

HIGH SCHOOL STUDENTS' PERCEPTIONS TOWARD ENVIRONMENTAL ISSUES: A PHENOMOLOGICAL STUDY

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Abstract: The purpose of this study was to explore 10th grade high school students' perceptions towards environmental issues such as air pollution, global warming, greenhouse effects, ozone layer depletion, and acid rains. In the study, phenomenological research design as a qualitative approach was utilized. Five students from a high school participated to this study. Data were collected through semi-structured interviews and analyzed by doing content analysis. Results of the interviews indicated that students confused the global warming, greenhouse effects, ozone layer depletion, and acid rains. In addition, they thought that there were cause effect relationships between greenhouse effect and ozone layer depletion, and between greenhouse effect and acid rains. Moreover, it was revealed that students had some misconceptions towards these issues. Although there was no direct relationship between these issues, they always made connections between them. Based on the results, it was suggested that the awareness of students should be increased with a variety of environmental education. Scientific activities such as conferences, symposiums, and panel should be executed. Moreover, students should be motivated in the courses during primary, secondary and undergraduate education. Finally, the awareness of people about the negative effects of environmental pollution should be raised by using the media.

Keywords: Air pollution, Global warming, Greenhouse effects, Ozone layer depletion, Acid rains Qualitative research,

INTRODUCTION

Environmental issues are an important area of interest around the world and still under discussion. Every day, our world is affected more by environmental problems. Air pollution, global warming, climate change, greenhouse effect, acid rain, and ozone layer depletion constitute some of the major environmental problems (Myers, Boyes, & Stanisstreet, 2004).

Air pollution is defined as the presence of harmful substances in the atmospheric air which damage the ecological balance. The main reasons of air pollution are the energy sources used for various purposes, heating, motor vehicles and industrial facilities. On the other hand, air pollution has many negative effects on human health (Kampa, & Castanas, 2008; Seinfeld, & Pandis, 2012).

The sunlights filtered through the atmosphere are absorbed and warms the Earth's surface. Gases in the atmosphere prevent the earth's heat loss. This property of the atmosphere is called as "greenhouse effect". Regarding this issue, carbon dioxide has the greatest heat retention properties in the air (Seinfeld, & Pandis, 2012). Various industrial processes, fuels used for heating, fossil fuel power plants and exhaust gases pollute the atmosphere, and emit sulfur dioxide (SO₂), nitrogen oxides (NO_x), hydrocarbons and solid particles which are falling back to earth in the form of acid rain (Kampa, & Castanas, 2008; Seinfeld, & Pandis, 2012). Ozone is found in the stratosphere and absorbs ultraviolet (UV) rays which are harmful to living things. Without the ozone layer, the harmful UV rays would reach the Earth's surface and cause serious damage to living things. In case of a reduction of ozone concentrations up to not do its duty, ozone layer depletion occurs, which means a hole in the ozone layer among the people (Seinfeld, & Pandis, 2012).

Examination of students' opinions about environmental issues shed light on their scientific literacy for science educators and researchers. Training scientifically literate individuals is among the main goals of contemporary science education (AAAS, 1993; BouJaoude, 2002; Stern, Powell, & Ardoin, 2008). A scientifically literate person can easily understand basic concepts of science and nature of science, follow scientific developments, and use these concepts appropriately by incorporating scientific process skills. Also, s/he wonder about the events occurs around him/her and correctly interprets relationship between science and the environment (Laugksch, 2000).

Educating individuals with the environmental awareness is important to eliminate and overcome environmental problems. Environmental education is a continuous learning process in which individuals acquire knowledge, skills, values, and experiences in order to improve their perception of the environment, to ensure environment-related values, attitudes and recognition of the concepts related to environment, and generate a healthy and clean environment for future generations (Shobeiri, Omidvar, & Prahallada, 2007; Tilbury, 1995; Vaughan, Gack, Solorazano, & Ray, 2003). Environmental education is important for several points since individuals are aware of some environmental issues. They also produce solutions in order to resolve these issues and develop positive and realistic attitudes about the environment (Davis, 1998; Shobeiri, et al., 2007; Vaughan, et al., 2003). In order to give an effective environmental education to the individuals and improve environmental awareness, it is important to determine their prior knowledge and perception about the environment, and their attitudes toward the environment by conducting research studies in all levels of education (Duvall, & Zint, 2007). However, related literature indicates that studies were mainly at university level (Çabuk & Karacaoglu, 2003; Erdal, Erdal & Yücel, 2013; Khalid, 2001). For instance, Khalid (2001) examined 113 pre-service elementary teachers' misconceptions regarding the greenhouse effect, atmospheric ozone, and acid precipitation. Participants had some misconceptions which are the skin cancer may be occurred by the greenhouse effect, ozone depletion may cause global warming, ozone layer have multiple functions, and pollutants evaporate with water, later come down as acid rain. Similarly, Çabuk and Karacaoglu (2003) investigated whether students' personal characteristics such as gender, age, department and class affect their ideas about the environmental sensitivity or not. They found that gender, departments, and class affected students' environmental awareness significantly whereas age did not have significant effect on their ideas about the environmental sensitivity. In addition, students' opinions indicated that most of the students do not pay attention to using public transport and they use harmful substances to the ozone layer like deodorants. They also stated that they occasionally pay attention to ingredients of cleaners whether they include harmful chemicals or not. Moreover, according to the students' opinions, sufficient education on air, water and soil pollution was not given in the formal education. In another study, Erdal, Erdal and Yücel (2013) carried out a study with 253 university students to determine students' levels of environmental awareness. Students' responses indicated that the majority of students had a high level of environmental awareness. The result of the study revealed that students generally acquired information about the environmental problems from television and the internet. Only 44% of them stated that they got enough courses related to environmental education in school up to university. In addition, 75.49% of the students mentioned that their university did not show sensitivity to the environment. They claimed that there were no organizations, seminars or applications.

Research studies carried out at other education levels are limited (Darçın & Çıbık, 2009; Shobeiri, et al., 2007; Yılmaz, Boone & Andersen, 2004). For example, Darçın and Çıbık (2009) examined levels of knowledge of 327 secondary school students about air pollution with respect to their gender, settlement units, educational level of the mother and father, the monthly income of the family, and geographic location. According to the results, although students had relatively more information on sources and negative effects of air pollution, they had insufficient knowledge about the air pollutants and their impacts. Moreover, it was observed that students' knowledge of air pollution was affected by the settlement units in which they study and the education level of their fathers. Similar study was conducted by Yılmaz, Boone and Andersen (2004) in order to identify students' views on environmental issues and to determine how these views differ by gender, grade level, previous science achievement, socio-economic status (SES), and school location. A total of 458 students in grade 4–8 classrooms completed a 51-item Attitude toward Environmental Issues Scale (ATEIS) involving 30 distinct concepts related to environmental issues such as air, water, and soil pollution, public awareness about environmental problems, and environmental protection. Results of the study indicated that high achievement in science courses resulted in more positive attitudes toward environmental issues. In addition, the study revealed that the older female students exhibited more support for environmental issues than did male students. Students with high family income, and those students living in urban areas, displayed more positive attitudes toward environmental issues than students with low family income and those living in suburban areas.

In the literature, there were also some studies conducted with teachers. For example, Yılmaz-Tüzün, Teksöz-Tuncer and Aydemir (2008) investigated 183 primary school teachers' knowledge about air pollution, ozone

layer depletion, acid rain and clean energy sources. The data were analyzed with quantitative methods. The results revealed that 50% of teachers did not have adequate information about these issues. Although the teachers knew basic air pollutants (e.g., carbon dioxide, methane, sulfur dioxide (SO₂), and nitrogen oxides (NO_x), they did not have any idea about how these pollutants cause air pollution.

In the related literature, there were many studies aimed to determine the students' perceptions of environment and environmental issues such as air pollution, acid rain, ozone layer depletion, and global warming (e.g. Boyes, Skamp, & Stanisstreet, 2009; Khalid, 2001). However, the related literature indicated that there were a few research studies on these issues at secondary level (e.g. Shobeiri, et al., 2007). Therefore, in the present study, it was aimed to determine high school students' perceptions about these issues.

When related literature was examined, there were many studies on the identification of misconceptions about environmental problems (Arsal, 2010; Dove, 1996; Groves & Pugh, 1999; Papadimitriou, 2004; Summers, Kruger, Childs, & Mant, 2001; Yılmaz, Morgil, Aktuğ, & Göbekli, 2002; Yılmaz-Tüzün et al., 2008). For example, in the study of Arsal (2010) with 171 preservice science and classroom teachers, it was identified that the preservice teachers thought that with the increase of greenhouse effect, more fish deaths would occur in the seas, lakes and rivers and more earthquakes would occur in the world. In addition, most of them believed that increasing acid rain, using more fertilizers in agriculture and too many sun's rays were the causes of the greenhouse effect. Similar results were also found by Groves and Pugh (1999) conducted with 330 college students from the colleges of Education, Pure and Applied Sciences, Pharmacy and Health Sciences, and Liberal Arts. The results of their study indicated that students had incorrect ideas about consequences and causes of greenhouse effect. Students thought that the greenhouse effect increases chance of getting skin cancer and earthquakes. In addition, they incorrectly believed that holes in the ozone layer and too many sun's rays were the cause of greenhouse effect. In another study, Papadimitriou (2004) stated that preservice teachers had misconceptions on ozone depletion and acid rains. They also confused ozone depletion with greenhouse effect.

The present study attempted to determine high school students' perceptions of environmental issues. Examination of students' perceptions of environmental issues also will provide us information about students' scientific literacy, which will facilitate their future life. Therefore, this study will provide valuable contribution to the environmental education literature. The research question of the study is as follow:

What are the 10th grade students' perceptions towards environmental problems such as air pollution, global warming, greenhouse effects, ozone layer depletion, and acid rains?

METHODOLOGY

In this study, qualitative research method was used. In qualitative research studies, any situation is examined in detail and the researcher will try to find answers for why and how questions (Merriam, 2009; Yıldırım & Şimşek, 2013).

Design

Phenomenology argues the perceptions and experiences of individuals. It offers the researcher the ability to examine the facts that we know but do not understand exactly and to get depth information about them. (Patton, 2002; Yıldırım & Şimşek, 2013). In this study, it was aimed to investigate students' perceptions on environmental issues in depth and to determine their level of conceptual learning and misconceptions. Therefore, students' perceptions on environmental issues were demonstrated through phenomenological research design.

Participants

In this study, purposive sampling technique was utilized (Fraenkel & Wallen, 2000). Participants were randomly selected among the students in 10th grade level at a high school during the fall semester of 2013-2014. The high school was selected based on its convenience to be used for the researchers in terms of transportation during the study. In addition, the reason for studying with 10th grade students was that they were taught environmental chemistry in Grade 9 in their chemistry class. Five students participated voluntarily in this study. Three of the participants are female and two are male. Their ages were 15.

Data collection instruments

Interviews provide an information from individuals' own perspective and in their own words (Bogdan & Biklen, 2007). In this study, data were collected through semi-structured interviews to explore students' perceptions of environmental issues. Semi-structured interviews are in-depth interviews and provide the interviewer flexibility to explore details or further responses. A semi-structured interview consists of a pre-determined set of open-ended questions based on the topic areas. Some further questions might also be created during the semi-

structured interviews (Creswell, 2009). In this study, ten interview questions including some probes were prepared after review of the related literature (Aksan & Çelikler, 2013; Aktepe & Girgin, 2009; Boyes et al., 2009; Khalid, 2001; Papadimitriou, 2004). To ensure the content validity of the questions, researchers got expert opinions from two science educators and a chemistry teacher. Moreover, a pilot study was conducted with a 9th grade high school student. Based on the expert opinions and pilot study, the researchers revised the interview questions in terms of clarity of questions, compatibility and content. Before interviews were conducted, the researchers informed students about the purposes of the study and invited them to participate in the study. Each interview took about 25-30 minutes. All interviews were audio-recorded and transcribed verbatim. Sample interview questions were:

- 1) In your opinion, what may be the possible causes of air pollution?
- 2) What do you think about the possible changes in the world as a result of global warming?
- 3) What could be the cause of the depletion of the ozone layer?
- 4) What do you know about greenhouse gases?

Data analysis

Content analysis provides a systematically scientific method for the interpretation of raw data by using deductive or inductive approaches. With a deductive approach, the researcher examines the data by applying existing codes or categories in the literature. On the other hand, with an inductive approach, the researcher derives codes, themes and categories directly from the data (Marshall & Rossman, 2006). In this study, the data were analyzed via content analysis in order to get depth information about students' perceptions of environmental issues. Firstly, interviews were transcribed and written documents were formed. Then, these written documents were coded, and in this way themes and categories were established, inductively. Table 1 shows the categories and sub-categories (themes). Codes for sub-categories also were presented in the result section. Throughout the study, the names of female students were coded as Selin, Ece, and Oya and those of male students were coded as Okan and Deniz.

Table 1. Distributions of sub-categories according to categories

Categories	Sub-categories (Themes)
Air pollution	Air pollution
	Effects of air pollution on human health
	The most affected people by air pollution
	Causes of air pollution
	Participants own effect on air pollution
	The duties of individuals to prevent air pollution
	The duties of institutions to prevent air pollution
Global warming	Global warming,
	Possible changes in the world
	Precautions must be taken to prevent global warming
	The relationship between global warming and greenhouse effect

Greenhouse effect	Greenhouse effect
	Greenhouse gases
	Impact of greenhouse effect on the world
	Precautions must be taken to prevent greenhouse effect
Acid rains	Causes of acid rains
	Consequences of acid rains
	Precautions must be taken to prevent acid rains
Ozone layer	Causes of ozone layer depletion
	Effect of ozone layer depletion on living things

Validity and reliability

For reliability and validity of qualitative studies, researcher should ensure some criteria such as credibility, transferability and confirmability (Creswell, 2009). To ensure credibility of the results of this study, direct quotations from participants' interviews were provided in the result section by keeping their identities. In addition, this study was conducted with 10th grade students who had taken "environmental chemistry" course in their 9th grade chemistry class in order to discover realistic and accurate results on students' perceptions. Transferability refers to the degree to which the results of qualitative research can be generalized or transferred to other contexts or settings (Yıldırım & Şimşek, 2013). In the current study, the research context of the study was described in details in order to increase the transferability. Furthermore, confirmability refers to the degree to which the results could be confirmed or corroborated by others (Creswell, 2009; Yıldırım & Şimşek, 2013). For this study, two experts in qualitative study were separately analyzed the codes, categories and themes formed by the researchers in terms of eligibility. In addition, a person outside the field compared raw data and the result of the study for ensuring reliability of the study. Finally, another expert examined the data collection, analysis procedures, and results in terms of their appropriateness and coherence in order to enhance confirmability.

RESULTS

In this study, students' responses to the interview questions were analyzed qualitatively and categorized according to the themes (see Table 1). For each theme, codes were created regarding the students responses and their frequency of occurrence were shown in the related tables below.

Air pollution

When we looked at the Table 2, it was seen that participants had different opinions about the air pollution. Two participants (Oya and Deniz) defined air pollution as releasing of harmful things into the air. Regarding this definition, Oya stated that "I think it is release of harmful substances to the air by people". Views of the other participants (Selin, Ece, and Okan) were as follows, respectively: "I think air pollution is directly irresponsibility of people", "Air pollution is an environmental problem occurring due to our use of some substances unconsciously", and "It is dirty smoke coming from the chimney, exhaust fumes of cars etc., all kinds of factors that pollute the air".

Table 2. Students' codes about the air pollution

Participant	Codes			
	Irresponsibility	Unawareness	Harmful substances	Dirty fumes
Selin	X			
Ece		X		
Oya			X	
Okan				X
Deniz			X	

Effects of air pollution on human health

Table 3. Students' responses to the question: "What are the effects of air pollution on human health?"

Participant	Codes	
	Negative effects without an example	Negative effects with an example (e.g., respiratory tract infections, cancer, depression)
Selin		X
Ece	X	
Oya		X
Okan	X	
Deniz		X

Participants thought that air pollution had negative effects on human health. When they were asked to give an example, two participants, Okan and Ece could not give an example. On the contrary, Oya, Deniz, and Selin gave following examples respectively: respiratory tract infections (asthma, bronchitis), cancer, and depression. For instance, Selin expressed her idea as "It looks like a bad weather. People feel upset or depressed".

The most affected people by air pollution

Table 4. Students' responses concerning the question "Who do you think could be most affected by air pollution?"

Participant	Codes	
	People	
	Children	Older people
Selin	X	
Ece	X	
Oya	X	X
Okan		X
Deniz	X	X

All participants thought that air pollution mostly affects people. In fact, Selin, Ece, Oya, and Deniz stated that children are more likely to be affected by air pollution. In addition, Oya, Okan, and Deniz stated that older people are also affected by air pollution. For example, Oya stated that "Children will be affected the most because they are in development age. In addition, the shortage of health care is increasing with age, so I think the elderly are also very affected by air pollution".

Causes of air pollution

Table 5. Students' responses regarding the possible causes of air pollution

Participant	Codes				
	Fuels, Fossil fuels	Fumes from stoves, cars, cigarette and chimney chimneys	Natural disasters and factory	The destruction of forests	Nuclear power plants
Selin	X	X	X		
Ece		X		X	
Oya		X			
Okan	X	X		X	
Deniz	X	X			X

Table 5 indicated that students put forward more than one reason about air pollution. For example, Selin stated that fossil fuels are one of the reasons of air pollution and expressed her idea as follow: "The biggest cause of air pollution is irresponsibility and unconsciousness of people. Then fossil fuels and cars". In addition, the students agreed with fumes from stoves, cars, cigarettes and factory chimneys as one of the causes of air pollution. For example, Ece said that "Not afforested surroundings, smoking cigarettes, car exhaust, etc. can be given as examples".

Participants own effect on air pollution

Table 6. Students’ responses about the effects of individuals on air pollution?"

Participant	Codes		
	Direct effect	Indirect effect	No effect
Selin		X	
Ece	X		
Oya	X		
Okan			X
Deniz	X		

All participants, except Okan, thought that they had an impact on air pollution. While Ece, Oya, and Deniz thought that they had a direct effect on air pollution, Selin believed that she had an indirect impact on it. For instance, Ece stated that "I have an impact on it. Deodorants that I used can create a cloud of harmful gases in the air. So, I have an impact on the air pollution, of course". On the other hand, Selin expressed her idea as follow:

I do not use cigarettes, perfumes and drive car. I'm not going to go anywhere by car directly. I'm using the tram on weekends when I'm going somewhere or I prefer to walk. I do not think I have an impact on air pollution directly. But I might affect it indirectly because of my environment or other reasons.

The duties of individuals to prevent air pollution

Table 7. Students’ responses about the duties of individuals to prevent air pollution

Participant	Codes			
	Awareness on air pollution	Public transport and electric vehicles	Afforestation	Using environmentally-friendly products
Selin	X			
Ece	X	X	X	
Oya		X		X
Okan		X		X
Deniz	X			

As Table 7 shows most of the participants express more than one opinion about the duties of individuals for preventing air pollution such as awareness on air pollution, using public transportation and environmentally-friendly products, and afforestation. For example, Ece stated that "I think we need to use public transport more actively, plant more trees, and further raise awareness on this issue".

The duties of institutions to prevent air pollution

Table 8. Students’ responses regarding the duties of institutions

Participant	Codes	
	Effective control	Public awareness (seminars, posters, etc.)
Selin		X
Ece		X
Oya		X
Okan		X
Deniz	X	

According to Table 8, almost all participants thought that the duty of institutions was to raise the awareness of the public (via seminars, posters, etc.). For example, Ece expressed her idea as follow: “Our school can organize a seminar about it or the labels at the top of the cigarette box indicating the harmful of it could be done on the bottle of the deodorants in order to indicate their harm”. Moreover, Deniz mentioned the effective control of furnace filters and the smoke-free areas. He said that “Chimney filters and the application of smoke-free air space must be control regularly”.

Global warming

Table 9. Students’ responses about the global warming

Participant	Codes		
	The death of the world	Dying polar bears / melting glaciers	Depletion of the ozone layer
Selin	X		
Ece		X	
Oya		X	
Okan			X
Deniz		X	

As Table 9 indicates, while most students described global warming as “Dying polar bears / melting glaciers”, two of them expressed it as “The death of our world” or “Depletion of the ozone layer”. For example, Okan stated that “I know that depletion of the ozone layer occurs due to the global warming”. Ece also said that “Death is actually a direct result of global warming, we kill the world”.

Possible changes in the world as a result of global warming

Table 10. Students’ responses about the possible changes in the world as a result of global warming

Participant	Codes		
	Water shortages	Air pollution	Climate change
Selin	X	X	
Ece			X
Oya	X		
Okan			X
Deniz			X

Ece, Okan, and Deniz stated that one of the possible changes in the world as a result of global warming was climate change. For example, Ece expressed her idea as follow: “Future weather will not be like today. We may never see snow in the future. The weather will be much warmer”. On the other hand, two participants (Selin and Oya) claimed that water shortages would be experienced as the result of global warming. In addition, Selin also stated air pollution would be increased in the future as the result of global warming. An illustrative statement from Selin’s interview is below:

I think water supply will be the biggest problem of the future as a result of global warming. For example after 100 or 200 years, we will be faced with completely run out of water. Thus, the human race will be destroyed gradually. In addition, people will need to use oxygen mask outside since one of the cause of global warming is air pollution. Air pollution will be increased in the future.

Precautions must be taken to prevent global warming

Table 11. Students’ responses about how to reduce the effects of global warming?

Participant	Codes		
	Prevention of water pollution	The use of non-destructive gases and fuel	Preventing the establishment of nuclear power plants
Selin	X	X	
Ece		X	
Oya	X		
Okan		X	
Deniz		X	X

Four participants stated that the use of non-destructive gases and fuel reduce the effects of global warming. For instance, Deniz mentioned that “we cannot use the perfume since it damages the atmosphere”. Moreover, Selin and Oya considered that people must not pollute the water. In addition, Deniz stated that nuclear power plants should not build in the country.

The relationship between global warming and greenhouse effect

Table 12. Students’ views about the relationship between global warming and greenhouse effect

Participant	Codes	
	Yes	I do not know
Selin	X	
Ece	X	
Oya		X
Okan	X	
Deniz	X	

Students were asked the question “Do you think there is a relationship between global warming and greenhouse effect?” It was seen that all students, except Oya, answered “Yes” to the question. Oya stated that she did not have any knowledge about this issue. Okan, who believe that the relationship between global warming and greenhouse effect, expressed his idea as follow:

Of course, there is a relationship. Let’s think the world as a greenhouse. The ozone layer covers the world. In other words, if the rays do not go back, temperature of the world increases. Therefore global warming is related to the greenhouse effect.

Greenhouse effect

Table 13. Students’ responses to the greenhouse effect

Participant	Codes	
	Harmful gases	Hot air / sunlight
Selin	X	
Ece		X
Oya		X
Okan		X
Deniz		X

According to the Table 13, four participants explained greenhouse effect by associating with hot air or sunlight. For example, Ece stated that “Gas clouds cover the sky or air. These clouds keep the sun’s rays over the world. Hence, these rays cannot reflect back again and hot air forms over the world”. On the other hand, Selin described greenhouse effect as unpleasant gases. She expressed her idea as follow: “The greenhouse effect is a major problem resulting from global warming. I think it is destruction of the atmosphere by harmful gases released to the earth due to global warming”.

Greenhouse gases

Table 14. Students’ responses to the following question: “What do you know about greenhouse gases?”

Participant	Codes	
	Harmful gases to the environment (CO ₂ , O ₃)	I do not know
Selin	X	
Ece		X
Oya		X
Okan		X
Deniz		X

Table 14 indicates that most students did not have knowledge about the greenhouse gases. Only Selin explained her idea about the greenhouse gases. She described gases that harm the environment as greenhouse gases. She

explained her idea as follow: “Firstly, carbon dioxide. Then, I think, ozone and other gases harmful to the environment might be greenhouse gases”.

Impact of greenhouse effect on the world

Table 15. Students’ views to the question “Do you think greenhouse effect have negative or positive impact on our world?”

Participant	Codes	
	Negative	Depending on circumstances
Selin	X	
Ece	X	
Oya	X	
Okan		X
Deniz	X	

As shown in Table 15, while four students thought that greenhouse effect had negative impact on the world, one student (Okan) stated that the impact of greenhouse effect on the world might vary, depending on circumstances. Okan expressed his idea as follow: “That can lead to bad results if its rate increases. It should be neither more nor less”.

Precautions must be taken to prevent greenhouse effect

Table 16. Students’ responses to the question: “How can we prevent the negative effects of the greenhouse effect?”

Participant	Codes		
	Reduce the use of harmful gases	Raise awareness	I do not know
Selin	X	X	
Ece			X
Oya		X	
Okan	X		
Deniz	X		

Table 16 indicates that students, except Ece, suggested two different precautions to prevent greenhouse effect. Ece answered “I do not know” to the question. Students suggested that use of harmful gases should be reduced and people should be informed about greenhouse effect. For example, Selin expressed her idea as follow:

I think that perfumes and deodorants have the most negative effective on it. People use them very often. For example, our friends at school use them at every break. This affects both us and the world directly. As result of this, the atmosphere layer becomes thinner. Therefore, awareness of people on this issue should be raised. To do this, people should not be given only lectures on the subject by meeting somewhere. Instead of this, in my opinion, giving examples from around the world in a friendly atmosphere might be more effective to raise awareness.

Deniz also stated that “The use of harmful gases must be reduced as much as possible. There are hundreds of elements. I think, chemists can found something harmless and replace with these harmful gases.”

Causes of acid rains

Table 17. Students’ responses to the following question: “What would be the factors that lead to acid rain?”

Participant	Codes	
	Gases (CO ₂ , nitrogen, etc.)	Polluted water
Selin	X	
Ece		X
Oya	X	
Okan	X	
Deniz	X	

Table 17 indicates that most of the students thought that some gases such as CO₂ and nitrogen lead to acid rain. One of the participants (Deniz) stated that harmful gases releases due to the use of cheap fuel gases cause acid rains. Moreover, one of the participants (Ece) thought polluted water as a factor that lead to acid rain. She stated that “Polluted water might be reason of acid rain because the clouds are composed of water evaporated from the earth. Therefore, we can be exposed to acid rain because of a dirty air”.

Consequences of acid rains

Table 18. Students’ responses to the following question: “What do you think about consequences of acid rains?”

Participant	Codes		
	Diseases	Erosion of historical monuments and objects	Soil pollution
Selin	X		
Ece	X	X	X
Oya		X	X
Okan	X		
Deniz	X	X	

As seen in the Table 18, students described consequences of acid rains as diseases, erosion of historical monuments and objects, and soil pollution. Most of the students claimed that acid rains lead to diseases. For example, Selin stated that acid rains could cause genetic problems in the future. In addition to impact of acid rain on human health, Ece, Oya and Deniz emphasized effect of it on erosion of historical monuments and objects. For example, Deniz expressed his idea as follow:

It has a very big impact on our lives. It causes of skin cancer. People are going to getting skin cancer one by one and cancer rate is increasing. It also leads to damage to historical monuments around us and our vehicles, having monetary value for us.

Moreover, Ece and Oya also highlighted the effect of acid rains on soil pollution. An illustrative statement from Oya’s interview is below:

For example, I know that it will be harmful to plants. When people are affected from the acid rain, it is impossible for the plants to avoid the damage of it. Yield will surely reduce. When acid rain falls to earth, it will reduce the yield and I know that it erodes historical monuments.

Precautions must be taken to prevent acid rains

Table 19. Students’ responses to the following question: “What can be done to eliminate the negative effects of acid rain?”

Participant	Codes			
	Raising awareness	Use of chimney filters	Increasing forest	Precautions for water pollution
Selin			X	
Ece				X
Oya	X			
Okan		X		
Deniz	X			

As shown in the Table 19, students suggested four precautions to prevent acid rains: raising awareness, use of chimney filters, increasing forest, and precautions for water pollution. While two students emphasized public awareness of acid rain, other each precaution was recommended by only one student. For instance, regarding use of filters, Okan stated that “Fuels that we used were harmful. We need to replace them or we should take the precautions if we have to use them. Harmful gases can be cleaned by building filters in chimneys on factories”.

Causes of ozone layer depletion

Table 20. Students' responses to the following question: "What could be the cause of the depletion of the ozone layer?"

Participant	Codes	
	Harmful/unpleasant gases	Human effect
Selin	X	
Ece	X	
Oya	X	
Okan	X	
Deniz		X

Table 20 indicates that most students pointed out harmful/unpleasant gases (e.g., gases released from burning fuels and chemical weapons) as a reason of the ozone layer depletion. In addition Deniz thought that human also was the cause of it. He stated that "I think the biggest cause is human. If there are no people and only animals live in the world, it would be a much better place than today".

Effect of ozone layer depletion on living things

Table 21. Students' responses to the question: "What do you think about the effect of ozone layer depletion on living things?"

Participant	Codes		
	Harmful effects		
	Shortening of life	Diseases / skin problems	No detailed explanation
Selin	X		
Ece			X
Oya			X
Okan		X	
Deniz		X	

Table 21 indicates that all the participants thought that ozone layer depletion has harmful effects on living things. While two students (Okan and Deniz) stated that ozone layer depletion causes diseases related to skins, another student (Selin) expressed that it causes the shortening of human life. On the other hand, although other two participants thought that it has negative effects on living things, they did not give detailed information about it. For example, one of them (Ece) stated "As a result of depletion of the ozone layer or more sun rays coming to earth, our world will suffer a great harm".

DISCUSSIONS and CONCLUSIONS

The results of the study revealed that air pollution was seen as a major problem. Participants put many reasons on the causes of air pollution. In a similar study conducted with 240 students studying in different parts from different universities, Özdemir and Yapıcı (2010) found that students perceived air pollution as a serious environmental problem. Although participants agreed that air pollution is a serious problem for the environment, they could not give detailed answers to the question: "What measures should be taken to prevent air pollution?" They also failed to reveal examples of contaminants that pollute the air. This situation indicates that they had insufficient knowledge about air pollution. This result was supported by the study of Yılmaz-Tüzün et al. (2008). Their study also revealed that most of the participants did not have sufficient knowledge about air pollutants and factors causing air pollution. On the contrary, Darçın and Çıbık's (2009) study indicated that middle school students had relatively more information about sources of air pollution and negative effects of it.

In the study of Yaçınkaya (2013), participants focused on air and water pollutions, and problems with waste. They asserted that the insensitivity of people was the main cause of environmental problems. In addition, her study revealed that environmental awareness campaigns were seen as one of the solutions for the prevention of environmental problems. Similarly, in this study, participants thought that human activity was a major cause of air pollution and emphasized on environmental awareness to prevent it. Moreover, as in the other studies (e.g., Erdal et al., 2013), participants of this study highlighted the necessity of organizations or seminars on environmental problems. They thought that people's awareness was raised through little interesting posters and seminars which everyone could attend to.

Furthermore, participants of this study thought that media has an important role on building environmental awareness. However, they stated that such issues are not addressed sufficiently in the media. For example, Deniz stated that *"There are many issues in the public spotlight, but I have never seen anything about acid rain and air pollution"*. Suggestions of the participants for the prevention of environmental problems was supported by the study of Şenel and Güngör (2009) which found that programs related to global warming published by the media affected students' knowledge on this issue.

Regarding the global warming, research studies indicated that students generally know that global warming causes polar ice caps to melt (e.g. Boyes & Stanisstreet, 1992). Similarly, in this study, when participants were asked what comes to their mind when they hear the word global warming, most of them talked about melting of glaciers. For example, Oya stated that *"Here we know that melting of the glaciers. I read somewhere if it continues to heat up in this way, glaciers will melt more quickly. Even, Holland is going to remain under waters because the world's temperature rose 4 degrees"*.

The related literature indicates that students confuse environmental problems. For example, Khalid (2001) revealed that students confused global warming and ozone layer depletion. They failed to distinguish between the causes and consequences of these environmental problems. Moreover, other research studies revealed that the majority of students considered that the deformation of ozone layer causes to the global warming (Boyes & Stanisstreet 1997; Boyes, Stanisstreet, & Papantoniou, 1999; Koulaidis & Christidou, 1996; Mason & Santi, 1998; Meadows & Wiesenmayer, 1999). In addition to these, Aksan and Çelikler (2013) found that student confused the reason of the greenhouse effect and the precautions that can be taken to reduce it. The findings obtained in this study are similar to aforementioned results in the literature. During the interview, one of the participants of this study said that *"You've asked many questions and so many are going to come to the same thing. Therefore, I give same answers to them"*. This indicates the students' failure to distinguish between the causes and consequences of the environmental problems.

In addition to low level knowledge, research studies indicate that students have misconceptions related to environmental problems (Boyes & Stanisstreet, 1992; Boyes et al. 1999; Bozkurt & Koray Canstüngü, 2002; Dove, 1996; Groves & Pugh, 2002; Koulaidis & Christidou, 1996; Mason & Santi, 1998). The results of this study also supported that some students had misconceptions about greenhouse effect, global warming and depletion of ozone layer. One of the participants (Okan) stated that *"I know that global warming occurs due to the depletion of the ozone layer"*. Similarly, Meadows and Wiesenmayer (1999) found that students tend to establish a causal relationship between depletion of ozone layer and global warming.

In conclusion, this study revealed that students had low level knowledge and perception about environmental problems such as air pollution, greenhouse effect, global warming, acid rain, and depletion of ozone layer although they took a course related to global environmental problems in the their 9th grade class. The reason of their insufficient knowledge and misconceptions might be due to education they received previously in their school as stated by other research studies (e.g. Aksan & Çelikler, 2013). In addition to school environment, family and social environment might be the reason of low level of perception and knowledge. Moreover, having insufficient knowledge and misconception related to air pollution might be due to poor scientific literacy among the students which found in other studies (Chin, 2005).

SUGGESTIONS

In conclusion of the study, following suggestions can be made for environmental education:

- If the people's irresponsibility is thought to be major cause of environmental problems, people's awareness of environmental issues should be raised through a variety of environmental education.
- In schools, the environmental education should be supplied in which students' attention were taken to the environmental problems through various social and educational organizations.
- At all levels of formal and informal education, conferences, symposia, and panels on current environmental issues such as acid rain, depletion of ozone layer, the greenhouse effect and global warming should be organized.
- Not only the schools but also the parents, social communities and the media should support the students with the same sensitivity. Mass media such as TV and newspapers should inform people about the negative effects of environmental pollution.
- Regarding the future research studies, students' perceptions of environmental issues could be investigated at different level of secondary education unlike from this study.
- The effectiveness of environmental course could be explored by comparing perceptions of students taking the course with perceptions of those did not take.

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