



ISSN 1648-3898

## PRE-SERVICE SCIENCE TEACHERS' KNOWLEDGE LEVEL ABOUT SOME BASIC AIR POLLUTANTS

**Abstract.** *The aim of this study was to investigate the Turkish pre-service science teachers' level of knowledge about air pollution. The participants' levels of knowledge about "Air Pollution" were identified via a closed form questionnaire. The measuring instrument is applied on 325 female and 137 male students inside of the sample and a total of 462 students was applied this test. The questionnaire using in this study consisted of 17 statements. The results of the study revealed that; even though Turkish pre-service science teachers' level of knowledge about air pollution were well shaped, it is shown that most of these pre-service science teachers have misconception. The results show that they did not have adequate knowledge (level) about some basic air pollutants and their effects. The results also revealed that pre-service teachers have misconceptions about whether the pollutants CFCs, CO<sub>2</sub> and Hydrocarbons are pollutants or not. In order to prevent that, pre-service teachers should be informed about the effects and activities of these pollutants and what should be done.*

**Key words:** *pre-service science teachers, misconception, air pollution.*

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### Introduction

In recent years, natural resources are reduced quickly parallel to the rapid industrialization of modern communities, population growth, high consumption at industrial countries, careless development and extension of urbanization and increase of agricultural areas. Consumption of natural balance is inevitable due to excessive usage of natural resources which are extinguished via industrialization.

Technological developments bring along environmental problems owing to the change of balance, mechanism and structure of ecosystem. Especially, human activity based air pollution causes global problems such as greenhouse effect, ozone layer depletion and acid rains (Myers, Boyes & Stanisstreet, 2004). Greenhouse effect occurs due to the increase of CO<sub>2</sub> in the atmosphere which is a consequence of especially burning of fossil fuels (Österlind, 2005). In addition, gases such as water vapor, methane, CFC<sub>s</sub> and ozone also cause greenhouse effect and some of these gases play an active role in the development of other big environmental problems (Daniel, Stanisstreet & Boyes, 2004). For example CFC<sub>s</sub> and its derivatives are effective chemical substances which damage ozone layer deeply. Furthermore, at intensively industrialized areas, sulphur dioxide and nitrogen oxide which are faded out from factory chimneys or vehicles diffuse into air react with water and oxygen and acid rains form. This causes an environment disaster which affects so many living and non-living ecosystem. At the same time, many pollutants which are formed owing to the burning of coal, oil, natural gas and solid waste (carbon originate fuels) are very dangerous for human health. These pollutants cause especially skin cancer and various diseases depending on their physical, chemical and biological properties (Kırımhan, 2006).

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In the literature of the environmental education, level of knowledge and misconceptions of students (Boyes, Chuckran & Stanisstreet, 1993; Cordero, 2001; Daniel et al., 2004; Grodzinska-Jurczak, Stepska, Nieszporek & Bryda, 2006; Leighton & Bisanz, 2003; Myers et al., 2004; Pekel & Özay, 2005; Thornber, Stanisstreet & Boyes, 1999; Yeung, Boyes & Stanisstreet, 2004; Yılmaz, Morgil, Aktuğ & Göbekli, 2002), and pre-service teachers at different age groups (Bahar, 2000; Boyes, Chambers & Stanisstreet, 1995; Daskolia & Papageorgiou, 2006; Dove, 1996; Groves & Pugh, 1999; Khalid 2001, 2003; Michail, Stamou & Stamou, 2007; Papadimitriou, 2004; Pekel, 2005; Soran, Morgil, Yücel, Atav & Işık, 2000) were investigated.

For example, there is a study of Thornber et al., (1999) which is about the nature of air pollution, and its' biological and physical effects. The subjects of their study were 10-11 years old students. Their results showed that most of the students used the expression "gases pollute air" unscientifically and they named the pollutants like CFC<sub>s</sub>, CO, SO<sub>2</sub> individually. However, it was stated that, they could adopt knowledge which are gained from their own environment by living them and they matched the environment problems with only well-known pollutants.

Yeung et al., (2004) carried out a study with secondary school students at Hong-Kong which aimed to determine the ideas about air pollution and what should be done to stop it. In their study, when the level of knowledge about air pollutants at different age groups was measured; it was showed that there was lots insufficient knowledge at the group named "not a pollutant". Similarly, it was also seen that students had various misconceptions and misunderstanding about the ratio and effects of gases which constitute air. Furthermore, it was stated that the knowledge of students about the constituents of unpolluted air varied with respect to age.

According to some research, the most common misconception were about forming erroneous cause effect relationships among environmental pollution subjects like ozone, greenhouse effect, global warming and acid rains. The results of the study which was held by Boyes et al., (1993) showed that, some misconceptions occurred when high school students are asked to construct a relationship among different environmental problems such as ozone depletion, acid rain and global warming. The results of another study which was held by Khalid (2003) revealed that, senior level secondary science education students had misconception about greenhouse effect, ozone depletion and acid rain. According to the study of Yeung et al., (2004), the misconception of considering the greenhouse effect and acid rains as natural processes varied with respect to ages. There is another study which is about student teachers' knowledge and understanding of the greenhouse effect, ozone layer depletion and acid rain held by Dove (1996). This study revealed that the most common misconception was that the greenhouse effect was the result of ozone layer depletion. These misconceptions are formed due to lack of scientific knowledge about environmental problems and their consequences (Pekel, 2005). Therefore, to develop a positive environment consciousness in future generations, primary-secondary school teachers and pre-service teachers who will inform students should be well-informed too. Furthermore their skills of systemic thinking should also be improved.

We observed from recent studies that, student and pre-service teachers' knowledge levels about environmental problems are varying on account of multiple factors. Variables like gender and class level are very important factors that affect their knowledge levels for example. Gambro & Switzky (1994) defined in their study that, male and female high school students had similar knowledge levels about environment pollution. At another study which was conducted by Pekel & Özay (2005), researchers observed that there was no meaningful difference between male and female Turkish high school students about environment problems. There are some studies in the literature in which the class level variant affects the knowledge levels of students and pre-service teachers about environmental problems (Boyes et al., 1993, 1995; Leighton & Bisanz, 2003; Dove, 1996; Groves & Pugh, 1999; Khalid, 2003; Pekel & Özay, 2005).

There are so many studies about the environmental pollution in the literature. But these were only written on papers and we should start doing something to be realized in our lives and education. Most of those articles are foreign originated (Myers et al., 2004; Thornber et al., 1999; Yeung et al., 2004). There are examples of such studies made in Turkey but there are a limited number of them and they usually concern other dimensions of environmental pollution (acid rains, ozone layer depletion, global warming) (Bahar, 2000; Pekel, 2005; Pekel & Özay, 2005; Soran et al., 2000; Yılmaz et al., 2002). Also, most of these



domestic studies are of the primary and secondary school level. Considering these reasons, this study will contribute to literature about the air pollution, a sub-branch of environmental pollution, and will also guide the researchers who want to study about this subject.

In our study, we aimed to determine the level of knowledge of pre-service teachers (who will be the teachers of tomorrow) about air pollutants, sources of air pollution, and adverse effects of air pollution according to the gender and class level.

### Methodology of Research

The sample of the study consists of pre-service science teachers from Gazi University Gazi Faculty of education. They are the first, second, third, and fourth-year students. The study was carried out in 2006-2007 season spring semester. Pre-service science teachers who will be employed in the primary schools in the sample of this study participated willingly. The measuring instrument is applied on 325 female and 137 male students inside of the sample and a total of 462 students was applied this test. The purpose of choosing these participants was to define the qualification of these pre-service teachers' level of knowledge about some basic air pollutants. In this study, a questionnaire which is consisting of 17 statements was used to detect the level of knowledge of pre-service teachers. The instrument used determining knowledge levels was developed by the researchers. During the period of developing the measuring instrument, we have benefited from some other studies. (Myers et al., 2004; Thornber et al., 1999; Yeung et al., 2004; Yılmaz, Sipahioğlu & Yıldız, 2005). In the first stage, it was consisted of 20 statements; however pilot study showed us that some of the statements were not suitable. Some of them were considered to be modified with respect to some field expert opinions, but the ones that could not be modified were removed completely. Finally, a scale which was consisted of 17 statements was decided to be the instrument of data collection for this study. The instrument with its first form was also applied to a group of 60 students who had the same properties as the sample. According to the data gained from this application, the statements in the instruments that had to be changed were modified. Opinions of experts were taken for content validity of statements. These experts were determined from the scientists who carried out some valuable studies about these subjects. The reliability of the survey was calculated as  $\alpha=0.70$ . The main goal of this research is to examine the level of knowledge of pre-service teachers about air pollution. For this reason, the instrument used to determine knowledge levels provides necessary information about validity and reliability of the research. According to Karasar (2004), reliability is testability of results of a research by other researchers. Statistically, reliability takes a value between zero and one. As this value tends to (1.00), reliability is assumed to be high. In this research, the reliability coefficient of the instrument used determining knowledge levels of pre-service teachers about air pollution is computed as  $\alpha = .70$ . This value proves the reliability of the results of the research and also shows that it is appropriate for social sciences studies (Büyüköztürk, 2007). The content validity of a research is about whether the questions in the instrument are eligible and whether it represents the area which wanted to be measured. Content validity is determined through expert ideas (Karasar, 2004). For the validity concept of this study, the content validity is investigated and the research is carried out via making necessary revisions under the opinions of experts.

The instrument was consisted of 17 statements; 5 were about pollutants of air, 5 were about sources of air pollution and 7 were about adverse effects of air pollution. There are both true and incorrect statements about air pollution in the scale. According to the answers given to the each statement, it is determined that whether the pre-service teachers have misconceptions. For example, we assume that, if a participant says true to a wrong statement or says false to a true statement, he or she has misconception about this statement. True answers worth "1" points, false and empty answers worth "0" points in the assessment of the questionnaire. The maximum score of the test is "17" points. Obtained data were analyzed by SPSS program. By being practiced for independent groups "t" test, one-way ANOVA test, frequency, percent analysis quantitative information were used. According to the findings, the misconceptions of the pre-service teachers were determined and the effects of their daily lives on these misconceptions



were discussed with respect to their answers. Independent t-test was conducted to evaluate statistically differences among total scores of pre-service teachers with regard to gender.

## Results of Research

The answers of the pre-service science teachers to the statements in the scale are briefed at Table 1, Table 2, and Table 3. Each statement in the topics is discussed under their topics. Table 4 shows the test results which indicate the variation of overall scores of pre-service teachers according to the gender and Table 5 shows ANOVA results which indicate the variation of scores of pre-service teachers according to the grade levels.

### *Pollutants of Air*

Table 1 shows the answers of pre-service teachers to the statements about "pollutants of air" along with the frequency and percentage results.

**Table 1. The distribution of the answers about "pollutants of air".**

STATEMENTS	True		False		Don't know	
	F	%	f	%	F	%
2. Sulphur dioxide (SO <sub>2</sub> ) is not a primary air pollutant	90	19.5	234	50.6	138	29.9
5. Halogen compounds are not air pollutants	106	22.9	123	26.6	233	50.4
9. All oxidized compounds causes air pollution	97	21.0	253	54.8	112	24.2
13. CFC <sub>s</sub> is one of the primary pollutants which spreads on air directly	202	43.7	50	10.8	210	45.5
16. Carbon dioxide (CO <sub>2</sub> ) is one of the secondary pollutants which forms through some mechanisms at the atmosphere	247	53.5	118	25.5	97	21.0

As can be seen in Table 1, 19.5% of the participants have the misconception that "SO<sub>2</sub> is a primary air pollutant" where 50.6% of them think this is not true. Also, 29.9% of them picked the answer "don't know". For the statement 5, which says "Halogen compounds are not air pollutants", 50.4% of them had no idea, 22.9% of them established an incorrect connection about the statement, while 26.6% of them picked true answer which shows their awareness. When we look to the answers of statement "All oxidized compounds causes air pollution", 21.0% of pre-service teachers are aware that all oxidized compounds cause air pollution. However, 54.8% of the students are not aware of the statement or they have misconception because of their prior knowledge which are not true. For the statement 13, the percentage of the pre-service teachers who have the misconception that "CFCs is one of the primary pollutants which spreads on air directly" is 43.7%, and 45.5% have no idea about this. Only 10.8% of them think that this not a correct correspondence. Considering the statement 16, the percentage of the pre-service teachers who did not accept the statement and chose the true answer is 25.5%. However, a high percentage of pre-service teachers (53.5%) have misconception.

### *Sources of Air Pollution*

Table 2 shows the answers of pre-service teachers to the statements under the topic of "sources of air pollution"



**Table 2. The distribution of the answers about "sources of air pollution"**

STATEMENTS	True		False		Don't know	
	f	%	f	%	F	%
4.Exhaust gases of vehicles spread CO	379	82.0	50	10.8	33	7.1
7. Hydrocarbons form due to the agricultural activities	127	27.5	118	25.5	217	47.0
11.One source of the CFC <sub>s</sub> is the plastics manufacturing industry	286	61.9	23	5.0	153	33.1
14. CO does not form due to the agricultural activities	153	33.1	172	37.2	137	29.7
15. Nitrogen oxides which are spread from motor vehicles cause acid rain	379	82.0	41	8.9	42	9.1

If we examine the Table 2, the results showed that 82% of pre-service teachers gave the answer "yes" to the 4<sup>th</sup> statement and they have the correct idea. On the other hand, 10.8% of them said "no" and proved the misconception that they do have. Also, 7.1% of them pointed out that they do not have any idea about this statement. For the answers of statement 7, it can be explicated that 47% of students do not have any idea about the statement "Hydrocarbons form due to the agricultural activities" and 25.5% of them have an incorrect connection about this subject. We look to the answers of statement 11, 61.9% of students are aware that one of the sources of CFC<sub>s</sub> is the plastics manufacturing industry, 33.1% of them are not aware about the subject or could not match these 2 conditions directly. According to the statement "CO does not form due to the agricultural activities" which is the statement 14; it can be deduced that 33.1% of pre-service teachers gave false to this statement and have misconception. It is seen that 37.2% of these pre-service teachers gave true answer. The fewest misunderstanding was seen at the statement 15. Only 8.9% of the pre-service teachers said that the statement "Nitrogen oxides which are spread from motor vehicles cause acid rain" is wrong and these have some misconception. However, an high percentage (82.0%) of the students marked the true answer and showed that they have the correct perception.

#### *Adverse Effects of Air Pollution*

Table 3 shows the answers of pre-service teachers to the statements under the topic of "adverse effects of air pollution"

**Table 3. The distribution of the answers about "adverse effects of air pollution"**

STATEMENTS	True		False		Don't know	
	f	%	f	%	f	%
1.CO causes the reduction of O <sub>2</sub> in the blood	380	82.3	47	10.2	35	7.6
3.Ozone (O <sub>3</sub> ) causes the plant in toxication	186	40.3	112	24.2	164	35.5
6.Particulate substances which are formed owing to the industrial processes cause climate change	359	77.7	39	8.4	64	13.9



STATEMENTS	True		False		Don't know	
	f	%	f	%	f	%
8.Usage of fossil fuels do not cause climate change	99	21.4	287	62.1	76	16.5
10.Hydrogen sulphur causes digestive system diseases when it spreads into a few portion of air	178	38.5	25	5.4	259	56.1
12. Hydrocarbons do not have cancerogenic effects	55	11.9	215	46.5	192	41.6
17.Metals which are released through leaded oils do not have any effect on health	25	5.4	354	76.6	83	18.0

In terms of Table 3, which is about the adverse effects of air pollution; investigating the statement 1, we observe that 82.3% of pre-service teachers marked the true answer, 10.2% of them marked the false and 7.6% of them said "don't know" about the statement "CO causes the reduction of O<sub>2</sub> in the blood". There is a positive awareness amongst pre-service teachers about CO which is a very dangerous gas for health. For the percentages of answers for statement 3, 40.3% of pre-service teachers are aware of ozone's toxic effect on plants, where 35.5% are not aware of condition and 24.2% of them have misconceptions due to the prior knowledge. The statement 6 indicates "Particulate substances which are formed owing to the industrial processes cause climate change". 77.7% of pre-service teachers said "yes" and showed their correct perception, 13.9% said don't know, and a small percentage (8.4%) said "no" and presented their misconceptions. Again the high percentage shows the teachers' awareness again. For the statement 8 of the topic adverse effects of air pollution, 62.1% of the students said "no" to the statement "Usage of fossil fuels do not cause climate change" and thus they showed their awareness. 21.4% of them said "yes" and 16.5% said "don't know". As we examine the statement 10, 38.5% of the pre-service teachers said "Hydrogen sulphur causes digestive system diseases when it spreads into a few portion of air", but 56.1%, which is about the half of participants, could not match the conceptions. Only 5.4% gave false. With regard to the 12<sup>th</sup> statement, it can be said that 11.9% of students have misconception, because they said "yes" to this statement. However, 46.5% said "no" to this statement and showed their correct ideas. 41.6% of them have no idea about the statement. Finally, according to the results about this statement "Metals which are released through leaded oils do not have any effect on health", a very high percentage (76.6%) of the teachers are aware of the falsity of the statement and said "yes". On the other hand 5.4% of them have misconception and 18% of them have no idea.

In order to determine whether the overall score taken from the scale differs or not according to the gender, independent groups t-test was carried out and results are shown in Table 4.

**Table 4. T-test results of overall scores of pre-service teachers according to the gender**

Gender	N	$\bar{X}$	S	Sd	t	p
Female	325	8,66	2,53	459	-1,922	0,086
Male	137	9,18	2,91			

According to the Table 4, overall scores of pre-service teachers do not have a significant difference statistically, according to the gender ( $t_{(459)} = 1,922$ ,  $p > 0.05$ ). Again, according to these results, male and female pre-service teachers have analogous level of knowledge and misconceptions about sources of air pollution, pollutants of air, and adverse effects of air pollution.



The one-way ANOVA test was then used to determine whether there were significant differences among pre-service science teachers from different class levels. The significant level was calculated in between 95% intervals of reliability.

One-way ANOVA test was conducted to evaluate statistically differences among total scores of pre-service students with regard to class level and results were presented in Table 5.

**Table 5. The ANOVA results of the scale scores of pre-service teachers according to class levels.**

	Sum of squares	Df	Mean square	F	Sig.	
Between Groups	90,487	3	30,162	4,341	0,005	III-II
Within Groups	3182,344	458	6,948			
Total	3272,831	461				

According to the Table 5, there is a significant difference among overall scores taken from the scale and grade level [ $F_{(3-458)} = 4,341, p < 0.05$ ]. With respect to the Scheffe test results which was carried out for defining the differences of groups, we see that III grade ( $\bar{X} = 9, 27$ ), pre-service teachers are more successful than the II grade pre-service teachers ( $\bar{X} = 8, 42$ ).

We brief below the Table 6 which includes the answers that have high percentage. The statements within the column "true" indicates knowledge levels of pre-service teachers, the column "false" shows their misconception and the column "don't know" denotes the insufficient knowledge of pre-service students about that statement.

**Table 6. Answers that have high percentage.**

True	%	False	%	Don't know	%
Sulphur dioxide (SO <sub>2</sub> ) is not a primary air pollutants	50.6	CFC <sub>s</sub> is one of the primary pollutants which spreads on air directly	43.7	Halogen compounds are not air pollutants	50.4
Exhaust gases of vehicles spread CO	82.0	Carbon dioxide (CO <sub>2</sub> ) is one of the secondary pollutants which forms through some mechanisms at the atmosphere	53.5	CFC <sub>s</sub> is one of the primary pollutants which spreads on air directly	45.5
One source of the CFC <sub>s</sub> is the plastics manufacturing industry	61.9			Hydrocarbons form due to the agricultural activities	47.0
Nitrogen oxides which are spread from motor vehicles cause acid rain	82.0			Hydrogen sulphur causes digestive system diseases when it spreads into a few portion of air	56.1
CO causes the reduction of O <sub>2</sub> in the blood	82.3			Hydrocarbons do not have cancerogenic effects	41.6



	True	%	False	%	Don't know	%
Particulate substances which are formed owing to the industrial processes cause climate change		77.7				
Usage of fossil fuels do not cause climate change		62.1				
Metals which are released through leaded oils do not have any effect on health		76.6				
Hydrocarbons do not have cancerogenic effects		46.5				
All oxidized compounds causes air pollution		54.8				

## Discussion

During decade, researches about current environment problems were done which were involving students, young people and pre-service teachers. The results of the research revealed that the level of knowledge of these people about the substances which cause environmental pollution and the damage they do to the environment is low (Yeung et al., 2004; Pekel, 2005). They also have various misconceptions due to the incorrect information.

The results of this study suggested that although Turkish pre-service science teachers' have some basic knowledge about "pollutants of air", "sources of air pollution" and "adverse effects of air pollution", most of them have misconception due to the incorrect information. They do not have any knowledge about some pollutants and their effects. The knowledge of pre-service teachers about environment problems which are possessed during their education is not consistent with the ones obtained from other sources (family, visual and printed media, social surroundings...etc). This contradiction leads them to obtain misconceptions about environment problems.

About half of the pre-service teachers said this statement is not true and thus we can say that there could be so many reasons under their thinking. We can say that either the participants couldn't match these phrases or they do not have any knowledge about the oxidized compounds and their effects. Most of the participants have incorrect information about the statement "CFCs are primary pollutant gases" and nearly half of them do not have any idea about CFCs. Nearly half of the students showed that they have correct information about these gases. However, it is always discussed at visual and printed media and at text books that CFCs are gases which released from perfumes and refrigerators. This information could be the reason of true answers of half of the participants. Khalid (2001) stated that half of the students have correct knowledge about the source of CFCs. In another study which was carried out by Yeung et al., (2004), it was revealed that students at different age groups have a misconception that CFCs is a gas existing in the atmosphere. These results are inversely proportional with the increasing age groups (51%, 45%, and 39%). In other similar studies, it was revealed that most of the participants do not have knowledge about "what is CFCs" and "what its effects are" (Thorner et al., 1999; Papadimitriou, 2004).

We found that participants think "CO<sub>2</sub> doesn't exist in the atmosphere naturally" and this suggest an





important misunderstanding. The basic role of this atmospheric gas is to have a key position for plants to carry out their photosynthesis. However, as industrial process and fossil fuel consumption increased at recent years, it becomes one of the primary pollutants in the air. The reason of the misunderstanding of pre-service teachers about CO<sub>2</sub> to be a secondary pollutant could be that they matched it with other secondary pollutants like SO<sub>2</sub>, NO<sub>2</sub>, CO and the recent events stated above. In the study of Khalid (2001), more than half of the participants stated that; "CO<sub>2</sub> exists in the atmosphere with a high ratio, this gas forms due to the respiration of animals and plants, consumption of fossil fuels, motor vehicle exhaust gases and so it is a secondary pollutant". In another research which was carried out by Myers et al., (2004), 34% of the participants stated that CO<sub>2</sub> doesn't exist in unpolluted air and it exists in the atmosphere as a pollutant with a high ratio. All these misconceptions are determined within that study. In the study of Yeung et al., (2004), 22% of students stated that the increase of CO<sub>2</sub> in the atmosphere from current ratios to higher would not effect the environment negatively and this shows that they have some misconceptions. On the other hand, 48% of them did not accept that statement.

Less than half of the students gave the true answer to the statement "Hydrocarbons do not have any effect on health, especially on one of the most challenging medical problems, cancer". The amount of participants which could not match the carbon originated pollutants and their effects on health are high too. As hydrocarbons, which are formed due to the human activities, spread into the atmosphere, the ozone layer can not filter the harmful ultraviolet rays of the sun enough and it causes skin, lung and other kinds of cancer in humans. Almost half of the students did not mention any idea about whether the halogen compounds which exist in the atmosphere as gases are pollutants or not.

On the other hand, most of the students stated that they do have correct knowledge about sources of CO and there is a high awareness about its' adverse effects on living-things too. When Yeung et al., (2004) investigated the level of knowledge of students at different age groups about CO; they found that "don't know" answer decreased as the age increased. Thornber et al., (1999) also revealed similar results in their study. They found that more than half of the participants do not have knowledge about whether the pollutants like hydrogen sulphur have effects on digestive system or not. Namely, most of them are aware of the adverse effects of metals on health. According to the results of the study of Myers et al., (2004) which was carried out with students at different age groups, it was seen that more than half of the students have correct knowledge that air pollution caused by pollutants such as hydrogen sulphur, acid oxide and SO<sub>2</sub> can cause stomach diseases. However, the number of the students who confirm this statement is inversely proportional with the increase of age (50%, 49%, and 33%). The results of the study of Yeung et al., (2004) state the exact opposite. Only 21% of the students at different age groups stated that air pollution can cause stomach diseases. However, declining the relationship between stomach disease and air pollution is inversely proportional with the increase of age groups (56%, 41%, and 38%).

The participants are seemed to have correct knowledge about the SO<sub>2</sub> gas. Similar results reported in the study of Michail et al., (2007) which was applied on primary school teachers that 47% of the participants have similar correct ideas.

This study also suggest that a very high percentage of the participants have correct ideas about the gas NO<sub>2</sub> (the highest level of knowledge among all statements) which have an important role in the formation of acid rains. So, most of the participants are aware that the formation of acid rain is not a natural process and is a consequence of human activities. It was that 66% of Greek primary school teachers are aware that the formation of acid rain is a result of human activities (Michail et al., 2007). In the study of Khalid (2003), students are asked to answer the question whether the consumption of fossil fuels causes acid rains or not. 96% percentage of students marked "yes" which the true answer is. The most important reason of these true answers is enough prior knowledge of students (Bahar, 2000). The percentage of true answers given to a similar question is 68% in the study of Khalid (2001). Students may have some misconception due to the misunderstanding. In the study of Myers et al., (2004), it was implied that 47% of students have a misconception that they consider the formation of acid rains as a complete natural process. As a last note, it is seen that most of the participants are aware that pollutants which are formed due to the human activities cause climate change. Similar results for climate change are reported by other studies (Papadimitriou, 2004; Groves & Pugh, 1999; Dove, 1996; Khalid, 2003).



According to the obtained results, environment problems which occur due to industrial activities are in the core of pre-service teachers' knowledge about air pollution. Although, the pollutants like SO<sub>2</sub> and NO<sub>2</sub> are known by pre-service teachers, they have unsatisfactory knowledge about CO, CFCs, hydrocarbons and hydrogen sulphur, their mechanism and the damage they gave to the environment. Many studies supported our results and our results supported them (Grodzinska-Jurczak et al., 2006; Soran et al., 2000; Yilmaz et al., 2002).

Environmental problems (especially air pollution) are often emphasized in the visual and printed scientific media. The effect of CFCs to the greenhouse effect, the effect of SO<sub>2</sub> and NO<sub>2</sub> to the acid rains and the effect of CO to the asthma and other diseases are examples which are commonly used in the media (Thorner et al., 1999). Most of the pre-service teachers gain information about the air pollution events like ozone layer depletion, greenhouse effect, and acid rains from their families, media and especially from their social surroundings. Consequently, they have misconception. Since they learn these events from non-scientific sources, they are unable not match the conceptions and confuse them. For example, there is a general confusion that greenhouse effect is a consequence of ozone layer depletion (Dove, 1996). Our results support many earlier studies (e.g. Andersson & Wallin, 2000; Bahar, 2000; Boyes et al., 1993, 1995; Dove, 1996; Khalid 2001, 2003). For example; according to the study of Michail et al., (2007), 69% of teachers matched the concepts of greenhouse effect and ozone layer depletion wrongly. These environment problems (such as ozone layer depletion) are very complicated and difficult to comprehend in many aspects (Pekel, 2005). Consequently, understanding, comprehension and concluding these problems are highly difficult among students as well as pre-service science teachers (Groves & Pugh, 1999). Cordero (2001), which is about Australian students' understanding of ozone layer depletion, found that most of the students have misconception as the ozone hole is above the Australia and therefore skin cancers are common. This matching of students may be due to adjacency of Australia to the Antarctic ozone hole. Furthermore, students have a little information about CFCs, aerosol and their sources. Our results support the results of earlier studies (Groves & Pugh, 1999; Leighton & Bisanz, 2003; Pekel & Özay, 2005).

The test scores of pre-service teachers did not show a significant difference in gender ( $t(459) = 1,922, p > .05$ ). Based on the result, male and female students have similar knowledge. Similar results have been presented by many researchers in recent years, e.g. (Tosunoglu, 1993; Riechard & Peterson, 1998; Littlelyke, 2004; Pekel & Özay, 2005; Tuncer, Ertepinar, Tekkaya & Sungur, 2005; Alp, Ertepinar, Tekkaya & Yilmaz, 2006). However, according to the relationship between the overall scores and grade level, the 3rd grade pre-service teachers' level of knowledge is higher than the 2nd year pre-service teachers [ $F(3-458) = 4,341, p < 0.05$ ]. Through the obtained results, one reason of success of 3rd grade pre-service teachers may be that the "environmental education" course is being studied at this grade. It means the acquisitions of the course are new and not forgotten yet. But it should be considered that education given is fully theoretical. For efficient and consistent learning, from pre-school education to all levels, applied environmental education should be thought along with the theoretical learning. Together with the cognitive knowledge level of pre-service teachers, their effective and psychomotor skills should be considered too. Consequently, these people would be educated as informative, representative and aware about environmental problems and things to do. There are also similar studies in the literature. For instance, at the study of Pekel & Özay (2005), researchers observed that first year and final year students have different knowledge levels about ozone layer depletion which is a sub-dimension of environment pollution

Most of the studies revealed the fact that unscientific media has a very effective role on people's (including students, teachers and general public) conceptions about environmental issues (Daskolia & Papageorgiou, 2006; Yilmaz et al., 2002). These people's main access to this knowledge consists of the knowledge gained from unscientific media. However, the study which was held by Daskolia & Papageorgiou (2006) showed that this information contain some misconception and erroneous facts and can lead people to acquire some invalid conceptions about environment issues. Another research which was held by Yilmaz et al., (2002) also showed that 46% of high school and college students gained their knowledge about environment and environment pollution through printed and visual media. According to these results the necessity of using devices such as radio, television and compu-



ter more correct and efficient was suggested. Consequently, the knowledge about the environment and environment problems which are gained through media and far from the scientific knowledge, lead students to misconceptions about these concepts even if these knowledge are highly accurate and correct (Boyes et al., 1995). According to most of the researchers, the knowledge of environment and environment education of pre-service teachers and especially preschool, primary and secondary school pupils where the basis of environmental education was established was gained from firstly parents, then from their environment and personal experiences.

According to Adler (1992), the knowledge which is obtained through visual and printed unscientific media contain misconceptions and incorrect information. In the learning of such complicated issues these invalid knowledge lead students to have misconceptions in further periods. For this reason, applied environmental education courses should be added to the science education department curriculum along with the theoretical courses. Taking these courses at undergraduate level enables teachers to feel themselves sufficient about environmental education and to do a more effective teaching.

### Implications for Teaching Teachers

High levels of environment consciousness and awareness is necessary for living in a healthier and safer world for all people around the world. These levels could only be achieved by environmental education which is supported by enough knowledge about technological developments and parallel environment problems. Teachers have a very important role when educating the future generations about the global environment problems which have reached international dimensions.

The research studies about the environmental problems have shown us that, individuals equipped with many misconception and far to the future threatening environmental problems were grown up along with the misconceptions which are not gained from school at all levels of education (Brody, 1991; Khalid, 2001; Papadimitriou, 2004; Yeung et al., 2004). The roles of audial, visual and printed media are implied by many researches. For example; according to a research in USA, primary school students obtained 63% of their knowledge about environment from visual and printed media. However the percentage of school is 12% and the family and the friends is 9% (Brody, 1991). Pre-service teachers are in confusion whether the pollutants CFC<sub>s</sub>, ozone, SO<sub>2</sub> and NO<sub>2</sub> are pollutants or not. In order to prevent pre-service teachers should be informed enough about the effects and activities of these pollutants and what should be done. In the period of education of pre-service teachers, under consideration of these facts, misconceptions and prior knowledge should be determined from first 2 year and teaching methods should be developed according to these data. For example, it is hard to teach the abstract concept "air" only with experimental methods. Knowing the prior ideas of students about the effects of air pollution on human health and nature enables teacher to make more effective class discussions and to give the science curriculum more efficient (Yeung et al., 2004). According to the Leighton & Bisanz (2003), there are similar problems in teaching the abstract concept "ozone layer". Bounded with the general knowledge level of students, teachers can use visual materials to help students to understand relationship between constituents of ozone layer. Teaching of acid rains is similar too. Firstly, acid rains should be thought as a fact which damage trees and buildings. Then, SO<sub>2</sub> should be thought as a gas that causes acid rain and relationship between them could be given (Yeung et al., 2004).

If we wish to educate people who are more informed and aware of this issue firstly, pre-service teachers should get a rich and qualified environmental education within their university education. Hence, their misconception concerning environment problems could be reduced through application of various education methods within the classroom. For this reason, applied environmental education courses should be added to the science education department curriculum along with the theoretical courses. Taking these courses at undergraduate level enables teachers to feel themselves sufficient about environmental education and to do a more effective teaching.



## Acknowledgement

We wish to thank all of the participants who completed the questionnaire and Aytekin Çıbık for his help.

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Received 04 November 2008; accepted 15 February 2009.

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