

# COGNITIVE PERCEPTIONS OF PRE-SERVICE SCIENCE TEACHER FOR ENVIRONMENTAL POLLUTION

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## Introduction

Human beings are social creatures and they need technologies to make their lives easier in society and products to meet their needs. These needs cause more consumption and pollution. In this century followed by industrialization and technological developments, the concept of 'environmental education' emerged as a new education field with the realization of the negativities the environmental problems cause. Environmental education is defined as the primary way of cognitive, affective and behavioral change that has become essential for human beings to maintain their lives without destroying nature (Ozdemir, 2016). Environmental education aims to raise individuals who can absorb the habitats of living creatures, the elements that make up the environment and the relationships between these elements, have a level of awareness to prevent the deterioration of natural life, and take responsibility for environmental issues (Genc & Karabal, 2016).

Human forms an inseparable whole with the environment in which it lives, and therefore it is an inevitable fact that human interacts with nature. Human beings benefit from nature and change nature according to their needs if need be in order to maintain their lives. As a result of using nature one-way use contemptibly, environmental problems which are very hard to reverse have emerged. Especially with science and technology developing rapidly, overpopulation, industrialization, unplanned urbanization, etc. have caused these problems to snowball every day. Environmental issues that these problems cause have become a problem that has started to concern the whole world. For this reason, environmental problems have often started to take place on the world agenda (Fereidoun et al., 2007; Kocatas, 2003).

Environmental pollution comes to mind first when it comes to environmental problems. Environmental pollution as undesirable consequences surfacing as smell, noise, and waste as a result of the deterioration of ecological balance occurring in the air, water, and soil as a result of human activities (Briggs, 2003; Kocatas, 2003). These pollutions have reached more remarkable dimensions in cities where industrial establishments are concentrated (Kromm, 1973). Excessive pollution adversely affects human, animal and plant health and diversity, especially tropical rain forests (Tropical Rainforest Animals, 2008).



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**Abstract.** *This research aims to determine cognitive structures about environmental pollution of pre-service science teachers and their perceptions of the most important environmental pollution in their lives. Data have been obtained from 33 pre-service science teachers. In this research, both quantitative and qualitative research methods were used together. Data is collected with word association test, open-ended questions, and drawing technique. The data obtained were analyzed using descriptive analysis and content analysis methods. According to the data obtained from the word association test, environmental pollution was put into four categories. These categories are 'sources of pollution', 'types of pollution', 'consequences caused by pollution' and 'those affected by pollution'. The pre-service teachers drew mostly air pollution and then water and soil pollution in their drawings. Similarly, pre-service teachers wrote mostly air and water pollution as the most important environmental pollution. The majority of the pre-service teachers were seen to have the perception that humans cause environmental pollution. However, it was determined that some pre-service teachers hardly mentioned the extent of pollution over other living things.*

**Keywords:** *cognitive perception, drawing technique, environmental pollution, pre-service science teacher, word association test.*

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Numerous methods and techniques are used in order to reveal the cognitive perceptions of students and pre-service teachers. Questionnaire, drawing technique, interview, concept maps, word association test, and metaphor are examples to these (Bahar et al., 2008). Word correlation test and drawing technique are often used in determining the cognitive structure recently. The related techniques are stated to be quite successful in revealing the conceptual structure (Bahar et al., 2008; Hovardas & Korfiatis, 2006).

### *Research Focus*

When the literature related to environmental problems and pollution is examined, it is seen that there are various research. The research were conducted with pre-service teachers or primary school students (Aydın, 2010; Badem, 2010; Cabuk & Karacaoglu, 2003; Cetin, 2015; Eroglu & Aydogdu, 2016; Erol & Gezer, 2006; Ersoy & Turkkan, 2010; Erturk, 2017; Ibis, 2009; Ignaccolo, 2000; Khalid, 2003; Negev et al., 2010; Ozsoy & Ahi 2014; Papadimitriou, 2004; Pinar & Yakısan, 2017; Sadik et al., 2011; Turkum, 1998; Yakışan et al., 2013; Yalcinkaya, 2013; Yardımcı & Bağcı Kılıç, 2010; Yılmaz et al., 2002). There is not much research on pre-service science teachers in this field. In one of the research, the opinions of pre-service science teachers about the environmental problem were tried to be determined using drawing, concept map and interview techniques. In another study, Arık and Yılmaz (2017) conducted a research on the pre-service science teachers' attitudes towards environmental problems and their metaphorical perceptions about environmental pollution, and they observed that pre-service teachers focus on to whom environmental pollution does harm, the type of damage environmental pollution causes, the effects of environmental pollution, and the process of environmental pollution. Pinar and Yakısan (2017), tried to determine the primary school students' perceptions of the environment by analyzing their drawings about the environment. They determined that the students mostly expressed that environmental pollution is caused by trash. Ozcan and Demirel (2019) conducted research on the cognitive structures of secondary school students by focusing on environmental problems such as acid rain, destruction of natural sources, global warming and the greenhouse effect. They determined that the students have the least knowledge about the greenhouse effect among environmental problems.

### *Research Aim and Research Questions*

The aim of this research was to examine the cognitive structures and perceptions of pre-service science teachers about environmental pollution using open-ended questions created to determine the conceptual perception and word association test together. Although humans are aware of environmental pollution, pollution continues to increase all over the world. In order to reduce environmental pollution, it is necessary to create a behavior change from childhood. For this reason, the perception of the environmental pollution of pre-service science teachers who will educate our children has been tried to be determined. In line with data obtained, it is hoped that it will be possible to train teachers who are sensitive to environmental pollution and also to improve the environmental pollution issues in the environmental education curriculum. Within the scope of this research, the questions:

1. What are the concepts in pre-service science teachers' cognitive structures about environmental pollution?
2. How do they define environmental pollution?
3. What is the most important environmental pollution according to pre-service science teachers?

It is thought that an important contribution to the literature can be made in this field with this research.

## **Research Methodology**

### *General Background*

In this research, phenomenology design which was one of the qualitative research methods was used. With phenomenology design, the thoughts of those who experience a particular phenomenon or event was examined in-depth in their own environment (Ger, 2009). In qualitative research, perceptions and events were observed realistically without disintegrating (Seale, 1999). During the research, the language, concepts, and personal meanings the participants use was revealed and thus what their experiences mean to them can be determined (Ekiz, 2015).

The research was carried out at the end of the spring term. The reason for this is that the environmental education course takes place in the spring term.



### *Participants*

The research group consisted of 33 3<sup>rd</sup> (8 female, 2 male) and 4<sup>th</sup> grade (18 female, 5 male) pre-service teachers studying in the department of science teaching at Mustafa Kemal University Faculty of Education. The participants were composed of a small sample group selected for the purpose of qualitative research. In sample selection, convenience sampling, which was one of the purposeful sampling methods, was used. In phenomenology design, individuals who experience and can express this phenomenon should be selected (Yıldırım & Simsek, 2016). For this reason, the participants were selected from 3<sup>rd</sup> and 4<sup>th</sup> grade pre-service teachers who took the environmental education course. It was explained that the purpose of the research, the results will be used only for scientific purposes and their personal information will not be disclosed in the research before the data collection tools were distributed to the participants. The participation was carried out after obtaining conscious consent on a voluntary basis. Also, it was not insisted on the pre-service teachers who did not want to participate in the research.

### *Instrument and Procedures*

Word association test and open-ended questions created to determine conceptual perception were used together as the data collection tool in this research. Within the scope of the research, the data collected by using more than one data collecting tool are thought to support each other.

#### Word association test

Within the scope of this research, the pre-service science teachers applied a word association test about 'environmental pollution' first. Word association tests help determine the cognitive structures of individuals, the connections and relations they establish between concepts (Basol, 2016). When word association tests are used, basic concepts related to the subject are chosen and the students are asked to list the words that concept evokes. Thus, it is possible to have an idea about the subject by looking at the number of words that the student associates with the basic concept (Basol, 2016). In this research, environmental pollution was presented as a stimulant word as below.

Environmental pollution .....  
 Environmental pollution .....  
 Environmental pollution .....  
 Environmental pollution .....  
 Environmental pollution .....

The pre-service teachers were asked to list the words environmental pollution evokes. The pre-service teachers were given 30 seconds for this (Bahar & Ozatlı, 2003).

#### Open-ended questions created to determine the conceptual perception

These questions consisted of three open-ended questions, one of which was a drawing, in order to reveal the conceptual association levels of the pre-service teachers related to environmental pollution. Research on the environment were examined while creating the questions (Erturk, 2017; Pınar & Yakısan, 2017) and they were put into final forms by consulting experts. Questions created to determine conceptual perception are as follows:

1. Define environmental pollution with one sentence.
2. Which environmental pollution is the most important for you? Why?
3. Can you draw a picture of pollution?

Pre-service teachers were not restricted for a certain period of time and were asked to answer questions comfortably. It took approximately 30 minutes.

### *Data Analysis*

Before analyzing the data, the papers collected from the pre-service teachers were numbered as S1,...S33. Word association test was analyzed using the content analysis. Content analysis coding and quantifying what individuals write or express (Balci, 2016; Starcks & Trinidad, 2007). In content analysis, the data are examined for



themes and codes that appear concurrently, and then the relations between the themes and codes are tried to be determined (Balci, 2016).

The words the pre-service teachers wrote in the word association test are categorized. The ones repeated once were excluded from the evaluation. The concepts taking place in each category were coded and their frequencies were determined afterward.

Open-ended questions were analyzed using the content and the descriptive analysis method. In the descriptive method, data are interpreted according to predetermined themes. The aim of descriptive analysis is to present the data to the reader clearly by organizing the findings (Yıldırım & Simsek, 2016). In this analysis method, the opinions of the interviewed people are included directly. The drawings of pre-service teachers are also categorized, and examples of these drawings are included in the research.

For reliability, the related data were checked by two academics from science and biology education field. It was used (agreement/(agreement+disagreement) $\times$ 100) formula of Miles and Huberman (1994) in order to ensure the consensus between the codes. The interpersonal consensus for the reliability of the research results is calculated as 94%. Different techniques such as word association technique and drawing technique were used together and the validity of the data was tried to be increased. In addition, the drawings that were not understood were confirmed by discussing with prospective teachers.

## Research Results

### *Findings regarding the Word Association Test*

The answers the pre-service science teachers gave in the word association test and the sentences they wrote were examined using content analysis method and four categories were determined for the concept of environmental pollution. The concepts repeated only once were not combined with the other concepts and these concepts were included in the comments section. Results obtained from the word association test were shown in Table 1.

**Table 1**

*Distribution of categories create for the answers obtained from the word association test*

Categories	Codes	Frequency (f)	Total Frequency
Pollution sources	Trash/waste	18	43
	Smoke	5	
	Human	5	
	Exhaust	3	
	Ignorance	2	
	Substances that do not decompose in nature	2	
	Factory gases	2	
	Fossil fuels	2	
	Fire	2	
	Toxic gases	2	
Types of pollution	Air pollution	11	31
	Water pollution	8	
	Noise pollution	8	
	Soil pollution	4	



Categories	Codes	Frequency (f)	Total Frequency
Consequences caused by the pollution	Disease	5	24
	Death	4	
	Acid rain	3	
	Food pollution	2	
	Imbalance	2	
	CO <sub>2</sub> gas	2	
	Odor	2	
	Global warming	2	
	Negativities	2	
Those affected by pollution	Life	5	19
	Environment	3	
	Ecosystem	3	
	Air	2	
	Health	2	
	Water	2	
	Soil	2	
Total	30 words		117

The most frequently used content in the *pollution sources* is 'trash/waste'. The reason for this might be that various publishing establishments, especially textbooks, and videos with course content, often contain trash and waste when depicting or painting environmental pollution.

'Ignorance', an abstract concept in the same category, was used by 2 students. The remaining concrete concepts were listed as 'smoke', 'human', 'exhaust', 'substances that did not decompose in nature', 'factory gases', 'fossil fuels', 'fire' and 'toxic gases'. Within the scope of the relevant category, 'cutting down trees', 'excessive irrigation', 'unawareness', 'earthquake', 'unnecessary fertilizer', 'unhygienic', 'human hand', 'hurricane', 'sewage', 'chemical', 'coal', 'perfume', 'nylon bag', 'industry' and 'public transport' were written once by the pre-service teachers.

Within the scope of *types of pollution*, the pre-service teachers wrote mostly the 'air pollution'. 'Water pollution', 'noise pollution' and 'soil pollution' followed this respectively. 'Radiation pollution' and 'visual pollution' were not included in this category as they were written once.

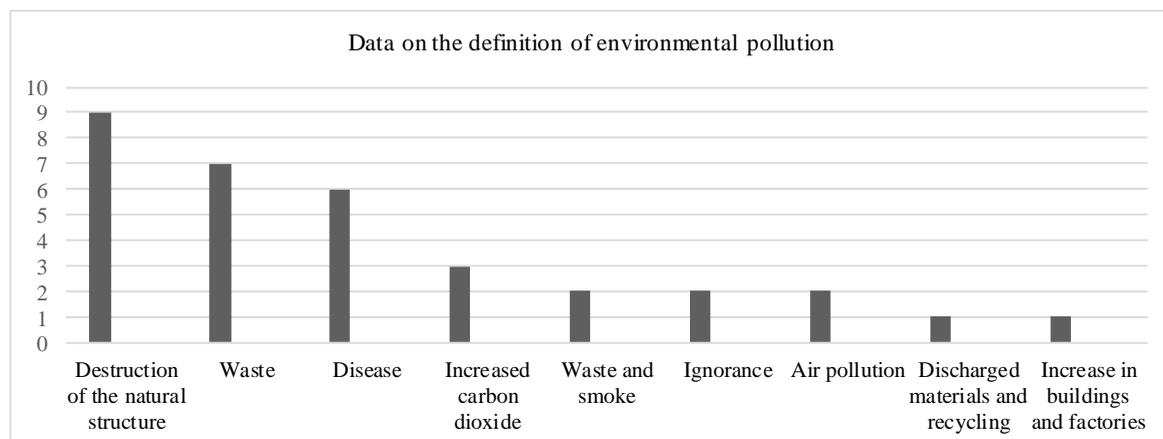
Concepts such as 'disease' and 'death' were written in *consequences caused by the pollution* category. These answers were listed according to their frequencies as 'acid rain', 'food pollution', 'imbalance', 'CO<sub>2</sub> gas', 'odor', 'global warming' and 'negativities'. The answers that were not included in the category as they were repeated once are 'acid rain', 'asthma', 'destruction of nature', 'disaster', 'greenhouse gases', 'fog', 'respiratory tract diseases' and 'danger'.

In *those affected by pollution* category, the pre-service teachers mostly emphasized: 'life', 'environment' and 'ecosystem'. The concepts included in this category are 'air', 'health', 'water' and 'soil'. The concepts excluded from the category as they were mentioned only once were 'awareness', 'sea', 'generation', 'O<sub>2</sub>', 'school', 'ocean' and 'ozone layer'.

#### *Findings of Open-Ended Questions Created to Determine Conceptual Perception*

The pre-service teachers were asked to define environmental pollution in the first question. The categories created for the pre-service teachers' definition of environmental pollution were given in Figure 1.



**Figure 1***Data obtain from pre-service teachers' definition of environmental pollution*

When the categories of the pre-service teachers' definitions were examined, it was found that they mostly pointed out 'destruction of the natural structure'.

It is the deterioration of the natural environment as a result of unnecessary interventions in areas such as soil, air, and water (S3).

The second most emphasized category is 'waste'.

It is an environmental problem in which people play a role, which threatens the living space of living things by polluting the environment (S23).

Environmental pollution is the threat of life by leaving trash and chemical wastes in soil and water (S32).

Some pre-service teachers were realized to have expressed that environmental pollution may cause 'diseases' and they emphasized that most.

Environmental pollution caused by the nylon bags people drop around, smoke and noise that comes out of their cars, and the odor of these cause diseases in human beings (S17).

People create a dirty environment by dropping litter around and various diseases may emerge in this unhygienic environment (S9).

In 'waste and smoke', 'ignorance' and 'air pollution' categories, the pre-service teachers mostly mentioned the negativities occurring in the air. They stated that environmental pollution is caused by people in the 'ignorance' category. Some pre-service teachers, however, were detected not to have mentioned the effect of pollution on other living creatures.

Water, land and air pollution are caused by the exhausts from the engines and people dropping their litter in rivers and on the roads and this harms the people again, the water they drink and air they breathe affect human lives badly (S26). Environmental pollution is a situation which affects human health badly and is performed by humans (S31).

The categories the pre-service teachers mentioned the least are 'discharged materials and recycling' and 'increase in buildings and factories'.

The answers the pre-service teachers gave to the second question which is 'Which environmental pollution is the most important one for you? Why?' are given in Table 2.



**Table 2***Pre-service teachers' views on the most important environmental pollution*

Categories	Codes	Frequency (f)	Total Frequency
Air pollution	Essential for life	8	12
	Negative impact on health	2	
Water pollution	Destruction of nature	2	10
	Essential for life	8	
Waste	Destruction of nature	2	3
	Death of creatures	1	
Human	Ignorance	2	3
	Selfishness	1	
Raising buildings in empty areas	No space to visit	1	1
Air and water	Essential for life	1	1
Air, soil and water	Destruction of nature	1	1
Pollution of public places	Cleanliness is required	1	1
Soil pollution	Food pollution	1	1

When the data in Table 3 were examined, it was seen that the most important pollution for the pre-service teachers was air pollution and water pollution. The pre-service teachers associated air pollution with respiration which is essential for life. They emphasized that no living creature could maintain their lives without air.

The most important pollution is air pollution. Living creatures need air to maintain their lives. Oxygen is very important for we can't survive without it for even 1 minute (S11).

It is air pollution. Because respiration is the source of life. Harmful gases entering our blood as we aspirate is dangerous (S21).

The category of water pollution was separated into two themes as 'essential for life' and 'destruction of nature'.

In my opinion, the most important pollution is water pollution. Because water is life. Without water, there is no life. If water is polluted, human beings will die (29).

The category of waste was also put into two categories as 'destruction of nature' and 'death of living creatures'.

Releasing harmful materials such as waste into the environment causes environmental pollution and the death of living creatures (S22).

The human category was separated into two themes as 'ignorance' and 'selfishness'.

The most important factor in environmental pollution is ignorant people. They act without thinking even though they have the capacity to think (S8).

People are disrupting the course of nature by making irreversible destructions because of their selfish behavior (S25).

The categories of 'raising buildings in empty areas', 'air and water', 'air, soil and water' and 'pollution of public places' were represented by only one theme.

The most important environmental pollution is raising buildings in all of the empty areas. Because when they are built, we are left with no environment to enjoy (S1).

The most important environmental pollution is air and water pollution. Because living creatures need water and oxygen to live (S15).

The answers the pre-service teachers gave to the third question which is "Can you draw the picture of pollution?" were given in Table 3.

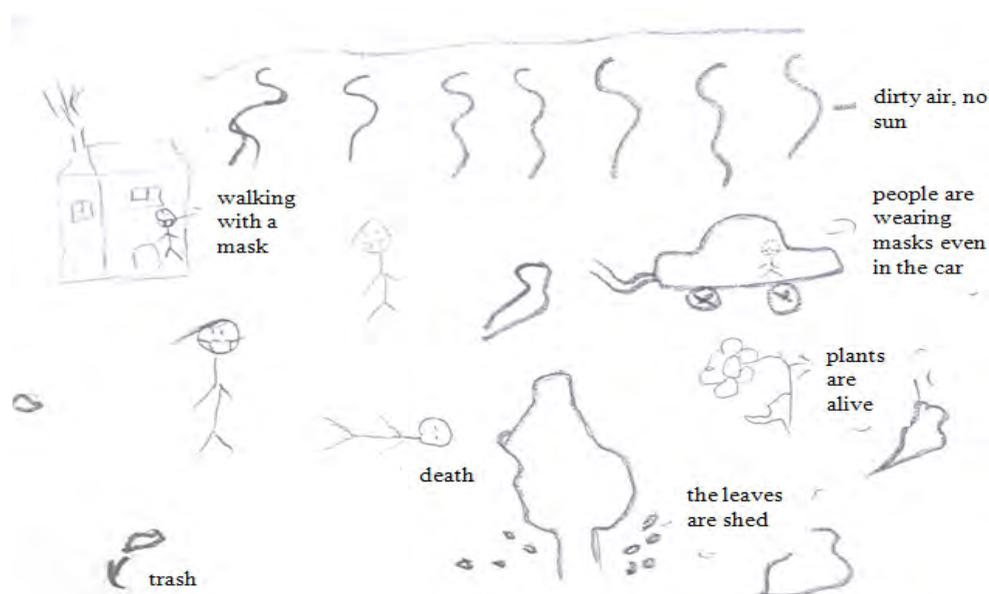


**Table 3***Categories and themes of pre-service teachers' environmental pollution drawings*

Categories	Codes	Frequency (f)
Air pollution	Smoke coming out of chimneys	13
Water pollution	Trash in the water	6
	Water mixed with sewage	1
Soil pollution	Waste	6
Air, soil and water pollution	Trash and smoke coming out of chimneys	6

When the data in Table 3 were examined, it was seen that the most important pollution for the pre-service teachers was air and water pollution.

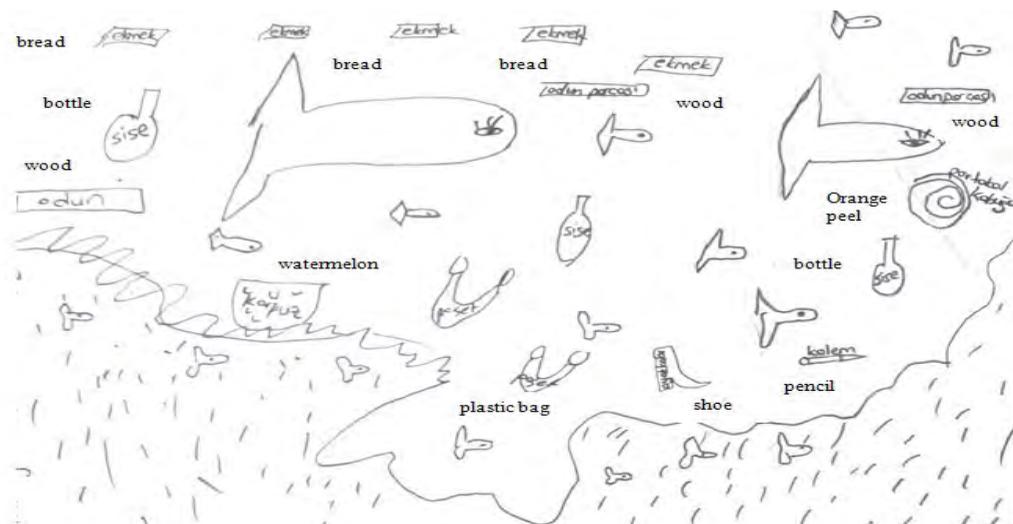
The pre-service teachers drew mostly 'smoke coming out of chimneys' in the air pollution category. They emphasized, 'trash in the water' and 'water mixed with sewage' in the category of water pollution.

**Figure 2***Drawing sample of pre-service teachers (S4)*

When the drawing in Figure 2 was examined, it was deduced that the pre-service teacher associated air pollution with foul air, no sun, misty air, fallen leaves. The pre-service teacher emphasized the consequences of the situation by foreseeing that as a result of increasing air pollution people would have to wear masks, plants would lose their liveliness, and people would die from airlessness.

**Figure 3**

Drawing sample of pre-service teachers (S2)



Wastes floating in the water was seen in the drawing of the pre-service teacher with code S2 (Figure 3). It is realized that the pre-service teacher mostly drew the materials that people use such as bread, bottle, watermelon, and orange peel. Based on the drawing, it could be said that the pollution of the aquatic environments was mostly caused by the trash people throw.

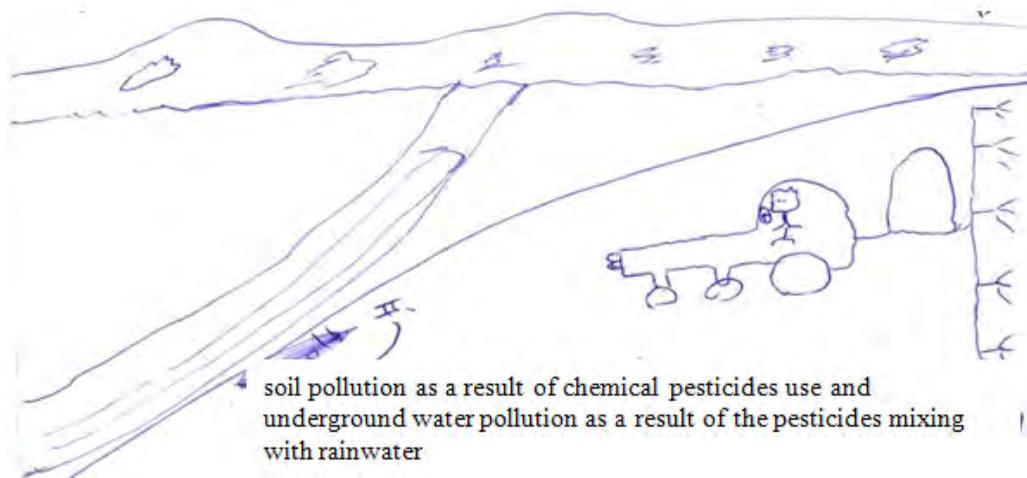
**Figure 4**

Drawing sample of pre-service teachers (S10)

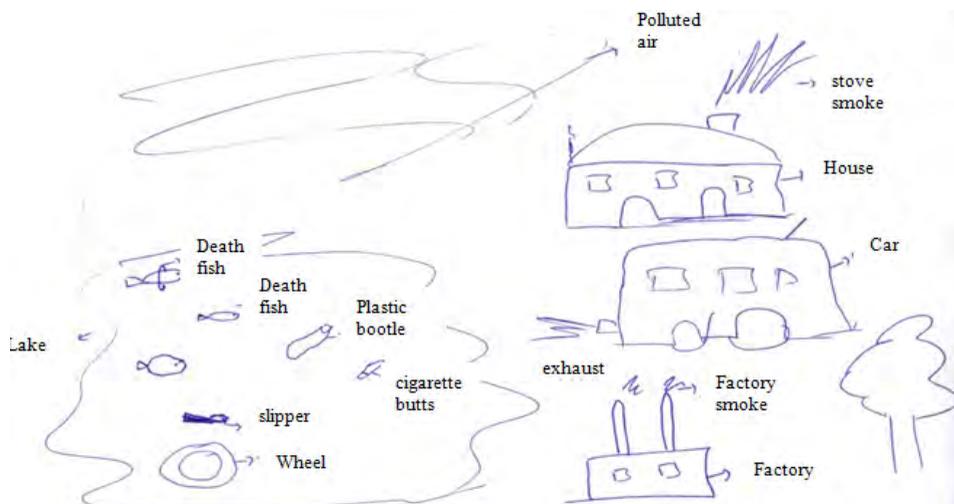


The pre-service teacher with code S10 drew people littering the ground instead of using trash cans (Figure 4). In addition, the pre-service teacher pointed out that people drop litter out of the windows of the cars.



**Figure 5***Drawing sample of pre-service teachers (S19)*

When the drawing in Figure 5 was examined it was seen that a person applying medicine on the soil was depicted. The pre-service teacher also explained the situation by writing and used the expression 'soil pollution as a result of chemical pesticides use and underground water pollution as a result of the pesticides mixing with rainwater'. It seemed that the preservice teacher was aware that pesticides could not only pollute the soil but also pollute the water.

**Figure 6***Drawing sample of pre-service teachers (S15)*

When the drawing in Figure 6 was examined, it was seen that the pre-service teacher mentioned both trash in water and fish that died and were harmed by the trash. Thus, the pre-service teacher tried to reveal the effects of the results of trash and waste on fish. The pre-service teacher showed air pollution with the expressions of 'stove smoke', 'factory smoke' and 'exhaust smoke' and emphasized this situation by writing 'polluted air'.

**Figure 7***Drawing sample of pre-service teachers (S13)*

The pre-service teacher depicted air pollution with smoke coming out of chimneys and soil pollution with trash scattered on the ground near the trash can (Figure 7). The pre-service teacher also tried to show water pollution by drawing dead fish washed up on the shore of a river. The element that grabs the most attention in the drawing was a stickman kicking a plastic bottle into the river. The perception that people polluted the environment intentionally awakens from this drawing.

**Discussion**

The pre-service teachers produced numerous answers related to environmental pollution. These answers were listed as *pollution sources*, *pollution types*, *consequences caused by pollution* and *those affected by pollution* according to their frequencies. It is seen that the answers such as trash/waste, smoke, human and exhaust are mostly included in the category of *pollution sources*. Similar concepts are seen in the research Yalçinkaya (2013) and Uyanık (2017) conducted. The answers given in the *pollution types* category were air pollution, water pollution, noise pollution, and soil pollution, respectively. OzataYucel and Ozkan (2016) stated that the pre-service teachers mostly wrote air pollution, pollution and water pollution in the category of types of environmental problems in the word association test they applied in order to determine their perceptions of pre-service science teachers about environmental problems.

When the sentences the pre-service teachers wrote are examined, it is seen that only one of these is positive and he stated what can be done to prevent this situation. *"One of the reasons for environmental pollution is waste; environmental pollution can be minimized as long as people are informed and with school education, people can become more informed and they won't harm the lives of living creatures, they will not break the balance in the ecosystem (S33)."* Gulum (2011) suggested that proper environmental education should be provided as a solution to environmental problems in her study.

The majority of pre-service teachers comprehend that environmental pollution is caused by humans. In the research Yalçinkaya (2013) conducted on environmental problems, it is seen that according to 8<sup>th</sup>-grade students the main reason for environmental problems is humans. In the research Uyanık (2017) took primary school students' opinions in environmental pollution, the majority of the students expressed that environmental pollution is *'the pollution caused by humans'*. However, it was determined that some pre-service teachers hardly mentioned the extent of pollution over other living things. These findings show that they have a very low perception of the environmental extents and effects on living creatures of environmental pollution. Demirtas and Pektas (2009), Gulum (2011), Ozata (2016) and Secgin et al., (2010) obtained similar results in the research they conducted.

The pre-service teachers answered mostly as air pollution, water pollution, waste, and human to the question of which environmental pollution is the most important. According to research Ozdemir et al., (2004) conducted,



according to medical students, the three most important environmental problems in the world are air pollution, waste, and reduction of forests. According to research Demirtas and Pektas (2009) conducted, they determined that primary school students see environmental pollution, air pollution and wastes as the most important environmental problem. In Yalcinkaya's (2013) semi-structured interview with 8<sup>th</sup>-grade students, it was determined that water and air pollution are the most important environmental problems according to the students.

When the pre-service teachers' drawings are examined, it is seen that they mostly drew about air pollution. The most distinguishing theme in their drawings is smoke coming out of chimneys. Smoke coming out of chimneys may have a negative effect on people's lives as the winters are cold in Turkey and natural gas is not available in many cities. This is even more striking in cities where industrial establishments are commonly found. Considering this situation, it can be considered natural for pre-service teachers to draw smoke from factories and houses. In the research Sadık, Cakan ve Artut (2011) conducted on 11-12-year-old children, it is seen that the children depicted environmental problems like air pollution mostly. Pinar and Yakısan (2017) asked primary school students to draw about environmental pollution and they expressed that the students mostly drew trash scattered around and smoke coming out of house and factory chimneys. Considering the majority of the drawings, trash scattered around, wastes, trash floating in the water and dead fish are mostly seen. Environmental pollution is often conceptualized with trash pictures. There are various research in literature similar to these findings (Kılcan & Çepni, 2015; Littledyke, 2004; Sadık et al., 2011). Kılcan and Cepni (2015) expressed that 8<sup>th</sup>-grade students often used the element of trash when depicting environmental pollution. Similarly, it was observed that teacher candidates drew the most trash, and smoke coming out of chimneys.

### Conclusions and Implications

In an environment where humans exist, it is not possible to wipe pollution out completely. For this reason, minimizing pollution or keeping it under control through consciously raised individuals will have positive results for the environment. In this respect, it is highly important to raise awareness in society and leaders of society. If the teachers, who are a role model in the training of students, are sensitive enough about environmental pollution, so will the individuals they train be.

In the light of findings of this research, it is very important that the pre-service teachers reflect what they learn in environmental education classes on their behaviors. For this reason, it should be ensured that pre-service teachers realize what they can do to prevent or correct environmental pollution. Pre-service teachers have drawn attention to people's selfishness. Therefore, the consciousness of "Nature does not need people, people need nature" should be taught. By drawing attention to the negative effects of environmental pollution on all living things, the course curriculum can be developed in this direction. In order to provide a deeper and more detailed knowledge of environmental pollution in the courses, the courses can be taught with various activities. In addition, pre-service teachers can be supported to find their own solutions by making projects for reducing the environmental pollution.

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