

The Knowledge of Pre-Service Science Teachers Receiving Education in Turkey Regarding Air Pollution

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Abstract

The aim of this study was to determine the knowledge of pre-service science teachers regarding the definition of air pollution, the concentrations of clean and polluted air, the source of air pollution, its effects, and the measures that can be taken against pollution. The study was conducted with 136 pre-service science teachers receiving their third year education in the Faculty of Education Department of Elementary School Science Teaching at a university within the Black Sea Region of Turkey. The results of this study demonstrates that the pre-service science teachers had rather insufficient knowledge regarding the composition of air, stating that oxygen was the most abundant gas in clean air, while carbon dioxide was the most abundant gas in polluted air. In addition to this, it was determined that the pre-service science teachers were aware of the significance of air pollution for the world.

Keywords: Air pollution, Air quality, Pre-service scienceteachers.

Introduction

The environment is defined as the whole set of biotic and abiotic factors (social, cultural, historical, climatic, physical) that affect a living organism throughout its life (Yücel & Morgil, 1998). Environmental education is an educational process that involves the raising of individuals with awareness of the rapidly increasing environmental changes across the globe, and who are capable of developing and implementing solutions to environmental problems. It is also a process in which individuals assume an active role in the protection and improvement of the environment. In this respect, environmental education aims to raise individuals who are aware and knowledgeable of environmental issues, who have acquired the necessary attitudes and behaviors for the protection of the environment, who have the necessary skill for resolving environmental problems, and who are aware of their role in the resolution of such problems.

Environmental education is an important component for the protection of the environment (OECD, 2002); to be effective, it needs to engender certain necessary and desired changes in the level of knowledge, the attitudes, the beliefs and the behavior of students (Boyes & Stanisstreet, 1998). Environmental education, which allows the instilling and development of environmental awareness, should be provided to children at an early age. As childhood is a critically important period for raising concern, interest, awareness, favorable disposition and value among children towards nature, beginning environmental education at an early age becomes even more important and necessary (Cordes & Miller, 2000). A comprehensive and effective environmental education should be provided based on a common understanding that also involves elementary school teachers and families into the process, as well as the larger society (Daskolia, et al., 2006). The word “air” is used to describe the substances that constitute the atmosphere. The air contains large amounts of nitrogen (N₂:78.084%) and oxygen (O₂:20.946%).The remaining 1% is largely composed of argon (0.934%), carbon dioxide (0.037%), neon (0.001818%), helium (0.000524%) methane (0.0002%), krypton, hydrogen, water vapor, nitrous oxide, xenon and trace amounts of ozone, sulphur dioxide, nitrogen dioxide, ammonia, carbon monoxide and iodine (Petrucci, et al., 2010).

Air pollution occurs due to the increase of solid, liquid or gas contaminants in the atmosphere that are harmful for human health, living organisms and the ecological balance (Bağ, 2009). Air pollution represents a significant threat for the world and all living organisms, and has nowadays attained the potential to adversely affect societies due to the multitude of health problems it engenders. The worldwide increase in air pollution is largely due to the intensification of energy production that occurred following the industrial revolution, and also to the present-day increase in forest fires (Görmez, 2003). In parallel to the rapid increase in world population, and to mankind's efforts to increase its living standards and to acquire more resources, the waste products that are generated as a result of increasing urbanization and industrialization are polluting the atmosphere and adversely affecting the living organisms on Earth (Bağ, 2009).

As all aspects of nature are ultimately interrelated with one another, it is undeniable that air pollution has the potential to directly and indirectly cause and trigger numerous environmental problems. In fact, the greenhouse effect and acid rains are the two most significant environmental problems caused by air pollution. These two environmental problems are serious issues which, nowadays, represent a significant threat for the world.

The gradual day-to-day increase in air pollution is responsible for the worsening of environmental problems such as acid rain and global warming (Fuqi et al., 2005; Ghose et al., 2005; Littledyke, 2004; Sushko, 2007). As one of the most significant problems engendered by air pollution, the greenhouse effect is caused by the increase in the atmospheric concentration of greenhouse gases, which absorb the energy from solar radiation and prevent its radiation back into space. The most important greenhouse gas is CO₂, which, in recent years, is being released in ever increasing quantities into the atmosphere as a result urbanization and industrialization. The other important greenhouse gases are methane (CH₄), ozone (O₃) and chlorofluorocarbons (CFC). A significant portion of these greenhouse gases are being released into the atmosphere as a result of human activities (Aydoğdu & Gezer, 2006; Chang, 2000; Girard, 2005). The increase in the atmospheric levels of these gases leads to global warming.

Another problem engendered by air pollution is acid rain. Various industrial activities, fuels used for heating purposes, thermal power plants that produce energy from fossil fuels and exhaust gases pollute the air by releasing sulphur dioxide (SO₂), nitrogen oxides (NO and NO₂), hydrocarbons and particulate matter into the atmosphere. Among these polluting substances (which can remain suspended in the air for 2 to 7 days), the nitrogen oxide and sulphur diode gases can be converted into sulphuric acid (H₂SO₄), nitric acid (HNO₃) and also into small quantities of nitrous acid (HNO₂) and sulphurous acid (H₂SO₃) because of photochemical reactions and the effect of water vapor. Environmental problems that represent a threat to the world as a whole are no longer issues that can be dealt with by a single country or society. For this reason, both states and individuals are now assuming responsibility in the generation as well as the prevention of environmental problems (Ünal et al., 2001).

Regarding environmental problems that can engender significant consequences for the Earth and its living organisms, it is important for the future that individuals become more conscious and aware of these problems and that the necessary education on the environment are provided. In this respect, it is necessary to raise environmental awareness among individuals, to determine their level of knowledge on the environment and environmental problems, and to assess the erroneous concepts held by these individuals on these subjects (Bozkurt & Aydoğdu, 2004). Recent studies on the importance of air pollution as an environmental problem have demonstrated that students from different age groups held erroneous concepts regarding air pollution (Çelikler, 2011; Myers et al., 2004; Pui-ming Yeung et al., 2004; Thornber et al., 1999) It is reported that teachers play an important role in the effectiveness of environmental education in schools (Simmons, 1993); thus, to increase the quality of environmental education, it is necessary to review and evaluate the perceptions of the pre-service science teachers themselves (Ballantyne and Bain, 1995). Considering the relationship between the teachers' teaching activities and the students' learning (Lang, 2000), the necessity to investigate teachers' knowledge on the subject becomes apparent. This is because environmental education, and hence the education provided by teachers, assume an important role in the resolution of environmental problems. This study aims to determine the level of knowledge of pre-service science teachers regarding the composition of air, the significance of air pollution as an environmental problem, the possible causes of air pollution, its consequences, and the measures that can be taken for the reduction of air pollution. It is believed that this study will contribute to the literature and body of knowledge in this area by reflecting in a detailed fashion the knowledge of pre-service science teachers pertaining to air pollution as an environmental problem.

Methodology

Study Group

The study was conducted with 136 pre-service science teachers, which includes 105 female and 31 male students, receiving their third year education at the Faculty of Education Department of Elementary School Science Teaching in a university within the Black Sea Region of Turkey.

Data Collection Tools

The study data were collected by interview form. When preparing the interview form, the relevant literature was reviewed and preliminary interviews were initially conducted with 10 pre-service science teachers. The interview forms were then prepared and finalized in light of the obtained data. The interview form consists of 5 open-ended questions. The pre-service science teachers were informed regarding the study being conducted, and were requested to answer these questions in detail. It was also explained to the pre-service science teachers that their answers would be read and kept by the researchers, that their responses would in no way be held or used against them, and that these responses would not be subject to an evaluation by grading. The pre-service science teachers' answers were obtained in writing.

In this study, the following open-ended questions were asked in order to determine the level of knowledge of pre-service science teachers regarding air pollution:

What is Air? Please describe.

Which gases are most abundant in clean air and polluted air?

What are the sources of air pollution? Please describe.

What are the effects of air pollution on human health and the environment? Please describe.

What are the measures that can be taken for the prevention of air pollution? Please describe.

Data Analysis

The written explanations provided by the pre-service scienceteachers to the open-ended questions were analyzed. The written explanations provided by the pre-service science teachers to the open-ended questions were analyzed by using qualitative study techniques. The completed forms of all students were numbered, and the explanations on the concentrations of clean and polluted air, the sources of air pollution, the effects of air pollution and the measures that can be taken for the prevention of air pollution were divided into separate categories. Common themes that were identified were then tabulated by taking into account their repetition and frequency. The written explanations regarding the definition of air were analyzed and evaluated based on the 5 different levels previously used by (Bartoszeck et al., 2008; Uzunkavak, 2009a; Uzunkavak, 2009b).

Results

The knowledge of the participating pre-service science teachers regarding the composition of air, air pollution, the possible causes of air pollution, its effects and the measures that can be taken for reducing air pollution were reviewed and evaluated. The results and responses that were obtained within the scope of the research questions are provided below by directly quoting the participants.

“What is air? please describe.”

In this study, the pre-service science teachers were asked to define what air is. The level of knowledge of the pre-service science teachers was determined by evaluating the written explanations they provided to the study question regarding the definition of air. The level groups that were formed in order to assess the pre-service science teachers' knowledge regarding the definition of air is provided in Table 1.

Table 1. The distribution based on level of the explanations provided regarding the definition of air.

| Level | Statements | f |
|---------|---|----|
| Level 1 | No knowledge at all | 9 |
| Level 2 | Erroneous knowledge | 9 |
| Level 3 | Partially correct knowledge | 18 |
| Level 4 | Incomplete knowledge | 71 |
| Level 5 | Entirely correct and complete knowledge | 29 |

When the explanations provided by the pre-service science teachers are evaluated, it was determined that seventy one pre-service teacher had correct yet incomplete knowledge on the matter, while only twenty nine pre-service teachers provided entirely correct and complete definitions for air. Examples of explanations given by the pre-service teachers are provided below:

“Air: It is the O₂ gas that we breathe”

In the example for a Level 2 explanation, it can be seen that the pre-service science teacher provided an erroneous explanation by defining air as the O₂ gas that we breathe.

“Air is the gas formed by the mixture of the O₂ released by plants as a result of photosynthesis and the CO₂ gases released by humans as a result of respiration”

In the example for a Level 3 explanation, it can be seen that the pre-service science teacher defines air as the gas formed by the mixture of the O₂ released by plants as a result of photosynthesis and the CO₂ gases released by humans as a result of respiration. The pre-service teachers’ statement that air contains the O₂ and CO₂ gases is correct; however, this student erroneously assumes that air is solely composed of these gases.

“Air is a gas mixture formed by mixing more than one gas in the atmosphereatmosphere”

In the example for a Level 4 explanation, it can be seen that the pre-service teacher defines air as a gas mixture formed by mixing more than one gas in the atmosphere. Although the pre-service teacher’s definition of air as a mixture of gases is correct, it can be seen that the student did not provide information regarding the composition of this gas mixture.

“Air is an agent that contains N₂, CO₂, O₂ and many other gas molecules in certain quantities, and which is essential for sustaining life”

In the example for a Level 5 explanation, it can be seen that the pre-service teacher provides an accurate definition when describing that air is essential for sustaining life, and that it contains N₂, CO₂, O₂ and many other gas molecules in certain quantities.

“Which gases are most abundant in clean air and polluted air?”

In this study, the pre-service teachers were asked to describe in writing the gases that are the most abundant in clean air. The explanations from the pre-service science teacher regarding the most abundant gases in clean air are listed according to their frequency in Table 2.

Table2. The distribution of gases that are the most abundant in clean air.

| Gases | Answer Frequency |
|----------------|-------------------------|
| Oxygen | 113 |
| Nitrogen | 14 |
| No Opinion | 12 |
| Carbon Dioxide | 6 |
| Hydrogen | 3 |
| Sulphur | 1 |

The answers provided to this open-ended question demonstrated that the pre-service teachers considered oxygen, nitrogen, carbon dioxide, hydrogen or sulphur to be the most abundant gases in clean air. The fact that the majority of the pre-service teachers provided oxygen as answer when asked to define the most abundant gas in clean air indicates that their knowledge regarding the composition of air is incomplete and erroneous.

In this study, the pre-service science teachers were asked to describe in writing the gases that are the most abundant in polluted air. The explanations from the pre-service teachers regarding the most abundant gases in polluted air are listed according to their frequency in Table 3.

Table3. The distribution of gases that are the most abundant in polluted air.

| Gases | Answer Frequency |
|------------------|-------------------------|
| Carbon dioxide | 98 |
| Carbon monoxide | 24 |
| Nitrogen | 20 |
| No Opinion | 18 |
| Sulphur Dioxides | 12 |
| Oxygen | 4 |
| Hydrogen | 3 |
| Methane | 2 |
| Phosphorus | 1 |

Most pre-service teachers described carbon dioxide as being the most abundant gas in polluted air. In addition, it can be seen that carbon monoxide, nitrogen, sulphur oxides, oxygen, hydrogen, methane and phosphorus were also described as the most abundant gases in polluted air by other pre-service teachers (Table 3). Although the pre-service teachers reflected correct knowledge when describing carbon dioxide as an indication of pollution, their explanation that carbon dioxide is the most abundant gas in polluted air is due to incorrect knowledge regarding the actual amounts of carbon dioxide in air.

It was observed that the large majority of the pre-service teachers did not know that N_2 is the most abundant gas in both clean and polluted air. It was seen that the pre-service teachers had incomplete and erroneous knowledge regarding the concentrations of gases in clean and polluted air; examples of explanations supporting this observation are provided below:

“Polluted air are gas mixtures in which the CO_2 gas is more abundant than the O_2 gas. Clean air has more O_2 , which is a factor for vital activities, than the CO_2 ”.

“The most abundant gas in clean air and polluted air is the O_2 (oxygen) gas”.

“The most abundant gas in clean and polluted air is CO_2 ”.

“The most abundant gas in clean and polluted air is N_2 ”.

“The amount of oxygen is greater in clean air, while the amount of nitrogen gas is greater in polluted air”.

“ N_2 is more abundant in Clean air, and CO_2 is more abundant in Polluted air”.

“Polluted air: the amount of CO_2 is greater than the amount of O_2 . Clean air: the amount of O_2 is greater than the amount of CO_2 ”.

“What are the sources of air pollution? Please describe.”

In this study, the pre-service science teachers were asked to describe in writing the sources of air pollution. The explanations from the pre-service science teachers regarding the sources of air pollution are listed according to their frequency in Table 4.

Table4. The distribution of the answers regarding the sources of air pollution.

| Sources | Answer Frequency |
|--|------------------|
| Industry | 114 |
| Car Exhausts | 92 |
| Use of fossil fuels | 52 |
| Sprays | 51 |
| Destruction of Forests | 43 |
| Lack of Environmental Awareness | 27 |
| Dump Sites | 15 |
| Chemical Waste | 14 |
| Greenhouse Effect | 8 |
| Volcanic Eruption | 6 |
| Nuclear Industry | 5 |
| Population Increase | 4 |
| Detergents | 4 |
| Acid Rains | 4 |
| Natural Disasters (Earthquakes, Erosions, Flood) | 4 |
| Technology | 3 |
| Unplanned Urbanization | 3 |
| Pesticides | 2 |
| The Thinning of the Ozone Layer | 1 |

When the answers of pre-service science teachers regarding the sources of air pollution were evaluated, it was observed that the majority of the pre-service science teachers described industrial organizations, car exhausts, fossil fuel use, sprays and the destruction of forests as the causes of air pollution. It was also observed that some of the pre-service teachers considered the lack of environmental awareness as one of the causes of air pollution. Certain pre-service teachers were correct in asserting that natural events such as volcanic eruptions, disasters also contributed to air pollution.

In addition, it was observed that certain s described incorrect relations between air pollution and environmental events such as acid rains, the greenhouse effect and the thinning of the ozone layer, while these events actually engender different effects on the environment (other than air pollution). Examples of explanations given by the pre-service teachers regarding the sources of air pollution are provided below:

“Sources of Natural Air Pollution

- Volcanic eruptions
- Earthquakes
- Floods
- Fires

Sources of Human-made Air Population

- Industrial Waste
- Natural fuels
- Car exhausts
- [illegible] activities”

“Sources containing harmful gases such as deodorants, exhaust gases, smoke from chimneys. Perfumes and various sprays also pollute the air. Acid rains”.

*“Sources of Air Pollution: - toxic substances and polluting gases released from factories, etc.
- gases emitted from automobiles
- trash that is thrown around (if not resolved)
-Nuclear industries”*

“Sources of air pollution are the greenhouse effect, factories without filters, chemical gases that are used (deodorants, etc.), fuels used for warming”.

“Humans cause air pollution. This is due to our irresponsible way of life.

- Rapid population increase, spillage of factory wastes, industrialization.
- Lack of recycling.
- Noxious gases emitted from car exhausts”.

“Factory wastes, unplanned urbanization, decrease in the amount of green areas, usage without filters of factory chimneys and car exhausts”.

“The main reason for air pollution is the misuse of nature by humans and the irresponsible consumption and use of natural resources. Examples include, the gases released by industrial chimneys, forest fires, car exhausts, etc...”.

“What are the effects of air pollution on human health and the environment? Please describe.”

In this study, the pre-service teachers were asked to describe in writing the effects of air pollution on human health and the environment. The explanations from the pre-service science teachers regarding the effects of air pollution on human health and the environment are listed according to their frequency in Table 5.

Table5. The distribution of the answers regarding the effects of air pollution on human health and the environment.

| Effects | Answer Frequency |
|---|------------------|
| Pulmonary and Respiratory Tract Diseases (Shortness of breath, Asthma, Bronchitis, etc.) | 95 |
| Adverse effects on Plants and Animals (reduction of yield/productivity, the extinction of species, developmental disorders) | 79 |
| Cancer | 31 |
| Psychological Diseases | 12 |
| Dermatological Diseases | 11 |
| Cardiac Diseases | 4 |
| Allergic Diseases | 2 |
| Obesity | 2 |
| Liver Diseases | 2 |
| Visual Disorders | 1 |

When the answers of the pre-service teachers regarding the effects of air pollution on human health were evaluated, it was noted that most of them identified a correct relation when asserting that air pollution causes pulmonary diseases such as the shortness of breath, asthma and bronchitis. The pre-service teachers also described that air pollution causes cardiac diseases, cancer, dermatological diseases, psychological diseases, allergic diseases and visual disorders.

Moreover, the large majority of the pre-service teachers expressed the opinion that air pollution can lead adverse effects on plants and animals, such as developmental disorders, the reduction of yield/productivity, mass deaths and the extinction of species.

In this study, it was determined that the pre-service teachers were unanimous on the opinion that air pollution will lead to adverse effects on living organisms and the environment. Examples of explanations given by pre-service teachers regarding the effects of air pollution of human health and the environment are provided below:

“Cancer, pulmonary disease, visual disorders, psychological effects, otorhinolaryngology diseases”.

“Air pollution can cause upper and lower respiratory tract infections, shortness of breath, asthma, pulmonary and cardiovascular diseases. These conditions are the effects of air pollution on human health. Effects on the environment include the decrease in productivity in both agriculture and gardens, and disease in living organisms”.

“The most important effects of air pollution on human health are upper respiratory tract infections and pulmonary diseases. In addition, the toxic substances that accumulate in the body through breathing can lead to various diseases. In addition, air pollution can lead to the extinction of many living species”.

“What are the measures that can be taken for the prevention of air pollution? Please describe.”

In this study, the pre-service teachers were asked to describe in writing the measures that can be taken for the prevention of air pollution. The explanations from the pre-service science teachers regarding the measures that can be taken for the prevention of air pollution are listed according to their frequency in Table 6.

Table6. The distribution of the answers regarding the measures that can be taken for the prevention of air pollution.

| Measures | Answer Frequency |
|---|------------------|
| The use of filters in chimneys and exhaust pipes | 136 |
| Forestation activities | 52 |
| Increasing environmental awareness | 50 |
| Reducing the use of products such as deodorants, sprays | 42 |
| Preventing the destruction of forests | 37 |
| Reducing the consumption of fossil fuels | 35 |
| Usage of public transportation vehicles | 26 |
| Decreasing the use of chemical substances | 10 |
| Increasing the emphasis on recycling | 10 |
| Using environment friendly fuels in vehicles | 10 |
| Management of chemical waste | 6 |
| Usage of renewable energy sources | 5 |
| Environment-friendly regulations and increasing legal inspections | 4 |
| Decreasing the level of industrialization | 3 |
| Reducing the nuclear industry | 2 |
| Orderly urbanization | 1 |
| Reducing the rate of population increase | 1 |

When the answers of the pre-service science teachers regarding the measures that can be taken for the prevention of air pollution were evaluated, it was seen that, foremost among the preventive measures, the pre-service teachers accepted the idea of using filters for house and factory chimneys and for exhaust pipes. In addition, it was observed that pre-service teachers also considered engaging forestation activities, preventing the destruction of forests, reducing the use of products such as deodorants and sprays, decreasing the consumption of fossil fuels, the use of public transportation vehicles and increasing environmental awareness within the society as measures that can be implemented within the context of the activities for countering air pollution. It was seen that a small portion of the pre-service teachers mentioned the importance of legal regulation and inspections, waste management, the usage of renewable energy sources and recycling. Examples of explanations given by the pre-service teachers regarding the measures that can be taken for the prevention of air pollution are provided below:

“Foremost among the measures that we can take to prevent air pollution is to make people more conscious about this subject.

For example, industrial installations must absolutely have filter on their chimneys. In addition to this, we should also attach filters to the chimneys of our houses, the exhausts of our motorized vehicles. We must increase the number of forests across the world. We must reduce the use of fossil fuels. We can achieve a cleaner air by taking such measures”.

- “The use of higher quality fuels must be ensured at households.
- Filters should be attached to chimneys and exhaust gases.
- Public transportation vehicles must be used.
- Caution must be shown in the use of cosmetic products such as deodorants.
- Public awareness regarding air pollution must be raised”.

“To prevent air pollution:

- Filters should be attached to the exhausts of factory chimneys and motorized vehicle exhausts.
- We should plant more trees, and also regain and revive forest areas destroyed by forest fires.
- We must increase people’s awareness.
- We must benefit from renewable energy sources”.

“To prevent air pollution, efforts should be made for forestation/reforestation, existing green areas should not be destroyed, measures should be taken for the prevention of fires and implemented consciously; trash and similar waste should not be thrown away into the environment, they should instead be gathered in locations for recycling; perfumes harmful to the environment should not be used irresponsibly”.

Conclusions and Recommendations

The fact that the majority of pre-service teachers described air as being composed solely of oxygen and carbon dioxide indicated their lack of content knowledge about its actual composition, and also that they considered air simply as a mixture of oxygen gas, which is necessary for life, and carbon dioxide gas, which is emitted through various processes and is used by plants for photosynthesis. The majority of the pre-service teachers described oxygen as the most abundant gas in clean air. This view among the pre-service teachers may have stemmed from the fact that, as one of the fundamental requirements for life, they associated oxygen with a substance that plays an important role in the vital functions of most organisms and is necessary for the proper working of their metabolism. In addition to this, the other underlying reasons for this prevailing opinion may have been the emphasis these pre-service teachers frequently encountered during their education regarding the importance of oxygen in biological systems, as well as their knowledge on the fatal consequences of oxygen deprivation.

The fact that the majority of the pre-service teachers erroneously described carbon dioxide as the most abundant gas in polluted air demonstrated not only that they correctly associated the increase in carbon dioxide emission with air pollution resulting from increasing industrialization and urbanization, but also that they had insufficient knowledge regarding the proportion of carbon dioxide in air. On the other hand, nitrogen is a substance that is necessary for the growth of organisms, and is an important component of many fundamental biological molecules (such as nucleic acids, proteins, various hormones and vitamins); it was also observed that the majority of the teachers could not identify nitrogen as the most abundant gas in air, and that they lacked sufficient knowledge regarding the proportion of nitrogen in air. This may have been due to their lack of knowledge regarding the nitrogen cycle, and also regarding the locations and times where chemical reactions that convert atmospheric nitrogen into biologically available forms take place. It was also observed that the pre-service teachers mostly failed to make any mention of water, which is one of the important constituents of air. This indicates their lack of content knowledge regarding the importance of the water cycle and on how this cycle is formed, as well as their inability to associate the water cycle with atmospheric water.

It was observed that the large majority of the pre-service science teachers described industrial organizations, car exhausts, fossil fuel use, sprays and the destruction of forests as the causes of air pollution, and that they hence possessed sufficient knowledge and awareness regarding the sources of air pollution. Moreover, the fact that a certain portion of the pre-service teachers described the lack of environmental awareness as one of the causes for air pollution demonstrates that these pre-service teachers were knowledgeable on the importance of providing education on the environment and raising environmental awareness. In this study, a small portion of the pre-service teachers demonstrated in-depth knowledge when they mentioned that natural events such as volcanic eruptions, disasters can also cause air pollution

On the other hand, it was observed that certain pre-service teachers described incorrect relations between air pollution and natural events such as acid rains, the greenhouse effect and the thinning of the ozone layer, which actually engender different effects on the environment (other than air pollution).

The large majority of the pre-service science teachers correctly described air pollution as the cause of pulmonary diseases such as the shortness of breath, asthma and bronchitis, accurately identifying the relation between air pollution and these health conditions. Some of the pre-service teachers demonstrated their awareness of the fact that air pollution can directly or indirectly lead to many other diseases. In this context, they described air pollution as a possible cause for cardiac diseases, cancers, dermatological diseases, psychological diseases, allergic diseases and visual disorders. Moreover, the large majority of the pre-service teachers expressed the opinion that air pollution can lead adverse effects on plants and animals, such as developmental disorders, the reduction of yield/productivity, mass deaths and the extinction of species. Based on the results obtained in this study, it was determined that the pre-service teachers were unanimous on the opinion that air pollution leads to adverse effects on living organisms and the environment.

It was determined that the large majority of the pre-service teachers considered the idea of using filters in house and factory chimneys and in exhausts as the first and foremost preventive measure against air pollution. In addition, it was observed that nearly half of the pre-service teachers were aware of the importance of engaging in forestation activities, preventing the destruction of forests, reducing the use of products such as deodorants and sprays, decreasing the consumption of fossil fuels, and increasing environmental awareness within the society as measures for countering air pollution. It was observed that some of the pre-service teachers mentioned decreasing the consumption of fossil fuels and the use of public transportation vehicles as measures that can be implemented for countering air pollution. Furthermore, it was noteworthy that a very small portion of pre-service teachers described the importance of legal regulations and inspections, waste management, the use of renewable energy sources and recycling as measures against air pollution. All of these results demonstrate that these pre-service teachers have correct yet incomplete knowledge regarding the measures that can be taken for the prevention of air pollution.

One of the underlying reasons for the various problems that occur in our country are the inadequacies with regards to acquiring knowledge and raising awareness. It is an undeniable fact that a society without environmental awareness will not be able to grasp the fact that the world we live upon is a not a heritage from the past, but rather an entrusted entity that must be protected, developed and hand-over to future generations in the best possible way (İnanç & Kurgan, 2000). Considering that mankind is the most significant factor responsible for the creation of environmental problems, the most effective preventive measure against such problems is raising awareness and ensuring that individuals become more mindful and sensitive towards the environment. This, in turn, can be achieved by implementing an effective environmental education.

Providing an environmental education that suits and fulfills its purposes first necessitates the raising of educators sufficiently qualified for providing such education. For this reason, raising teachers who will educate future generations that will take important decisions on the environment constitutes one of the most important stages of environmental education, which is intended as a life-long education for all segments of society. As such, teachers with education on the environment are considered as a first among priorities (UNESCO-UNEP, 1990). If future teachers are misinformed on the environment or do not acquire a sufficient grasp of the relevant concepts, it is likely that their preconceptions will persist in their classes (Hooper, 1988).

Taking into account the fact that teachers have a determining role on the level of knowledge and attitudes of students for many years, and also constitute a significant influence on them; ensuring that pre-service teachers have sufficient knowledge is of considerable importance for preventing misconceptions among future generations on environmental problems, and for raising individuals with greater awareness and sensitivity towards the environment.

Along with the rapid increase in world population, mankind's efforts to increase its living standards and to acquire more resources, the increasing urbanization and industrialization, and the insensible devastation of nature, air pollution ranks among the most important environmental problems that threatens living organisms. Considering the potential significance of air pollution for the world, the measures to be taken against this environmental problem are of vital importance.

As is the case with most other problems, the prevention and resolution of the global environmental problem that air pollution relies heavily on the raising individuals who are educated, conscious and aware of such issues. For this reason, it is important to assess the level of knowledge of teachers regarding global environmental problems. This is because these teachers will be responsible for ensuring the raising of future generations and the development of societies that are conscious on such issues. For this reason, the underlying reasons for the erroneous concepts assumed by the pre-service teachers regarding air pollution should be identified, and an education that is more meaningful and lasting should be provided by using student-centered methods and techniques. In addition to this, it is considered that the organization of social activities such as symposiums and conferences for the purposes of supporting the environment-related education in universities will be significant and beneficial for the pre-service teachers.

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