formation of fossil fuels took place during millions of years in ancient times.	92	4	4

In general prospective secondary science teachers' understandings were more refined than elementary science students in all issues. Ozone layer was the lowest scored issue in both groups. Although comparison of mean scores yielded statistically significant differences among majors, table 6, with such a big sample size (N=360) this was expected and the issue of, if there is a practical importance of the difference, is open to interpretation.

Table 6: Comparison of mean scores for environmental issues between students majoring in elementary and secondary science teaching

Environmental Issues	Major	M	SD	t	df	p
Biodiversity	Sec. Sci.(n=108)	12,2	1,52	3,54	358	.000
	El. Sci.(n=252)	11,1	1,24			
Carbon Cycle	Sec. Sci.(n=108)	13,1	1,09	5,91	358	.000
	El. Sci.(n=252)	11,0	1,22			
Global Warming	Sec. Sci.(n=108)	12,4	1,48	3,47	358	.001
	El. Sci.(n=252)	11,4	1,22			
Ozone Layer	Sec. Sci.(n=108)	8,3	1,00	2,19	357	.029
	El. Sci.(n=252)	7,6	0,96			

Conclusions and recommendations

The results of this study confirm those conducted in other countries. International studies have also reported that pre-service and in-service teachers have similar understandings of current environmental issues (Boyes et al., 1995; Khalid, 2003; Michail, 2007; Summers et al., 2001). To enhance future teachers' awareness and competencies, teacher education programs must make long-term commitment on environmental issues and make them priority on their curriculum.

Educational and scientific importance of the study

Science teacher education programs present a unique opportunity for developing teachers' competence and confidence in implementing education for sustainable development. If science teachers have misconceptions on current environmental issues, they will possibly perpetuate them in their classrooms (Khalid, 2003). This study aims to contribute to the literature and informing the program developers of education for sustainable development in a developing country.

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