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Determination of pre-service elementary science teachers' knowledge level about ozone layer

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Abstract

One of the global environmental problems which threaten the earth and humanity is the Ozone Layer Depletion and the negative results that it causes. With this study, the aim is to determinate the knowledge level of pre-service elementary science teachers about the causes of the Ozone Layer Depletion, results and the precautions they will take. In this study, 30-item-questionaire has been applied to 319 pre-service elementary science teachers using survey model. Percentage (%), frequency (f) and the single-factor variance analysis have been applied to the data obtained from application using this SPSS statistical packet program. At the end of the analysis, it has been revealed that pre-service teachers who educate the generations that will face up with this important environmental problem have both some misconceptions and inadequate and locking knowledge about Ozone Layer Depletion. Besides, it has been determinate that specific there is no difference between knowledge level of pre-service elementary science teachers about Ozone Layer according to grade level.
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Keywords: Pre-service elementary science teachers; ozone layer; knowledge level.

1. Introduction

Global warming as a result of the increase in the greenhouse effect, the thinning of the ozone layer and its consequences and the acid rains threatening the earth can be listed among the most effective global environmental problems (Brown, 2000; Bozkurt & Aydoğdu, 2004). Environmental education plays a crucial role in solving these global environmental problems.

Environmental education which will start from pre-school period should not be loading encyclopedic knowledge in the minds, it should be making students conscious of environmental threats, making them think about and produce solutions, and making them to gain the insight and consciousness that a clean, stable and healthy environment is necessary for a high-quality life (Soran et. al., 2000).

The ozone layer, which is highly important for the lives of living beings, has a function to filter the ultraviolet lights that come from the sun and that can have harmful effects for the living beings (Keleş, 1997). As the ozone

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layer becomes thinner, more ultraviolet lights reach the earth and endanger humanity and biological life (Cordero, 2001). Chemical substances called chlorofluorocarbons (CFCs) cause the protective ozone layer to become thinner. Climate changes, weakening of human and animal immune systems and skin cancer are among the consequences of the thinning of the ozone layer (Diffey, 2000; Çınar, 2003; Saraiya et al., 2004; Kirsner et al., 2005). It also causes visual defects such as cataract and other cancer types by making the immune system of the living beings weaker (Akın, 2008). Moreover, the negative effects of the thinning of the ozone layer on plants and animals are being investigated (Thines et al., 2008).

It is highly crucial for the future of the earth and the living beings to make individuals conscious and sensitive and also to give them the necessary environmental education about the environmental problems which can have important consequences for the Earth and the living beings. At this point, environmental consciousness should be raised in individuals; the level of their knowledge about the environment and environmental problems and also the wrong concepts they have on these issues should be recognized (Bozkurt & Aydoğdu, 2004). The aim of this research was to determine the pre-service elementary science teachers' knowledge level about ozone layer which is the part of a global environmental problem.

2. Method

A total of 319 pre-service teachers studying at Ondokuz Mayıs University Science Teaching Department participated in the study; 89 of these pre-service teachers were studying their first year, 90 were studying their second year, 71 were studying their third year and 69 were studying their fourth year. One of the quantitative research methods, the survey model was used in this study which aimed to determine the pre-service elementary science teachers' knowledge level about ozone layer. The survey used by Groves and Pugh (2002) was translated into Turkish and used with permission from the researchers.

Some changes were made on the survey and a likert survey of 30 items was formed which included items questioning the reasons of the thinning of the ozone layer, the cause and effect relation of this thinning and the prevention of this thinning. The pilot scheme of the translated survey was conducted to 93 pre-service teachers studying in the department of Science Teaching. The data obtained from this first conduct was analyzed and the items which were not answered by the students or which were not understood were revised and corrected. The Cronbach alpha reliability coefficient of the 30 items related to the ozone layer was .908. The responses to the items were designed according to five point likert scale. The responses of the students to the items were as "absolutely correct", "correct", "no idea", "incorrect" and "absolutely incorrect".

2.1. Analysing the Data

The analysis of the data collected from the responses of the 319 pre-service elementary school teachers to the items in the survey were determined as percentage (%) and frequency (f) values through SPSS statistical package program. The findings are presented on Table 2. In order to determine whether there is a significant difference between the knowledge levels of the pre-service elementary school teachers about ozone layer depending on their classes, a parametric test for no relationship samples, one way analysis of variance, One-Way Anova was used. The data obtained is given on Table 3.

3. Findings

The independent t-test analysis results which aimed to study the effects of gender showed that there was no significant statistical difference between male and female pre-service teachers.

Table 1. Independent t-test results of male and female students

Gender	N	$\bar{X}$	SD	t	p	
Female	174	61,86	14,231	-,312	,755	p > ,05 not significant
Male	145	62,40	16,569			

The percentage (%) and frequency (f) values of the responses of the pre-service teachers are given in Table 2.

Table 2. The percentage (%) and frequency (f) values of the responses of the pre-service teachers about the ozone layer

Items	Absolutely Correct		Correct		No Idea		Incorrect		Absolutely Incorrect	
	f	%	f	%	f	%	f	%	f	%
1. If the ozone layer problem becomes worse, our weather will get hotter.	168	**52.7**	132	**41.4**	17	5.3	2	0.6	-	-
2. If the ozone layer problem becomes worse, some of our tap water will be unsafe to drink.	101	**31.7**	126	**39.5**	70	21.9	18	5.6	4	1.3
3. If the ozone layer problem becomes worse, there will be more flooding.	92	**28.8**	102	**32**	93	29.2	31	9.7	1	0.3
4. If the ozone layer problem becomes worse, there will be more water pollution.	87	**27.3**	126	**39.5**	85	26.6	20	6.3	1	0.3
5. If the ozone layer problem becomes worse, more people will get skin cancer.	169	**53**	118	**37**	24	7.5	8	2.5	-	-
6. If the ozone layer problem becomes worse, there will be more insect pests.	166	**52**	121	**37.9**	23	7.2	8	2.5	1	0.3
7. If the ozone layer problem becomes worse, there will be changes in the world's weather.	170	**53.3**	111	**34.8**	32	10	6	1.9	-	-
8. If the ozone layer problem becomes worse, there will be changes in the world's ice caps will shrink in size.	149	**46.7**	94	**29.5**	57	17.9	8	2.5	1	3.4
9. If the ozone layer problem becomes worse, there will be more air pollution for us to breathe.	124	**38.9**	110	**34.5**	63	19.7	12	3.8	10	3.1
10. If the ozone layer problem becomes worse, more ultraviolet rays will reach the earth's surface.	165	**51.7**	106	**33.2**	41	12.9	6	1.9	1	0.3
11. The ozone layer problem is made worse by too much sunlight reaching the earth's surface.	133	**41.7**	98	**30.7**	65	20.4	17	5.3	6	1.9
12. The ozone layer problem is made worse because too much carbon dioxide is entering the atmosphere.	93	**29.2**	96	**30.1**	89	27.9	27	8.5	14	4.4
13. The ozone layer problem is made worse by man-made CFC (freon) gases entering the atmosphere.	110	**34.5**	133	**41.7**	68	21.3	6	1.9	2	0.6
14. The ozone layer problem is made worse by too much ultraviolet light reaching the earth's surface.	126	**39.5**	104	**32.6**	68	21.3	7	2.2	14	4.4
15. The ozone layer problem is made worse by gases from rotting wastes.	73	**22.9**	113	**35.4**	103	32.3	13	4.1	17	5.3
16. The ozone layer problem is made worse by radioactive waste from nuclear power.	95	**29.8**	119	**37.3**	92	28.8	10	3.1	3	0.9
17. The ozone layer problem is made worse by acid rain.	92	**28.8**	86	**27**	100	31.3	28	8.8	13	4.1
18. The ozone layer problem is made worse by gas from artificial fertilizers.	79	**24.8**	122	**38.2**	90	28.2	17	5.3	11	3.4
19. The ozone layer problem is made worse because sunlight reflected from the earth's surface cannot escape into space.	83	**26**	91	**28.5**	103	**32.3**	21	6.6	21	6.6
20. The ozone layer problem is made worse by the use of certain pesticides.	76	**23.8**	128	**40.1**	91	28.5	22	6.9	2	0.6
21. The ozone layer problem can be lessened by using nuclear instead of coal power stations.	55	**17.2**	90	**28.2**	117	**36.7**	29	9.1	28	8.8
22. The ozone layer problem can be lessened by keeping trash picked up.	51	**16**	139	**43.6**	87	**27.3**	27	8.5	15	4.7

23. The ozone layer problem can be lessened by using unleaded gas.	73	**22.9**	150	**47**	75	23.5	14	4.4	7	2.2
24. The ozone layer problem can be lessened by stopping the use of CFC gases.	81	**25.4**	113	**35.4**	114	**35.7**	6	1.9	5	1.6
25. The ozone layer problem can be lessened by planting more trees.	115	**36.1**	143	**44.8**	39	12.2	20	6.3	2	0.6
26. The ozone layer problem can be lessened by recycling household trash.	87	**27.3**	166	**52**	49	15.4	15	4.7	2	0.6
27. The ozone layer problem can be lessened by producing less carbon dioxide and methane.	99	**31**	128	**40.1**	54	16.9	35	11	3	0.9
28. The ozone layer problem can be lessened by protecting rare plants and animals.	54	**16.9**	124	**38.9**	109	**34.2**	30	9.4	2	0.6
29. The ozone layer problem can be lessened by launching fewer rockets and missiles through it.	67	**21**	120	**37.6**	106	**33.2**	23	7.2	3	0.9
30. The ozone layer problem can be lessened by stopping the use of certain pesticides.	88	**27.6**	152	**47.6**	62	19.4	13	4.1	4	1.3

When the responses of the pre-service science teachers' responses to the items concerning the consequences of the increase in ozone layer problem were examined, 90% of the pre-service teachers made the right association that more people will have skin cancer if the ozone layer problem is increased and 84.9% of the pre-service teachers made the right association that more UV rays will reach the Earth if the ozone layer problem is increased. As a result of an increase in the ozone layer problem, of the pre-service science teachers, 94.1% stated that temperature will increase, 88.1% stated that there will be a change in the Earth's temperature, 76.2% stated that the ice level of the Earth will be effected and get smaller, 60.8% stated that there will be more floods, 71.2% stated that it will be dangerous to drink tap water, 66.8% stated that there will be more water pollution, 73.4% stated that there will be an increase in air pollution. When these responses were studied, it was seen that the consequences of ozone layer problems were mistaken for the consequences of global warming problem and environmental pollution. Moreover, 89.9% stated that there will be more pests with the increase in ozone layer problem.

When the responses of the pre-service science teachers' responses to the items concerning the increase in ozone layer problem were examined, of the pre-service science teachers, 72.4% associated the ozone problem with more sunlight reaching the Earth, 59.3% associated it with the increase of CO_2 (carbon dioxide) level in the atmosphere, and 54.5% associated it with the fact that the sunlight reflected from the Earth cannot pass to the space. These responses show that the students confuse the consequences of greenhouse effect, global warming and ozone layer problems with one another. 72.1% of the pre-service teachers made the wrong association that the ozone layer problem will increase as a result of the increase in the UV rays reaching the Earth, since UV rays reach the Earth more as a result of the ozone layer problem; they are not cause for the ozone layer problem. Cause and effect relationship was not right. 76.2% of the pre-service teachers made the right association that the increase of CFC gases in the atmosphere cause an increase in the ozone layer problem. Concerning the increase in the ozone layer problem, 58.39% of the pre-service teachers made the right association that this increase is caused by gases from decayed wastes, 63.0% of the pre-service teachers made the right association that this increase is caused by gases from artificial manures, 63.9% of the pre-service teachers made the right association that this increase is caused by the use of some pesticides. 57.1% of the pre-service teachers stated that radioactive wastes from nuclear power plants caused ozone layer problem, 55.8% stated that the cause was acid rains. Thus, it was observed that the pre-service teachers confuse the cause-effect relation in some environmental issues.

When the responses of the pre-service science teachers' responses to the items concerning the prevention of ozone layer problem were examined, 45.4% of the pre-service teachers made the wrong association that the ozone layer problem will decrease if nuclear power plants are used instead of coal plants, and 36.7% of them stated that they had no idea. Concerning the issue of how to decrease ozone layer problem, 59.6% of the pre-service teachers stated that this could be done by collecting wastes, 69.9% stated that it could be done by using lead-free petrol, 79.3% stated that it could be done by recycling home wastes, 55.8% stated that it could be done by protecting rare plant and animal species, 58.6% stated that it could be done by launching less missiles and rockets, 71.1% stated that it could be done by producing less CO_2 and CH_4 (methane), 80.9% stated that it could be done by planting more

trees and consequently they confused the precautions that need to be taken for various environmental problems with how to decrease the ozone layer problem. 60.8% of the pre-service teachers made the right association that the ozone layer problem could be lessened by stopping the use of CFCs and 75.2% of the pre-service teachers made the right association that it could be done by stopping the use of pesticides.

When the responses of the pre-service science teachers' responses to the items concerning the ozone layer problem were examined, general conceptual mistakes and difficulties in building cause and effect relationships on issues such as global warming, greenhouse effect, air pollution, water pollution, environmental pollution, and ozone layer problem were identified.

The data concerning the One-Way-Anova analysis done to determine whether there is a statistical difference between the responses of the classes depending on their knowledge levels were shown on Table 3.

Table 3. One- Way Anova results of ozone layer success scored

Variance Source	Squares Total	df	Squares Average	F	p
Among groups	1240.994	3	413.665	1.776	,152
In groups	73355.382	315	232.874		
Total	74596.376	318			

As seen in Table 3, there is no statistically significant difference between the knowledge level of the students' studying in their first, second, third and fourth years about the ozone layer ($F_{(3,315)} = 1.776$; $p > .05$).

4. Result and Discussion

In previous studies, it was observed that various age group students had conceptual mistakes about the ozone layer (Bahar & Aydın, 2002; Boyes, Stannisstreet & Papantoniou, 1999; Groves & Pugh, 2002; Kalıpçı, Yener & Özkadif, 2009; Khalid, 2003; Papadimitriou, 2004; Pekel, Kaya & Demir, 2007; Selvi, 2007; Topsakal & Kara, 2009). Pekel & Özay (2005) conducted a survey to 16-18 year old students on the quality of the ozone layer, and the reasons, consequences and possible results of the thinning of the ozone layer. At the end of the research, they determined that the students did not have sufficient knowledge and they had conceptual mistakes on these issues. With this study, the conceptual mistakes of the pre-service science teachers about the ozone layer are brought to light.

Boyes et al. (1999), as a result of the research conducted on 11-16 year old high students, stated that the students confused the effects of global warming and greenhouse effect with each other and had conceptual mistakes. Groves and Pugh (1999), in a study they conducted to find out the thoughts of high school students and pre-service teachers on the reasons, consequences of the thinning of the ozone layer and the precautions to be taken about this issue, found out that most of the students confused the cause and effect relationships and had conceptual mistakes on this issue. Summer et al. (2001) also reached similar results in a study on pre-service teachers about environmental issues including ozone layer. As a result of the data obtained from this study, it was observed that the pre-service teachers confused cause and effect relations while trying to build a cause and effect relationship between global warming and ozone layer problem and as a result of this, made conceptual mistakes.

As a result of their study they conducted on 435 university students about the ozone layer, Boyes & Chambers (1995) stated that a great number of the students knew that the ozone layer is a gas layer that is naturally formed and it protects from the UV rays which come from the sun and which are dangerous for the living beings. These data support the findings of this study.

This study has stated that the increase in the thinning of the ozone layer causes more people to get skin cancer. Some studies have done also support this result (Boyes & Chambers, 1995; Boyes & Stanisstreet, 1998; Boyes, Stannisstreet & Papantoniou, 1999; Pekel & Özay, 2005; Selvi, 2007; Spellman, Field & Sinclair, 2003).

It has been stated that the success of environmental education in schools depends on the teacher (Simmons, 1993) and thus in order to increase the quality of this education, the perceptions of the pre-service teachers should be evaluated (Ballantyne & Bain, 1995). The results of some researches (Dove, 1996; Groves & Pugh, 1999; Khalid, 2003; Michail, Stamou & Stamou, 2007; Papadimitriou, 2004; Summers et al., 2001) show that not only students but also teachers and pre-service teachers have conceptual mistakes and misunderstandings about environmental problems. The teacher is the basic element of the learning-teaching process in which cognitive, affective and

kinesthetic behaviours are gained. Teachers from all levels of education should be sensitive and informed about the environment. Thus, environmental education should have the necessary place and importance in the programmes of the institutions which educate teachers (Arslan, 2008).

It is important for pre-service teachers to have adequate knowledge about the ozone layer problem which is global problem and about how to decrease this problem. This study proves that the pre-service science teachers do not have enough knowledge about the ozone layer problem, that they confuse the cause-effect relations of the ozone layer with the cause-effect relations of various environmental problems and they have conceptual mistakes about the ozone layer. These mistakes can be resolved through an effective environmental education. Pre-service science teaching department has courses such as "Special Subjects in chemistry" in the fifth semester and "The science of environment" in the sixth semester which deals with the ozone layer. In order to help students make right associations of the ozone layer problem with various environmental problems and not to have conceptual mistakes, student centred techniques and methods should be used while teaching the ozone layer in order to make learning more meaningful and more permanent.

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