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Determination of the Cognitive Structures of 8th Grade Students Related to the Concept of "Air Pollution" through Word Association Test

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ABSTRACT

Foreign language education gained popularity with the globalized world and started to be offered as a compulsory course in primary schools for young learners. Following this, EFL (English as a foreign language) teachers were recruited in primary schools and had to manage several classrooms in a primary school environment each having a different primary school teacher and classroom culture. Primary school students are daily exposed to their primary school teachers' varying ways of teaching and classroom management at school, while they face the EFL teacher for two lessons in a week. Since learners may be used to their primary school teachers' style it was assumed that primary school students may react in distinct ways to the weekly EFL lessons. In this qualitative study, EFL teachers' beliefs about the influences of primary school teachers on the EFL lessons were investigated. For this purpose a semi-structured interview was conducted with 10 EFL teachers. In order to scrutinize the results, content analysis was profited from and emerging codes were discussed. The findings showed that, according to the EFL teachers, primary school teachers' teaching styles, attitudes, and classroom management strategies affected the EFL lessons and the students' behaviour patterns in the language classroom.

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INTRODUCTION

Environmental problems are one of the biggest problems that people face and seek solutions in our age. Environmental pollution is increasing day by day depending on the developing technology and socio-economic conditions. Global warming, greenhouse effect, depletion of the ozone layer, destruction of rain forests, deterioration of natural balance, air pollution, water pollution and soil pollution can be given as examples of global environmental problems (Tuna, 2000). Air pollution, which is an important element among the environmental problems, can be defined as the increase of pollutant factors that can be found in the atmosphere in the form of dust, gas, water vapour, smoke, and odour to a level that is harmful to humans, other living things and non-living things (Kırımhan, 2006). Air pollution is caused either by natural causes such as forest and vegetation fires, volcano eruptions and dust storms, or by various activities performed by human beings such as urbanization and industrialization. Air pollution, which directly affects humans, animals and plants, not only affects the living conditions of living things, but also causes deaths and extinction of species (Çakır Sümer, 2014). Such subjects as environmental pollution, human-environment interaction, local and global environmental problems and the negative effects of environmental pollution on human health were included in the science course curriculum published in 2018 (MEB, 2018).

The environmental education has an important role in preventing the environmental problems and helping people acquire positive attitudes and behaviors towards the environment. Unfortunately, unsustainable lifestyles hinder the resolution of environmental problems each passing day. For this reason, people should go through an effective training in environmental education in order to make more conscious decisions and take the required actions (Eroglu, 2009; Özcan and Demirel, 2019). A society where quality of life of future generations are secured with the protection of natural resources can only be possible with lifelong education provided for individuals both in formal and informal environments (Tuncer, Tekkaya, Sungur, Cakiroglu, Ertepinar, Kaplowitz, 2009). Environmental education aims to educate individuals to acquire "environmental literacy." (Teksoz, Sahin & Ertepinar, 2010). Although there are different definitions of "environmental literacy", the main focus in the context of this term is to help people gain knowledge, awareness, sensitivity and responsibility related to the influences of human activities on the natural resources of the World.

As all domain in school science, it is also important in environmental education to determine the cognitive structure of individuals on the subjects and concepts, to analyze the knowledge network and to determine the long-term persistence of the relationships of the concepts. Cognitive structure is a very important factor in learning and remembering. There are different interpretations like structural knowledge (Jonassen et al., 1993 cited in Liu and Ebenezer, 2002) or knowledge structure (Nakiboglu, 2008) which are used to describe cognitive structures. Knowledge about how concepts within a domain are interrelated forms structural knowledge. It is also defined as the content-specific cognitive structure dealing with the essential element of students' conceptual understanding and differs from declarative knowledge. Studies on structural knowledge focus on how conceptual understanding is structured in terms of interrelationships between and among concepts, instead of describing students' concepts based on categories (Liu & Ebenezer, 2002). In the last decade different techniques such as word association tests, concept mapping, interviewing, etc. have been used as research techniques to examine the nature of cognitive structures in learners' knowledge (Lee, 1986; 1988). White (1985) explored some of these issues, for example the interactive nature of the purpose, the assumed model and the extent of cognitive structures of concern, and the methodologies employed. Additionally, it is possible that cognitive structures are modified while they are being investigated. Introspection is likely to cause some change in a respondent's cognitive structure due to methods based on interviews or the detailing of thought processes. Cognitive structures, like the mental connections between terms, concepts and process as forming the focus of this study, are not easy to identify. As it is stated above, there are many methods used in determining cognitive structures. One of these methods, word association tests (WAT), involves the students' answering in a way to convey the

ideas and understandings formed by the stimulus/key word/concept given to the student in a certain period of time. It can be stated that these sequential answers they give from their long-term memory reveal the concepts and connections between the concepts in the cognitive structure in a reliable manner (Bahar & Özatlı, 2003).

Significance of the Research

Among the environmental problems/issues that humanity needs to solve, such as air pollution, soil pollution, water pollution and noise pollution come to the fore. It is very important to raise conscious and sensitive individuals in solving these problems. Base on the above definition of the term "environmental literacy", we might state the "environmental literacy" as a blended mixture of the aspects of knowledge, awareness, sensitivity and responsibility related to the influences of human activities on the natural resources of the world. In this context, when it comes to foster knowledge aspect of the students' environmental literacy by providing them meaningful and permanent learning experience, we need to take into consideration their cognitive structures about the environmental subjects and concepts in teaching. With this perspective, in the present study, we focused to determine the cognitive structures of 8th-grade students about the "air pollution" concept.

Objective of the Research

The aim of the present study is to determine the secondary school 8th grade students' cognitive structures related to the concept of "air pollution" through the word association test (WAT) and reveal their knowledge structure.

METHOD

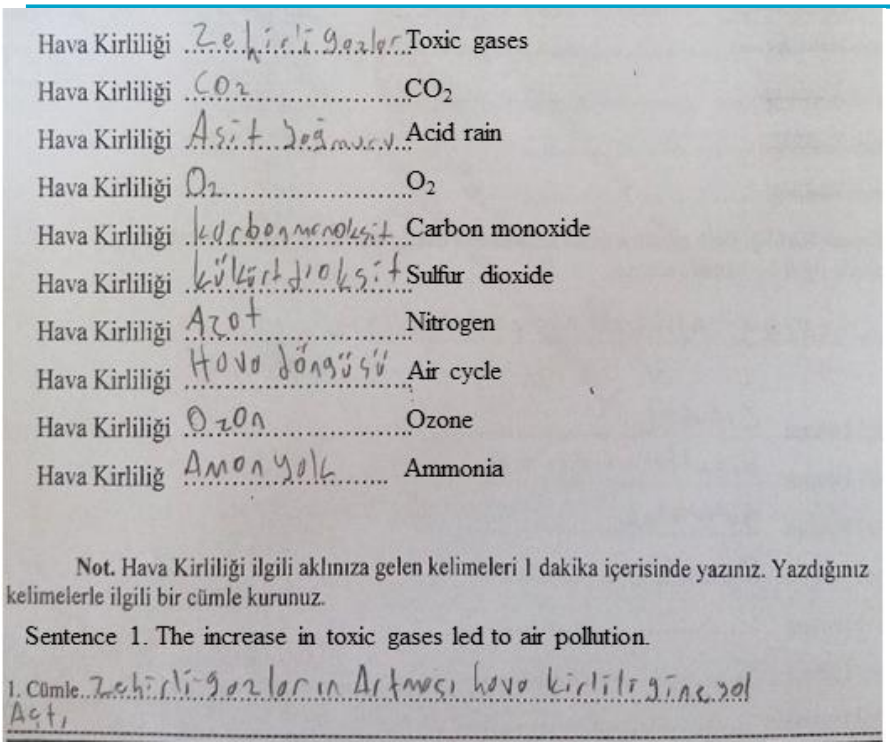
Qualitative research model was used in the present study. Qualitative research is to constitute a theory based on searching and understanding of social phenomena in the environment in which students live. A case study pattern which is one of the qualitative research models was used in this study and in the case study pattern, questions such as "how" and "why" are discussed and it is used in a detailed analysis of an event (Yıldırım & Şimşek, 2013).

Sample

Our research has been carried out with 8th grade students consisting of 34 girls and 26 boys who took Science and Technology lessons in Karatay district of Konya. Each student completed WAT approximately within 1 minutes. All participants were informed about the nature and methods of the study. They all agreed to participate in the study on a voluntary basis.

Data Collection Tools

In the present study, we have used a word association test (WAT) for collecting data. In a Science and Technology Course, firstly the WAT papers have been delivered to the participants then asked to write as many terms associated with the stimulus word as they could. To prevent a chain-reaction effect, which may be caused if someone is distracted by superfluous information, the stimulus word was written on a single A4-page with enough blank space around them to write down any thoughts. The participants were also asked to write a sentence including the stimulus word and their response words. According to the literature (Derman & Eilks; Derman & Ebenezer, 2020; Nakiboğlu, 2008) the students were given about 60 seconds per item. Most students completed the WAT in approximately 10 minutes. A sample data collection test of the applied WAT and its results are presented below in Figure 1.


Hava Kirliliği Zehirli gazlar Toxic gases
Hava Kirliliği CO_2 CO_2
Hava Kirliliği Asit Yağmuru Acid rain
Hava Kirliliği O_2 O_2
Hava Kirliliği karbonmonoksit Carbon monoxide
Hava Kirliliği kükürtdioksit Sulfur dioxide
Hava Kirliliği Azot Nitrogen
Hava Kirliliği Hava döngüsü Air cycle
Hava Kirliliği Ozon Ozone
Hava Kirliliğ Amonyak Ammonia

Not. Hava Kirliliği ilgili aklınıza gelen kelimeleri 1 dakika içerisinde yazınız. Yazdığınız kelimelerle ilgili bir cümle kurunuz.

Sentence 1. The increase in toxic gases led to air pollution.

1. Cümle. Zehirli gazların Artması hava kirliliğine sebep Açt.

Picture 1. *Word Association Test (WAT) application example*

Data Analysis

While analyzing the data, content analysis technique was used. With content analysis technique, it is possible to reach the concepts that can explain the collected data and the relations among these concepts (Lee, 1988). In the analysis phase of the WAT, the response words given by each student to the given stimulus word were determined and the ones with similar qualities were brought together and then categories were created. Frequency tables were prepared by considering the number of repetitions of these response words categorized according to certain topic titles. The data obtained as a result of these studies were analyzed by using the semantic relationship criterion as well as the number of words and answers (Atasoy, 2004). The total frequencies of these words, which were categorized using the semantic relationship criterion, were evaluated by calculating them and then tables were created. Response words with the same meaning were combined under the most frequently repeated word. In addition, words that do not have any associations with other words and repeated once were given under the relevant categories. It has also been stated in the relevant sources that this type of data analysis technique provides reliable results (Daskolia, Flogaitis and Papageorgiou, 2006; Kurt, 2013). By analyzing the WAT, similar answers on each paper were brought together and categories were created. Categories were created by using 2 or more repeated response words and according to their common characteristics. Response words that were not included in the categories and contain misconceptions were also given in the text. The response words in each category were first subjected to descriptive analysis and then frequency tables were created for the key concept.

In the second part of the test, the analysis of the sentences written by the students was carried out within 3 categories. First of all, if the students could relate the concepts they wrote about “air pollution” within a sentence and this sentence was also scientifically correct, it was included in the category of “sentence based on scientific basis” (Ercan, Taşdere and Ercan, 2010). Secondly, sentences that are not scientifically correct and include concepts or experiences that students use in their daily life were included in the category of “sentence containing unscientific and superficial information”. Finally, the sentences that students use differently and incorrectly, not according to their scientific meaning, were included in the category of “sentence containing misconception” (Üstün Kurt, 2013).

FINDINGS / RESULTS

The answers of 8th grade students in the WAT were examined and the findings of their cognitive structures about the concept of "air pollution" were evaluated. A total of 359 response words were categorized, and tables were created without including those repeated once and those not related to the stimulus word in any category. The frequencies of the response words included in the categories were calculated as 279. When the data have been evaluated, it has been seen that the answers were collected in 4 categories. The categories: "Causes of air pollution", "Atmospheric effects of air pollution", "Effects of air pollution on living things and the environment" and "Defining air pollution" have been given in the tables below.

Table 1. *Response Words and frequencies belonging to the category of "Causes of air pollution"*

Category 1	Concepts in the category and their frequencies		Total frequency of the category
Causes of air pollution	CO2 (37) Gas from exhaust (car exhaust etc.) (28) Toxic gases (15) Carbon monoxide (12) Factory (11) Carbon (8) Factory smoke (8) Nitrogen (8) Oxygen (7) Smoke (Smoke / gas from the chimneys) (7) Diesel (7) Industry (6)	Gasoline (6) Truck (5) Lorry (4) LPG (4) Perfume (4) Gas (3) Deodorant (3) Stove gases (2) Cigarette (2) Sulphur dioxide (2) Fossil fuels (2) Vehicles (2) Nuclear waste (2)	195

In the first category named "Causes of air pollution", the total number of response words repeated 2 or more is 25 and the total frequency is 195 (Table 1). The most repeated words in this category were listed as CO2 (37), gas from exhaust (car exhaust, etc.) (28), toxic gases (15), carbon monoxide (12), factory (11). The words written by the students are the expected answers and it is seen that the key concept of "air pollution" is mostly associated with pollutants (toxic gases, CO2, CO, car exhaust, factory smoke, etc.). These findings show that the cognitive structures of the students regarding the causes of air pollution are sufficient and the answers given are mostly at the expected level. In addition, response words that are not included in the table with a total number and frequency of 30 are; NaCl (1), Magnesium sulphate (1), car gas (1), carbon dioxide ratio (1), natural gas (1), hydrogen (1), human (1) it increases the CO2 ratio (1), cigarette smoke (1) , chimney (1), fumes from unfiltered chimneys (1), fumes from chimneys affect negatively (1), stove (1), coal (1), factories without filter (1), ammonia (1), less afforestation (1), reduction of green areas (1), tree cutting (1), human activities (1), special vehicles (1), industrial age (1), ozone (1), release of toxic gases (1), coal-heated houses (1), stubble burning (1), excess nitrogen (1), air of biological wastes (1), fire (1) and coal trains (1).

Table 2. *Response Words and frequencies belonging to the category of "Atmospheric effects of air pollution"*

Category 2	Concepts in the category and their frequencies		Total frequency of the category
Atmospheric effects of air pollution	Acid rain (15) Ozon layer (9) Air pollution (6) Atmosphere (5) Global warming (4)	Miasma (3) Polluted air (2) It causes global warming (2) Nitrogen rain (2)	48

The second category with high frequency was formed as "Atmospheric effects of air pollution" (Table 2). The total frequency of this category is 48 and it has a total of 9 response words. The most repeated response words in this category were acid rain (15), ozone layer (9), air pollution (6), atmosphere (5) and global warming (4). It is seen that students can establish a correct relationship between air pollution and global environmental problems such as acid rain, ozone layer and global warming in the second category.

Table 3. Response *Words and frequencies belonging to the category of "Effects of air pollution on living things and the environment"*

Category 3	**Concepts in the category and their frequencies**		**Total frequency of the category**
The effects of air pollution on living things and the environment	Disease (6) Water (6) Respiration (4) Dirt (3) Pollution (3) Trees (2)	Bad death (2) Garbage (2) Waste (2) It affects people's lives (2)	32

The third category was categorized as "The effects of air pollution on living things and the environment" considering the characteristics of the words (Table 3). Words in this category with lower frequencies compared to other categories are; disease (6), water (6), respiration (4), dirt (3), pollution (3), trees (2), death (2), garbage (2), waste (2), it affects people's lives (2) and these are among the expected answers. However, it has been seen from the answers given that the students grasp the knowledge about the effects of air pollution on the environment and living things superficially and the concepts about the effects of air pollution especially on living things are lacking in their cognitive structures. For example, there are no concepts related to the negative effects of air pollution on the growth of plants and respiratory diseases such as asthma and bronchitis in humans. In this category, words which have a total of 15 frequency and repeated once are; unliveable life (1), decrease in the number of living things (1), hot (1), disorder (1), it affects fish negatively (1), it harms nature (1),it harms humanity (1), it harms living things (1), it affects health negatively (1), it causes diseases in humans (1), it affects living things negatively (1), it affects humans negatively (1), it affects negatively (1), unhealthy (1), and death of living things (1).

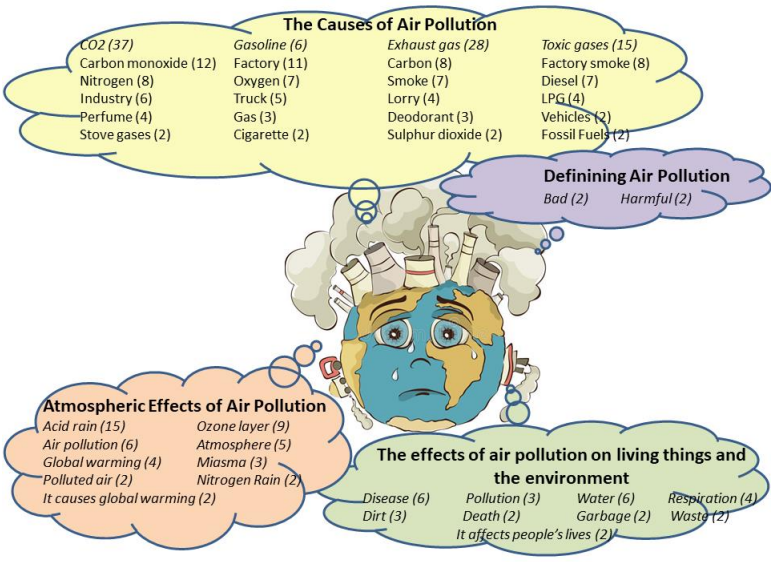
Table 4. Response *Words and frequencies belonging to the category of "Defining air pollution"*

Category 4	***Concepts in the category and their frequencies***		***Total frequency of the category***
Defining air pollution	Bad (2)	Harmful (2)	4

The last category was created as the "Defining air pollution" category. The total frequency of the 2 response words is 4 (see Table 4). It has seen that students associate the concepts related to air pollution with other categories more. It has thought that the limited number of words that can be used in defining this category causes the frequency value to be low. The response words that are not included in this category and repeated once are; it is dirty (1), germ (1), unsoundness (1), poison (1), poor quality life (1), harm (1), life (1) and hunger (1).

In addition to these 4 general categories, it has determined that there are 27 response words which were not included in the categories and contain misconceptions and their frequency is 31. These response words and their frequency values are; smoke (2), excess lights (2), cloud (3), sun (1), soil (1), sky (1), vapour (1), climate (1), food. (1), teachers (1), harmful rays (1), photosynthesis (1), it causes ozone depletion (1), factory affects negatively (1), bird (1), breath (1), cloud (1), dirt (1), air cycle (1), uranium (1), living things (1), we reduce CO2 by increasing the rate of cycling (1), clean air (1), recycling (1), we will not smoke (1) , we will not throw garbage (1), we will not spit (1).

In addition, a model has created by considering these four categories related to the cognitive structures of 8th grade students regarding the concept of air pollution (see Model 1). 4 basic categories related to the cognitive structure of the students about air pollution have been shown in this model.



Model 1. *The model related to the cognitive structures of eighth grade students about the concept of "air pollution"*

When the sentences written by the students about air pollution were examined, it has seen that there have been sentences based on scientific basis but there have been also sentences that were non-scientific or containing misconceptions. Some of the sample sentences belonging to them have been given in Table 5.

Table 5. *Sample sentences written by students about the stimulus word of "air pollution"*

Sample sentences containing scientific information	Gases from cars, unfiltered chimneys etc. cause air pollution. We can reduce air pollution by paying attention to the products and vehicles we use. Fumes from factories cause air pollution. The main cause of air pollution is human. Air pollution harms the world. Air pollution causes diseases.
Sample sentences containing non-scientific or superficial information	It is a very bad thing, we can die. Increase of toxic gases has led to air pollution Other scents can be applied instead of perfume. Thus, air pollution is reduced Materials should be used carefully to avoid air pollution. Let's not cause air pollution, let's protect our environment. Air pollution is harmful
Sample sentence containing misconceptions	Smoke from car exhausts gets into the air and causes ozone layer depletion Air pollution consists of CO2, N2 gases Overuse of deodorants creates harmful gases Death of living things, air's being polluted by smoke Air pollution increases carbon dioxide gas

When these sentences presented in Table 5 have been evaluated in terms of their content, it has seen that students are able to write scientific sentences covering almost all categories. This situation has been thought to have stemmed from the Science and Technology course content that 8th grade students have recently learned. However, it has been seen that some students' sentences have contained unscientific or superficial knowledge and some misconceptions.

DISCUSSION, CONCLUSION, RECOMMENDATIONS

In this study, conducted to determine students' cognitive structures about air pollution, it has seen that students produced lots of response words related to the concept of "air pollution" and they could relate them with one another. Among the response words students wrote about the stimulus word of "air pollution", the

ones which were mostly written were about the categories of "Causes of air pollution" and "Atmospheric effects of air pollution". In the category of causes of air pollution, it has seen that the stimulus word "air pollution" has mostly associated with pollutants (toxic gases, CO_2, CO, car exhaust, factory smoke, etc.) by students. Erduran Avcı, Demirekin, Hare, Özlü ve Özkan, (2013) obtained similar results in their study. In their study, they stated that students used drawings/conceptual expressions about the theme of air pollution the most and they mostly used the concept/drawings of factory smoke, exhaust smoke, cigarette smoke and landfill gas while expressing the air pollution.

It has seen that the response words written about another category with high frequency (48), "Atmospheric effects of air pollution" are mostly related to global environmental problems such as acid rain, ozone layer and global warming. While CO, CO_2 and SO_2 which are the gases causing global environmental problems have been used as response words, compounds causing global environmental problems such as HNO_3 and H_2SO_4 formed by SO_2 and NO_2 and have not been included. In addition, although the concept of global warming and greenhouse effect have been given as they are related with each other in the 2018 science curriculum (Özcan & Demirel, 2019). Students have used the concept of global warming, but they have not included concepts about the greenhouse effect. This finding has showed that the concepts about the greenhouse effect and some compounds that cause global environmental problems have been missed in students' cognitive structures. Yılmaz, Morgil, Aktuğ and Göbekli (2002) have concluded in their study, conducted with high school and university students, that the level of knowledge of the students has not been sufficient in such subjects as acid rain, greenhouse effect and gases damaging the ozone layer. In the study by Erduran Avcı et al. (2013), the perceptions of 8^{th} grade students on environmental problems have been examined with different techniques, and they have stated that the global environmental problems, such as ozone layer depletion, greenhouse effect and global warming have not been included on the pictures and mind maps made by students.

The low frequency value and variety of response words in the last two categories (having a lower frequency value) have indicated that these concepts have not been understood sufficiently (Bahar et al., 1999). In the literature, there has been a statement as "the individuals' creating their own attitudes, awareness and knowledge towards any concept has been related to how they could explain that concept (Atabek-Yiğit, 2019; Genç & Akıllı, 2016)". This statement has showed that descriptive conceptual expressions have been important. Because the low number of concepts in the category of "defining air pollution" has indicated that students have not learned the descriptive concepts thoroughly and their cognitive structures have not been sufficient in this category.

It has been observed that in the sample sentences written by the students regarding the concept of "air pollution", they have included the factors causing the air pollution and the results of the air pollution. For example, the factors that cause air pollution are highlighted in such sentences as; "Fumes from factories cause air pollution." and "The main cause of air pollution is human". Similarly, it has seen that they establish a relationship among the results of air pollution in such sentences as; "Air pollution harms the world" and "Air pollution causes diseases". It has also been understood that the concepts that cause air pollution and the results of air pollution are at the forefront in the perceptions of students about air pollution. It has seen that students also include sentences having lack of knowledge and misconceptions about air pollution. The sentence; "Smoke from car exhausts gets into the air and causes ozone layer depletion" contains misconception. A similar finding was also revealed in the study by Selvi (2007).

As a result of the research, in order to minimize and eliminate the misconceptions that students have, instruction plans should be done in a way that enables the interaction of concepts with comprehensive, explanatory and daily information. (Kaya & Akış, 2015). For this purpose, in teaching environmental issues including air pollution; concretizations might be made by including practices in which students will take an active role (Demirbaş & Pektaş, 2009). In addition, in order to draw attention to air pollution and to the rising awareness of the society in this field, knowledge and examples about the projects carried out by some institutions and organizations such as TEMA Foundation, Ministry of Environment and Forestry and UNESCO might also be included in the Science Curriculum of the Ministry of National Education (Sarıgöz, 2013).

It has thought that it would be appropriate to add communication tools and visual education activities to different education levels and especially to the secondary school curriculum to increase the awareness level of the students on environment. In addition, learning in environmental issues such as air pollution and the effects of air pollution might be realized more attractive, enjoyable, permanent and productive by using different methods such as inquiry based, project based and also outdoor-education applications.

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