DEVELOPING ENVIRONMENTAL EDUCATION PROGRAM FOR PRIMARY SCHOOL STUDENTS AND ASSESSING ITS EFFECTS ON PROSPECTIVE SCIENCE TEACHERS

by

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DEVELOPING ENVIRONMENTAL EDUCATION PROGRAM FOR PRIMARY SCHOOL STUDENTS AND ASSESSING ITS EFFECTS ON PROSPECTIVE SCIENCE TEACHERS

In Turkey, the Primary School Science and Technology Curriculum has been revised recently, and the content has been changed according to scientific and technological advances and emerging environmental problems. In this regard, training prospective teachers according to one of the new demands of the curriculum would be appropriate. Hence, this study aimed to develop an environmental education program and assess its effects on prospective science teachers.

The sample included 55 junior and senior pre-service teachers, who were attending Primary Science and Mathematics Education Program in Bogazici University. At the beginning and the end of the study, environmental attitudes and environmental knowledge of the subjects were measured. The experimental part was carried out during an education course for pre-service science teachers.

After the application of the program, statistically significant differences were concluded in environmental attitudes and environmental knowledge of pre-service teachers. To sum up, it could be stated that the program seemed to be working for this sample.

İLKÖĞRETİM ÖĞRENCİLERİ İÇİN ÇEVRE EĞİTİMİ PROGRAMI GELİŞTİRME VE PROGRAMIN ADAY FEN ÖĞRETMENLERİ ÜZERİNDEKİ ETKİLERİNİ DEĞERLENDİRME

Türkiye'de yakın zamanda, İlköğretim Fen ve Teknoloji müfredatı yeniden gözden geçirilmiş; bilimsel ve teknolojik gelişmelere ve oluşan çevre sorunlara göre içeriği değiştirilmiştir. Bu bağlamda, müfredatın yeni talepleri doğrultusunda aday öğretmenleri yetiştirmek uygun olacaktır. Bu çalışma bir çevre eğitimi programı geliştirmeyi ve programın aday fen öğretmenleri üzerindeki etkilerini değerlendirmeyi amaçlamaktadır.

Örneklem, Boğaziçi Üniversitesi İlköğretim Fen ve Matematik Öğretmenliği Programı'nda okuyan 55 üçüncü ve dördüncü sınıf öğrencisinden oluşmaktadır. Çalışmanın başında ve sonunda, deneklerin çevresel tutumları ve bilgileri ölçülmüştür. Deneysel bölüm ise aday fen öğretmenlerin için açılmış bir eğitim dersinde gerçekleşmiştir.

Programın uygulanmasından sonra, aday öğretmenlerin çevresel tutumları ve bilgilerinde istatiksel olarak önemli farklar elde edilmiştir. Özetle, programın bu örneklem için çalıştığı söylenebilir.

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LIST OF SYMBOLS/ABBREVIATIONS

Symbol/ Abbrevation	Explanation	Units used
BON	Balance of Nature	
DSP	Dominant Social Paradigm	
EA	Environmental Attitude	
EE	Environmental Education	
EEP	Environmental Education Program	
EK	Environmental Knowledge	
EKT	Environmental Knowledge Test	
GPA	Grade Point Avarage	
HON	Human over Nature	
LTG	Limits to Grow	
NEP	New Environmental Paradigm	
REB	Responsible Environmental Behavior	

1. INTRODUCTION

Environmental circumstances and scope of environmental problems have been changing drastically for the last few decades. Parallel with these changes, solving environmental crises and developing a safer and cleaner environment have become global concerns (Yang, 1993). In this respect, environmental education (EE) plays the crucial role in understanding the dynamics of continuously changing environment and its problems. Moreover, EE has another significant role; educating people to produce smart solutions for environmental problems.

As explained in The Belgrade Charter of UNESCO-UNEP (1976): "The goal of environmental education is to develop a world population that is aware of, and concerned about the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward solutions of current problems and the prevention of the new ones" (pp 1-2).

According to Wilke (1985), the key ingredient of EE was the teacher. Teachers designed a lesson by selecting appropriate instructional strategies, resources and deciding content of the subject matter (Harms and Yager, 1981). Hence, teachers could be said to be significant in developing effective EE programmes. Moreover, teacher training has 'multiplier effect' (Powers, 2004). In other words, a training course has the potential to impact a number of future teachers and in turn, these teachers will teach EE to several students. It is also important that teachers receiving prospective EE preparation were found to feel more confident about implementing EE in their future classes (Lane et al., 1995). In another study, Plevyak et al. (2001) concluded that teachers with EE background would more likely integrate EE in their classes than teachers who did not have EE experience.

On the other hand, teacher training in EE was announced as the weakest point in EE programs in five OECD countries; namely, Australia, Austria, Finland, Germany, and Norway (OECD, 1995). Ham and Sewing (1988) identified lack of teacher preparation in EE as a factor that impeded the implementation of EE. Moreover in Powers (2004) and McKeown-Ice's studies (2000), teachers expressed their own deficiency in environmental

knowledge as well. Consequently, teachers should be informed and trained about environmentally-related issues for successful EE programs and for a greater impact.

As a developing country, Turkey has just been taking the very first steps of EE (Tuncer et al., 2005). Consistent with new emerging environmental problems and the need to educate 14-million- student population (Hürriyet, 2006) about these problems, Primary School Curriculum was revised in 2005. However, the sudden change of the content and recommended learning strategies in the curriculum might result in unsafe conditions for teachers as appliers of the curriculum.

In this study, there was an attempt to design an EE program which is parallel with the content of revised Primary School Curriculum. The sample would be prospective science teachers and the prepared program would be applied in a teacher-training course in a public university.

2. REVIEW OF THE LITERATURE

2.1. Environmental Attitude

In social psychology, attitudes were defined as "favorable or unfavorable evaluations of and reactions to objects, people, situations, or any other aspects of the world" (Atkinson et al., 1996; p.606). Besides, attitudes facilitated to predict and even alter one's behavior. According to Yılmaz et al. (2004), attitudes were founded on life experiences and education influenced one's behavior noticeably. Behavior predicting feature of attitudes was also supported by 'Value- Attitude- Behavior Hierarchy Model', proposed by Homer and Kahle in 1988.

When it comes to environmental attitudes (EA), Schultz et al. (2004, p.31) defined EA as; "the collection of beliefs, affect, and behavioral intentions a person holds regarding environmentally related activities or issues". Pro-environmental attitudes were also characterized as; "people predispositions, relatively durable and relatively organized, to pay attention to, be concerned about, and ultimately, to act in the name of environmental protection" (Corraliza and Berenguer, 2000; p 833).

2.1.1. Environmental Attitude and Responsible Environmental Behavior

According to Kollmus and Agyeman (2002); an individual, who act consciously to reduce harmful impacts to natural and artificial environment, behaved environmentally responsible. Hsu and Roth (1998) also touched on improvement of the environment rather than talking about only protection of the environment, in their responsible environmental behavior (REB) definition.

Ajzen and Fishbein (1980) proposed the 'Theory of Reasoned Action', that claimed people's intentions were the best guides for their own behavior. And, the intentions depended on three variables; attitudes, subjective norms, and perceived control. That is to

say, behaviors could be predicted by people's attitudes toward the behavior, people's opinions about others' perspective when they behave accordingly, and people's beliefs about the difficulty of performing the behavior.

Grob (1995) proposed a model about relationship between EA and REB. According to the model, EA explained 39% - variance of REB. Huang and Yore (2003) also ended up that affective variables (including EA) were more explanatory for REB than cognitive variables. Hines et al. (1987) prepared a meta-analysis of 128 studies about predictors of REB. They grouped the predictors into four categories: cognitive variables, psycho-social variables, demographic variables, and experimental studies. The most important variables were categorized in psycho-social variables and EA was found to be the third most explanatory variable in terms of REB.

Although, people expressed relatively high level of pro-environmental attitudes, they preferred to engage in very few environmentalist actions (Maloney and Ward, 1973; Ostman and Parker, 1987; Smythe and Brook, 1980). Dunlap (1989) mentioned five possible reasons of the inevitable difference between expression and action:

- People believed that intuitions should have leading roles in cleaning the environment.
- Increasing governmental attention to environmental issues might have reduced public attention, since people might have thought that solely, government could take care of the environment.
- People would prefer among possible REBs. In other words, people might support recycling, but might not quit driving.
- People might not know enough to act in an environmentally responsible manner.
- Absence of strong leadership and obligation in environmental protection would make people that changing their life-styles were not so urgent.

2.1.2. Dimensionality of Environmental Attitude

There is not a consensus about dimensionality of EA in environmental literature. According to traditional views, environmental attitudes have been uni-dimensional. In other words, environmental attitudes should be accepted as a construct, ranging from concerned to unconcerned about environmental issues and New Environmental Paradigm (NEP) scale has been used to measure this construct (Dunlap & Van Liere, 1978; Dunlap, Van Liere, Mertig, & Jones, 2000). On the other hand, other scientists analyzed EA and ended up with multi-dimensional structure of EA. For instance, Thompson and Barton (1994) classified EA as either concern for all living things; "eco-centric" or in concern for humans; "anthropocentric". Schultz (2000) also studied environmental concern and identified three correlated factors: concern for the self; "egocentric", other people; "altruistic", and the biosphere; "bio-spheric".

Lots of researchers focused on measuring primary attitude factors and this resulted in production of large number of EA measures; probably at least 700 (Dunlap and Jones, 2002). In terms of EA's measurements, only two studies dealt with previous studies through factor analyses of former measures.

One of these studies was performed by Blaikie in 1992. He analyzed 24 items from former scales and ended up with seven first-order factors that described general ecological worldviews. These factors were 'use/abuse of the natural environment, precariousness of the natural environment, conservation of the natural environment, confidence in science and technology, problems of economic growth, and conservation of natural resources'.

The second study for combining former EA measures and determining general factors of EA was conducted by Bogner and Wiseman (1999). They analyzed a number of items of previous EA measures and found five first-order factors possessing four items each. These five factors were called 'intent of support, care with resources, enjoyment of nature, human dominance, and altering nature'. In a more recent study, Bogner and Wiseman (2002) factor analyzed their five first-order factors with three first-order factors of the NEP scale (namely; balance of nature, human over nature and limits to growth).

Their goal was to investigate second-order structure of EA. At the end, they came up with two second-order factors; preservation and utilization. In 2003, they proposed a two-dimensional 'Model of Ecological Values'; having two orthogonal dimensions. 'The preservation dimension' deals with conservation and protection of the environment, while 'the utilization dimension' concerns with utilization of natural resources. However, Milfont and Duckitt (2004) concluded that these two dimensions were strongly correlated dimensions rather than being uncorrelated and theoretically orthogonal.

2.1.3. Measurements of Environmental Attitudes

Although, NEP scale has been the most widely used and cited measure in the literature (Dunlap et al., 2000), other measures of environmental attitudes and environmental concern have also been developed.

For instance, the same year when Dunlap and Van Liere developed the NEP scale, Weigel and Weigel (1978) produced the Environmental Concern Scale. The 16-item scale examined attitudes about general environmental and ecological issues. In the study performed by Weigel and Weigel, the internal consistency of the scale was controlled (Cronbach's alpha = .85) on samples from a Western city and a New England town. Moreover, a strong correlation was found between environmental behavioral index's scores and the scale's scores ($r = .62, p < .001$).

Maloney and Ward (1973) designed the Ecology Scale that aimed to measure attitudes as well as knowledge, sensation and behaviors. The scale was composed of four subscales; 'verbal commitment, actual commitment, affect and knowledge subscales'. The 130-item scale was applied to a number of different groups of people (namely; collage students, environmental group members, and dwellers of Los Angeles). It was found that people tend to score higher in verbal commitment and affect subscales and lower in actual commitment and knowledge subscales.

As environmental education becomes vital as a consequence of emerging environmental problems, a need raises for development of scales to be applied on children. Musser and Malkus (1994) had an attempt to develop "Children's Attitude toward the Environment" scale for school-age children. The 25-item scale was administered to 90 third, fourth, fifth graders and Cronbach's alpha was found to be .70 . This scale was said to be useful for researches in school settings, since it had an understandable language for children and it took children less than 20 minutes to finish.

2.1.3.1. New Environmental Paradigm Scale. Since the Age of Enlightenment, Western industrialized societies have reflected the dominant worldview or Dominant Social Paradigm (DSP), whose framework was developed by Pirages and Ehrlich (1974). According to DSP, free enterprise, private property rights, economic individualism, unlimited economic growth, and faith in technology to solve human problems, including environmental problems were the supported dogma (Schafer, 2006).

The opposing worldview; NEP was announced by Dunlap and Van Liere in mid-70s. This framework emphasized beliefs about humanity's tendency to disturb the balance of nature, limits to growth for human population, and humans' questionable privilege to rule over the rest of the nature (Dunlap et al., 2000). Not surprisingly, approval of NEP was negatively related to endorsement of DSP (Dunlap & Van Liere, 1984; Schafer, 2006).

In a 1976 Washington State Survey, Dunlap and Van Liere had applied their set of 12-item Likert scale for measuring three aspects of the paradigm. The internal consistency of the scale was found to be high (Cronbach's alpha = .81) and it accomplished to discriminate between known environmentalists and the general public (Dunlap et al., 2000).

Despite of being the most widely used measurement on the issue of environmental concern; the debate on the number of dimensions of NEP has been still going on. As designers of NEP; Dunlap and Van Liere (1978) announced the scale as uni-dimensional, while other researchers had identified multiple dimensions. Most authors agreed on the three-dimensional structure of NEP, with dimensions; balance of nature, limits to growth and human over nature (Albrecht et al., 1982; Arcury, 1990; Edgell and Nowell, 1989;

Geller & Lasley, 1985; Noe and Snow, 1990). Still others have identified two dimensions (Bechtel et al., 1999; Gooch, 1995; Noe and Hamitt, 1992; Scott and Willits, 1994), while some scientists have identified four dimensions (Furman, 1998; Roberts and Bacon, 1997).

Researchers were advised to factor-analyze their whole set of items, whether the mostly used three dimensions existed in their individual study or not. Moreover, researchers were warned about the sample-specific nature of the dimensions of NEP (Dunlap et al., 2000).

Other than Dunlap and Van Liere's original study in 1978, many studies had consistent results such that environmentalists got higher scores than general public on the NEP (e.g. Edgell and Nowell, 1989; Pierce et al., 1992; Widegren, 1998). These findings suggested that the NEP scale had known-group validity. Moreover, a number of studies have resulted in significant relationships between NEP scale scores and various types of environmental behavior tests scores (e.g. Robert and Bacon, 1997; Schultz and Oskamp, 1996; Schultz and Zelezny, 1998; Scott and Willits, 1994; Stern et al., 1995). Hence, one could conclude that NEP had also predictive validity by referring these studies. (Dunlap et al., 2000)

The NEP scale was revised by Dunlap, Van Liere, Mertig, and Jones in 2000 in order to update and broaden its content. The revised scale was called "the New Ecological Paradigm Scale" to take attraction to the broader range of "ecological problems" rather than emphasizing "narrower, more specific and less systematic environmental problems". The revised scale includes 15 items and five facets of an ecological worldview; "the reality of limits to growth, anti-anthropocentrisms, the fragility of nature's balance, and the possibility of an eco-crisis" (Dunlap et al., 2000).

The revised NEP scale had some advantageous characteristics when compared to the original scale. The revised scale was found to be addressed to more facets of an ecological worldview. A second advantage of the new scale was that; it avoided usage of sex- biased terminology in the original scale. Besides, in the original scale, all of the four items in the 'human over nature' facet were worded in an anti-NEP direction. In the

revised scale, a balance was set between pro- and anti-NEP items and within the facets of the scale (Dunlap et al., 2000).

2.1.4. Factors Related to Environmental Attitudes

To understand the nature of EA, factors that are related or considered to be related had to be investigated. In a number of EA studies, factors; which were related to EA of particular samples, were analyzed. Designated factors of EA from previous studies would be discussed below.

2.1.4.1. Gender. The linkage between gender and EA has been one of the most discussed subject matter in EA literature. Most of the studies in this area agreed on women's relatively more positive EA compared to men's (Çabuk and Karacaoğlu, 2003; Dunlap and Van Liere, 1978; Eagles and Demare, 1999; Furman, 1998; Grifford et. al., 1983; Oweini and Houri, 2006; Tuncer et. al, 2005). On the contrary, some studies found no significant difference between males and females in terms of their EAs (Scott and Willits, 1994) and some other studies suggested that men had more positive EA than women (Arcury et. al, 1987; MacDonald and Hara, 1994).

The opinion, that females were more environmentally concerned, was also supported by some studies with samples other than adults. For instance, with a sample of Canadian and Taiwanese fifth graders (11 to 13 year-old students), females were found to have more positive EA, independent of their nationality (Huang and Yore, 2003). Another supporting study was conducted with a sample; consisting of Russian and German adolescents. The sample was divided into three age groups (12, 15 and 18-year olds) and analyzed accordingly. Regardless of their nationality, females were reported to be more environmental concerned (Szagun and Pavlov; 1995).

According to social theorists, designated sex-roles lead females to be more environmentally concerned than males in a society (McStay and Dunlap, 1983; Merchant, 1979; Reuther, 1975). Women were characterized as having "feminine" qualities such as showing affection, nurturing and caring for others, while men had "masculine" characteristics such as rationality, competitiveness and leadership (MacDonald and Hara,

1994). In accordance with Milfont and Duckitt's study (2004), women had significantly higher scores on "Preservation" dimension (that includes intent of support, enjoyment of nature, limits to growth and care with resources factors). However, there was no significant gender difference on "Utilization" dimension (that includes human over nature, altering nature, human dominance, and balance of nature factors). A supporting finding related to gender of parents and their perspective towards the environmental issues came from Blocker and Eckberg' study (1989). It was reported that due to "father effect", males were more concerned with economic rather than environmental consequences of problems, while "mother effect" lead to more concern about local environmental problems. In a sense, this study supported Milfont and Duckitt's study by emphasizing 'preserved' viewpoints of females.

There are instances when the difference between genders becomes insignificant. For instance, Mohai (1992) found that females expressed more environmental concern than males in local environmental issues. However, the difference between genders became smaller as the scope of the issues moved from local to national or to global level. Another relevant finding came from Bord and O'Connor's study (1997): They arrived at such a conclusion that when health risk perceptions were taken into account, the gender gap disappeared.

2.1.4.2. Education. Education can simply be defined as learning knowledge, attitude and skills (i.e. learning how to learn). According to Etllng (1993), learners had to internalize any knowledge, skills or attitudes into their own set of values and behaviors (namely, their life-style), otherwise learning became meaningless.

It is generally assumed that education and schooling are exchangeable expressions. However, it is the formal education that takes place in schools or in any specialized institutions. Whereas, informal education includes any kind of everyday experiences, that are not planned or organized. Peers and elders play a more important role in informal education (Etllng, 1993).

In environmental literature, most studies agree on the positive impact of education on pro-environmental attitudes (Arcury, 1990; Austin and Woolever, 1994; Jones and Dunlap, 1992; Scott and Willits, 1994; Van Liere and Dunlap, 1980). For instance, Yılmaz et al. (2004, p.1532) stated that: "Formal education influences students' attitudes positively by developing students' conceptions about environmental issues."

Rather than level of education or the number of years spent for education, quality of education becomes important. To compare content of education and EA of the participants, school settings and students would be better variables to investigate. For example, Reid and Sa'di (1997) studied on EA of Jordanian and British primary school students and concluded that British children had more positive EA than Jordanian children. The difference in attitudes was explained as impact of media and comparable structure of environmental education programs in the two countries. British media was accepted as more environmentally oriented than Jordanian media. Besides, EE programs had a more precise structure in Britain than in Jordan.

EE should be provided in three basic units; family, society and school (Çabuk, 2001; Tozlu, 1996). Hence, parent education level also determines their children's attitudes towards any subject matters. In a study that was conducted in a Turkish public university; students with university-graduated parents were found to have more positive EA than other students (Özmen et al., 2005). Another Turkish study about attitudes of students resulted in high EA of students who enrolled in private schools. When parents' education level of the sample was examined, parents of private school students had higher level of education compared to public school parents. In the study, it was concluded that high parent education level might be a factor of more positive more EA of private school students (Tuncer et al., 2005).

2.1.4.3. Age: The effect of age on EA has also been studied in a variety of contexts. Most researchers have agreed with the inverse effect of age on pro-environmental attitudes (i.e. as age decreases, people have more positive EA) [Arcury, 1990; Austin and Woolever, 1994; Jones and Dunlap, 1992; Scott and Willits, 1994; Szagun and Pavlov, 1995; Van Liere and Dunlap, 1980; Yılmaz et al., 2004]. Contradictory with the above studies, some researchers found no significant difference in EA of different age groups

(Armstrong and Impara, 1992), while some found a positive correlation between age and EA (Çabuk and Karacaoğlu, 2003; Furman, 1998; Özmen et al.2005).

Social theorists have explained the relationship of different age groups and their EA by referring 'cohort effect' or aging process. The cohort effect was expressed as the difference in attitudes between different age groups as a result of generational differences in socialization and experiences (Vlosky and Vlosky, 1999). For instance, environmental movements of 1960s and 1970s resulted in intense generational conflicts. According to Buttel (1979), higher environmental concern of young population of 60s and 70s could be enlightened by referring the cohort effect.

Moreover, Buttel (1979) also argued that attitude change could go together with the aging process. For example, younger people were more willing to fit themselves into new social systems. On the other hand as their age increased, people tend to become more cautious and conservative about their attitudes due to their attempts to achieve in the existing social system (Brim and Kagan, 1980; Cutler and Kaufman, 1975).

2.1.4.4. Political View. Studies on EA agreed on the notion that politically liberal individuals had more pro-environmental attitudes (Albrecht et. al, 1986; Buttel, 1987; Dunlap and Catton, 1979; Van Liere and Dunlap, 1980). In Scott and Willits's study (1994), NEP was also used as a measure of EA and social characteristics of subjects were examined to determine factors of EA. They found that politically liberal subjects had significantly higher scores on NEP and on 'Human over Nature' (HON) dimension of the scale.

Springer and Constantini (1974) argued that environmental concern was more related to social status rather than political view of individuals. Although, Buttel and Flinn (1978) agreed with them, they made a distinction: Different from general public, EA of educated population was founded on a broader ideological belief system. The studies on socially elite groups found correlations between positive EA and liberalism (Mazmanian and Sabatier, 1981).

According to libertarian view, the crucial point was that all individuals had inviolable rights of sovereignty over others and their private territories. Moreover, it was hypothesized that in a perfect libertarian world, environmental degradation would be naturally terminated by protecting human rights (Taylor, 1993). Hence, the results of the mentioned studies could be stated as being parallel with the libertarian philosophy. Since, environmentally concerned people would be more sensitive to rights of existence of all living things.

2.1.4.5. Residence. Different from other factors influencing EA, the environmental literature agrees on more positive EA of urban dwellers (Dunlap and Van Liere, 1980; Dunlap et al., 2000; Huang and Yore, 2004; Jones and Dunlap, 1992; Özmen et al., 2005; Şama, 2003). This fact has been explained due to the high intensity of environmental problems in urban residences.

Studies on adolescents and even pre-school children also ended up with relevant results. According to Hillcoat and Forge (1995), adolescents in urban schools thought about global problems to be more severe than local problems, whereas adolescents in rural schools had opposing views. Hart's (1979) and Kaplan's (1976) studies also asserted that children living in urban residences felt more anxiety and fear towards their environment than children in rural settings. These negative feelings could also be accepted as indicators of environmental awareness and evidences for consistency with dimensions of NEP.

2.2. Environmental Knowledge

Environmental knowledge (EK) comprises information about environmental issues and possible solutions to cope with environmental problems. According to Huang and Yore (2003), EK was an essential cognitive variable that affected how people reacted to and dealt with environmental problems. Furthermore in Furman's study (1998), it was concluded that individuals with more EK would be likely to consider environmental issues and problems in a wider geographical range.

2.2.1. Low Level of Environmental Knowledge

In 1980s, Council of Environmental Quality attempted to measure EK of general public. They came up with a disappointing result: Only 20 % of the subjects could give correct responses at least 70 % of the items in the instrument. The attempt was repeated in 1985, and the low EK level of the public was announced again (Arcury, 1990). Other studies also supported the general trend of having low EK (Coyle, 2004; Pennsylvania Center for Environmental Education, 1997; NEETF, 1998).

Other than studies conducted with general public, studies on students and even on university students still gave the same results. For instance, Yılmaz et al. (2002) ended up with insufficient EK level of high school and university students in Turkey. They also concluded deficiency in defining environmental problems. Moreover, Şahin et al. (2004) resulted in misconceptions related to important environmental concepts and low EK level of university students.

According to Minnesota Report Card on Environmental Literacy results (2004), there was an inconsistency between perceived and measured EK. In other words, people were more likely to consider themselves as more knowledgeable than they really were. This could be accepted as a barrier for environmental literacy and environmental activism.

2.2.2. Environmental Knowledge and Responsible Environmental Behavior

From a general perspective, Hungerford and Volk (1990) stated that an individual would be more likely to initiate an action if one was accustomed to the problem and its reasons, and if one knew about possible solutions. Kollmuss and Agyeman (2002) concluded that knowledge had an indirect influence on behavior by affecting values and attitudes in advance and somehow supported the 'Value- Attitude- Behavior Hierarchy Model' by Homer and Kahle (1988).

When environmental variables were taken into account, Hines et al. (1987) had an attempt to identify predictors of REB and concluded that EK was one of the predictor of REB with relatively low significance. Rather than having EK, skill to apply this knowledge had been emphasized in the study.

An interesting study, which was conducted by Finger in 1994, aimed to understand the underlying relationships between environmental experience, EK and REB. In the study, environmental behaviors were classified as; standard environmental behavior, limited activism, and protest behavior (stated in accordance with the increasing intense of environmental responsibility). It was concluded that the effect of EK on behavior would change with respect to the proposed types of environmental behavior. For instance, the most significant factors related to 'standard environmental behavior' were found to be experiences related to nature and environmental catastrophes. For individuals, who tended to act in this way, the main reason for willing to learn about environment was fear. Interestingly, this knowledge, which was gained through fear, was used to cope with anxiety and fear rather than to act in an environmentally responsible manner. Consequently, instead of environmentalist action, EK became the output. For limited activism and protest behavior, learning was found not to be related with fear and anxiety and EK acted as an enhancer of REB.

2.2.3. Factors Related to Environmental Knowledge

Similar with the case of EA, there is not a consensus about the effect of gender on EK. While most studies claimed that there was no significant EK difference between genders (Furman, 1998; Huang and Yore, 2003), some studies suggested that males had more EK (Arcury et al., 1986). In another study, Arcury et al. (1987) explained the gender difference by emphasizing the scientific and technological basis of environmental problems and stated that men were expected to be more knowledge about environmental issues.

Another factor related to EK was found to be residence. Arcury (1990) found a significant positive correlation between EK and living in urban areas. This was an anticipated situation such that; there were more educational opportunities and more possibilities to encounter industry-related environmental problems in urban settings.

Generally, factors related to EK were found to be somehow associated with educational issues. For instance, experiential learning activities, where students were able to learn the lesson content in natural settings and have natural experiences, would affect students' EK level. In this context, children having frequent nature experiences were found to be significantly more knowledgeable than other children (Huang and Yore, 2003).

Consequently, gender and residence resulted in differences in terms of EK. These differences would be diminished by increasing educational opportunities offered to females and to all students in rural settings.

2.3. Relation between Environmental Attitude and Environmental Knowledge

Environmental awareness was said to "comprise factual environmental knowledge, affective and behavioral attitudes toward environmental problems, and values related to the environment" in Szagun and Pavlov's study (1995, p.93). As two components of environmental awareness, EA and EK would be expected to be related to each other. However, studies didn't support such a direct and strong relationship between EA and EK.

Arcury (1990) stated there was an association between EK and EA, but it was a weak one. One possible reason for the weak association was put down to low level of EK. Consistently, Wade and Tavris (1994) claimed that an obstacle for attitude change was insufficient knowledge about an issue. One might postulate that there might a threshold limit of EK, where a positive correlation between EA and EK would initiate.

3. METHODOLGY OF THE RESEARCH

3.1. Statement of the Problem

As number and intense of environmental problems get bigger and structure of the problems becomes more complex, EE gains more importance. EE becomes a more vital issue especially in developing countries with big populations. Turkey is a good example of such a situation; having a young student population of approximately 14 million primary and high school students (Hürriyet, 2006). Parallel with new emerging environmental problems and the need to educate the young population about these problems, Primary School Curriculum was revised in 2005. Particularly, more standards and objectives about environmental issues have been placed in the revised Science and Technology Curriculum.

Although, the curriculum has been revised, whether the teacher, who directs learning activities in the classroom, has enough environmental knowledge or has positive environmental attitudes, is still an unanswered question.

It is obvious that in order to have an effective instruction of environmental issues, changing the curriculum will not be sufficient. Furthermore, teacher training programs should be revised. Even though, Primary School Curriculum has environmental content; in most education faculties in Turkey, environment courses are not complimentary. In most faculties, there are not any environmental education courses for prospective teachers.

3.2. Significance of the Study

In this study, there was an attempt to design an EE program which is parallel with the content of revised Primary School Curriculum. The prepared program would be applied in a teacher-training course in Boğaziçi University. Two components of EE; EA and EK which were said to be associated would be studied. EA and EK level of prospective teachers would be measured before and after the application of the program. Results of pre- and post-tests would promote development of a variety of other EE resources related to Primary School Curriculum.

3.3. Sample

The study included 55 junior and senior prospective teachers, who were attending Primary Science and Mathematics Education Program in Bogazici University, in Istanbul. In the sample, there were 20 major and 35 minor prospective science teachers. Ages of the prospective teachers ranged from 21 to 29. Detailed information about the sample is given on Table 3.1 .

Table 3.1. Frequency table for the sample.

		Gender		Total
		Female	Male	
Class	Junior	26	16	42
	Senior	3	10	13
Total		29	26	55

3.4. Instruments

3.4.1. Demographic Information

Demographic information about subjects participating in the study consisted of five items: gender, department affiliation, GPA, living place, and the last four digits of their student ID. Gender codes were: *female* = 0 and *male* = 1. Department was coded: *minor science* = 1, *major science* = 2. Living places was coded as; *big city* = 1, *city* = 2 and *town or village* = 3. For the subjects, who marked more than one place, the smaller unit was accepted during data analysis. Students were also asked about environmental courses they took and participation in environmental activities (coded *no* = 0 and *yes* = 1).

3.4.2. New Environmental Paradigm Scale

EA was measured by the original NEP scale. The NEP scale included 12 items and 3 subscales (4 items each); known as Balance of Nature (BON), Limits to Growth (LTG), and Humans over Nature (HON). All items were translated to Turkish and sex-biased wording was avoided (Furman, 1998). The NEP scale was administered to students twice, at the beginning and at the end of the term.

All attitude items were scored on the 5-point Likert scale (1= *strongly disagree*, 2 = *disagree*, 3 = *unsure*, 4 = *agree*, and 5 = *strongly agree*). Negative items (17, 18, 19, and 20) were recoded before analyses. Accordingly, higher scores represent more pro-environmental attitude.

3.4.3. Environmental Knowledge Test

Environmental Knowledge Test (EKT) was prepared by the researcher. The test contained 21 multiple-choice questions. There were four choices for each item. The questions were addressing various environmental issues. Among the questions, 13 of them were related to environmental experiments that were part of the developed program throughout the study. The remaining eight questions dealt with other environmental issues.

In Table 3.2, content of each question on the EKT is marked as related or not related to the experiments. The symbol '√' stands for related and 'X' for unrelated items.

Table 3.2. Environmental content of the items on EKT.

Environmental Issues	Item Numbers	Relatedness
Acid Rain	1, 10, 17	√
Hardness of Water	2	√
Toxicity	3, 19	√
Ozone Depletion	4, 21	X
Nuclear Energy	5	X
Evolutionary Adaptations	6, 12	√
Waste Management	7	X
Water Pollution	8,15	X
Holding Water Capacity of Soil	9, 16	√
World Population	11	X
Recycling	13, 18	√
Euthrophication	14, 20	√

3.5. Development of 'Environmental Education Program' (EEP) for Prospective Science Teachers

The experimental part of the study was carried out during an education course for prospective science teachers. The course 'Science Laboratory Applications II' was coded PRED 352. The main aim of the course was to design and present lesson plans for laboratory experiments to be applied in primary school science classes. Each group of students was assigned a specific environmental experiment to prepare. They were supposed to present the experiment, accompanied by lesson plans, to other students in a laboratory setting, and relate it to a particular environmental issue.

While selecting these environmental experiments, the following principles were followed:

- The experiments should be at primary school level.
- The experiments should be safe in order to apply them in primary school classes.
- The experiments should not take more than a lesson period in a primary school.
- The materials of the experiments should not be complicated; to ensure that experiments may be applied in every school even with a small budget.
- The experiments should be consistent with Science and Technology Curriculum.
- Each experiment should address a different environmental issue.

Before the preparation of each experiment, related environmental concepts, terms, and problems were introduced to the group. Students were asked to accompany their assignments with materials, such as charts and additional data that referred to consequences of the environmental problem they studied. Although, the subjects were directed to certain experiments and related environmental problems, they were free about choosing their classroom activities and instructional materials other than experiment equipments.

In the content of the course, various teaching techniques were taught. Throughout the course, the emphasis was put on constructivism, rather than on behaviorism and cognitivism, which equates learning with creating meaning from experience (Bednar et al., 1995). Revised Science and Technology Curriculum also supports constructivism as a way of learning (MEB, 2005). During the study, constructivist lesson plans enabled students to deal with the given tasks in real-life contexts, to learn collaboratively (in groups), to discuss their experiences in a supportive environment and to talk about possible solutions and outcomes of the given environmental problems.

While introducing the environmental experiments, concepts, and problems, the researcher acted as a mentor without directing the course of instruction. This is another aspect of constructivist theory, where the teacher facilitates learning and students are active throughout the learning process. Similarly, the presenting group assisted students during experimentation. Meanwhile, students were the active participants of the learning process by doing the experiment, sharing responsibilities of their groups; filling out given worksheets and data sheets, and discussing their results.

3.6. Design of the Study

The study lasted for eight weeks during spring semester of the academic year 2005-2006. At the beginning, subjects were informed about the course and content of the study. The questionnaires and tests were administered to students before and after the application of the experiments. Students had been separated into groups for the course beforehand. Each group had two weeks for preparation of their environmental experiment and the entire lesson plan. There were six environmental experiments (Table 3.3). Each week, two experiments were presented and presentations took three weeks. The entire course of the program is summarized in Table 3.4 .

Table 3.3. Experiments done during the EEP. (Experiments are listed chronologically.)

Groups	Experiments
Group I	Animal Adaptations
Group II	Designing a Toxicology Lab
Group III	Holding The Water
Group IV	Acid Rain
Group V	Identification of Hard Water
Group VI	Production of Recycling Paper

Table 3.4. Course of EEP

Procedure	Groups	Week(s)
Introduction of the EEP	All	1
Application of tests	All	2
Preparation for Exp. I & II	Groups I, II	3-4
Presentation	Groups I, II	5
Preparation for Exp. III & IV	Groups III & IV	4-5
Presentation	Groups III & IV	6
Preparation for Exp. V & VI	Groups V & VI	5-6
Presentation	Groups III & IV	7
Application of tests	All	8

3.7. Content of the Environmental Experiments

3.7.1. Experiment # 1: Animal Adaptations

The objectives of the experiment related to adaptations of living things are;

- To give examples and explain adaptations of living things to their environment.
- To point that living creatures, which share the same habitat, develop similar adaptations.
- To give examples of how adaptations contribute to biodiversity and evolution, as a result of environmental changes.

These objectives were taken from 8th grade Science and Technology Curriculum, under the unit of 'Cell Division and Heredity'.

This experiment consisted of two parts. In the first part of the experiment, models of different animals were created with simple materials. Four beakers having 100 ml. of boiled water (having the exact temperature) were closed with aluminum foil. Thermometers were put into each beaker. One beaker was placed into a wool sock;

representing an animal with heavy coat of fur. Second beaker was placed inside a flower pot containing sand. The second beaker represented an animal living in desert. The third beaker was located into a flower pot without sand. Students were asked to relate this model to an animal. The last beaker served as a control specimen. Then, students recorded temperature changes of water in four beakers for about 15 minutes.

In the second part, students plunged their two fingers into icy water, one bare and another covered with oil. Afterwards, they compared the temperature felt by both fingers in icy water. The same procedure was repeated with two thermometers; one covered with oil. The purpose of the experiment was to understand how animals adapt to different weather conditions.

The rationale for placing this experiment into the program was to draw attention to the flexible character of adaptations to various conditions. The emphasized environmental problem was 'Oil Spills'. Although, living creatures have the ability to adapt to certain changes in their environment, there are some incidents that cause extinction of species. Most of these incidents arise from human activities. In such cases, extinction of species takes place before suitable adaptations can be developed. Oil spills are examples of such incidents. The fur and feathers of aquatic animals and birds contain water repellent oil and fats, that help them to resist cold water. These are chemically quite different than oil and tar found in crude oil. Spilled oil dissolves away bird's normal oil in its feathers and then the toxic crude oil penetrates to the skin and is absorbed into the blood and kills the bird. During the presentation, the group emphasized drastic effects of oil spills to aquatic life and support the class to discuss consequences of oil spills.

3.7.2. Experiment # 2: Designing a Toxicology Lab

Among the six environmental experiments, only the toxicology lab exercises were not related directly to the subjects in Science and Technology Curriculum. Nevertheless, stations required and evaluated 'Solubility' and 'Acid-Base' knowledge that are components of the curriculum. Other than objectives related to these subjects, this experiment addressed some acquisitions that take place in the curriculum:

- To understand that management of wastes, that are end-products of any technological systems, is a crucial social and environmental problem.
- To exemplify expected and unexpected effects of scientific and technological advances to individuals, society and environment.
- To appreciate scientific studies and scientists.

Besides, these exercises also required some science process skills like measuring, drawing graphs, gathering and interpreting data.

The main objectives of this experiment were to make students familiar with some toxicology terms, to make them capable of identifying some toxic materials that are part of their lives, and to make them aware of different effects of toxic materials to organisms.

This experiment consists of four stations. In the first station, students learnt the term 'threshold limit' by tasting different amounts of salt solutions. They drew graphs and pointed out where they felt they drank salty water on the graphs.

In the second station, students added drops of food coloring to 100 ml and 500 ml of water and observed the resulting hues. This station was related to 'body size'; 100 ml beaker represented a little child and 500 ml beaker represented an adult.

In the third experiment, drops of red cabbage extract, which is the raw material of acid- base indicators, were added to vinegar solution (an acidic solution). Students filled out a chart as color of solution turned into red. Red color indicated that the organism died. During this station, students learnt about 'dose-response' relations.

In the last station, there were four beakers that looked like full of water. However, one beaker contained an acidic solution. As students poured droplets of red cabbage extract, only one solution gave a different response. This station emphasized the concept of 'individual susceptibility'.

All the stations were demonstrations of toxicology experiments. These demonstrations were safe to be handled in the classroom environment. Moreover, all the stations were easy to achieve and students were succeeded to finish and pass on the following station in sync. This experiment enabled students to work collaboratively in laboratory.

Before the experiment, the presenters played a little drama about scientists working in a toxicology laboratory. While students were doing the experiments, the presenters created an inquiry-based atmosphere by asking them questions related to the experiments. After completing the stations, each station was associated to real-life situations and students discussed the possible consequences of these real-life situations.

3.7.3. Experiment # 3: Holding the Water

This experiment is closely related to the unit of 'How Terrestrial Globe was Formed?' in the 6th grade Science and Technology Curriculum. Under this unit, there are objectives concerning this experiment:

- To recognize various soil types.
- To state reasons and effects of erosion.

The focus of the experiment was to compare holding capacity of water in different soil types. During the experiments, students worked with sand, compost, clay, and garden soil. By using funnels and coffee filters, they compared amount of drained water from the given soil type. After experimentation, they tried to figure out the effect of organic matter in soil on nature and which soil was supportive for living organisms.

During the presentation in the laboratory, a supportive atmosphere for discussion was created. By classroom questioning, students were led to recall the phenomena of 'erosion'. Students discussed their observations in the experiment and causes of erosion. Some figures and data about erosion were exhibited throughout the presentations. Ways to

protect soil from erosion, institutions that are responsible of avoiding erosion in Turkey were also introduced to students.

3.7.4. Experiment # 4: Acid Rain

The concepts of 'acidity and alkalinity' are placed under the unit of 'Structure and Characteristics of Matter' in the 8th grade Science and Technology Curriculum. The main objectives are to learn about measuring pH of substances and to estimate pH of daily materials. Moreover, there are some additional affective objectives such as:

- To be aware of what should be done to avoid negative effects of acids and bases.
- To realize that SO_2 and NO_2, which were emitted by industry and transportation, are the main sources of acid rain and are harmful to environment.
- To be aware of air, water, and soil pollutants.

The main purpose of this experiment was to give information about buffering capacity of soil. To attain this objective, students used a pH paper to measure acidity of a vinegar solution and then the acidity of the same solution that passed through a garden soil. After comparing pH of two solutions, students talked about buffering capacity of the soil. In the experiment, different soil types were used to make inferences of how various soil components affect buffering capacity of soil.

In the experiment, vinegar represented acid rain that was absorbed by soil. During the presentations, limited buffering capacity of soil was emphasized. In other words, although soil has buffering characteristics, this capacity will not be enough when exposed to rain containing strong acids. Furthermore, effects of acid rain to environment and living organisms were also discussed in the presentations.

3.7.5. Experiment # 5: Identification of Hard Water

The objectives related to this experiment are;

- To differentiate soft and hard water,
- To explain why hardness is not a preferable feature of water.
- To search for methods of reducing hardness of water.

These objectives take place 8th grade Science and Technology Curriculum, under the unit of 'Structure and Characteristics of Matter'.

Aim of this experiment was to test and to compare hardness of a variety of liquids. Testing method was simple and enjoyable for the primary school level; pouring the same amount of detergent to each liquid, shaking the liquids and measuring the thickness of foam with a ruler.

The presenter group focused on consequences of using hard water for domestic purposes, discharging detergents, and the problem of 'euthrophication' during the experiment. Although, euthrophication is a new term for 8th graders and even for prospective teachers, the aim was to raise awareness about discharging excessive amount of detergents that affect all the life forms and the environment.

3.7.6. Experiment # 6: Production of Recycling Paper

Objectives for recycling, in 8th grade Science and Technology Curriculum, under the unit of 'Relations between Living Organisms and Energy' are:

- To exemplify the process of recycling.
- To explain the necessity of recycling.
- To put recycling activities into practice.

In this experiment, the end product was the recycled paper produced by the subjects. Two days before the experiment, the presenter group had soaked some newspaper and white paper in water. During the experiment, after squeezing out excessive water,

paper was crushed with mortal and pestle until it turned into paste. The paste was put into water. After observing fibers in the water, the paste was placed in a frame and dried out. After drying, the recycling procedure was completed.

To compare end products, different paper types were used. To increase variety of paper products; food paints, dried flowers, and grass were used. The aim of the experiment was to emphasize the importance of recycling and to support consuming recycled products.

The presenter group focused on recycling data in Turkey. Regardless of excessive consumption of products and their packages, the inadequate recycling proportion was emphasized. Their affective goal was to make their students believe that their personal participation was valuable for environmental protection.

4. RESULTS

4.1. Results Related to Environmental Attitudes

4.1.1. Descriptive Statistics of Environmental Attitude Scale

EA of students, measured by the NEP scale and tested at the beginning (I) and at the end of the term (II) are presented in Table 4.1 . Responses '*agree*' and '*strongly agree*,' as well as '*disagree*' and '*strongly disagree*,' were combined together for better clarity. Internal reliabilities of the NEP scale, measured by Cronbach's alpha, were 0.64 (I) and 0.76 (II).

Calculated total scores for the NEP scale and its subscales at the beginning and at the end of the term were presented on Table 4.2.

Table 4.1. Percentages of responses to each item on the NEP scale.

Item	Agree [%]		Undecided [%]		Disagree [%]	
	I	II	I	II	I	II
Balance of Nature (BON)						
The balance of nature is very delicate and easily upset.	65.4	75	7.3	9.6	27.3	15.4
When humans interfere with nature, it often produces disastrous consequences.	67.3	59.6	20.0	26.9	16.4	13.5
Humans must live in harmony with nature in order to survive.	48.2	90.4	7.4	7.7	44.4	1.9
Humankind is severely abusing the environment.	81.5	82.4	9.2	11.7	9.3	5.9
Limits to Growth (LTG)						
We are approaching the limit of the number of people the Earth can support.	43.6	46.2	32.8	34.6	23.6	19.2
The Earth is like a spaceship with only limited rooms and resources.	37.0	51.9	14.9	9.6	48.1	38.5
There are limit to growth beyond which industrialized society cannot expand.	32.7	36.5	34.6	46.2	32.7	17.3
To maintain a healthy economy, we will have to develop a steady state economy where industrial growth is controlled.	87.3	59.6	10.9	5.8	1.8	34.6
Humans Over Nature (HON)						
Humankind was created to rule over the rest of nature.	24.1	34.6	16.6	11.6	59.3	53.8
Humans have the right to modify the natural environment to suit their needs.	18.5	17.3	24.1	21.2	47.4	61.5
Plants and animals exist primarily to be used by humans.	38.2	28.8	10.9	19.3	50.9	51.9
Humans need not adapt to the natural environment because they can remake it to suit their needs.	9.1	11.5	18.2	13.5	72.7	75.0

Table 4.2. Total scores for the NEP, BON, LTG, and HON scales.

	NEP		BON		LTG		HON	
	I	II	I	II	I	II	I	II
Mean	42.82	44.49	15.6	16.06	13.24	14.15	13.91	14.25
SD	5.35	6.19	2.36	2.51	2.86	2.77	2.81	3.36

4.1.2. Factor Analysis of Environmental Attitude Scale

As Dunlap et al. (2000) advised, factor analysis was done for comparing the employed NEP scale with the literature, and dimensions of the scale were identified. On combined NEP items, variance explained of the three designated components were relatively low; 41.52 %. Total variance of each component was presented on Table 4.3. Rotated varimax of combined NEP items were shown on Table 4.4 .

Table 4.3. Total variance explained of each component of the NEP scale.

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.641	19.336	19.336	3.577	14.904	14.904
2	2.985	12.436	31.773	3.536	14.734	29.638
3	2.339	9.747	41.520	2.852	11.882	41.520

According to Tables 4.3 and 4.4, the first component was recognized as HON, the second one as LTG, and the third one as BON. Positions of items 9, 11, and 13 were somehow ambivalent. Items 9 and 13 on the second round loaded on both LTG and BON factors. Item 11 on the first run did not have strong loadings in any of the factors. One possible reason for the weak loading of the factors might be misunderstanding of the items by the Turkish sample.

Table 4.4. Rotated varimax of combined NEP items. (Loadings below 0.3 were supressed for easy interpretation.)

	Component		
	1	2	3
NEP 19R 1	.763		
NEP 17_R	.758		
NEP 19_R	.739		
NEP 18_R	.736		
NEP 20R 1	.568		
NEP 20_R	.508		
NEP 18R 1	.468		
NEP 17R 1	.404		
NEP 14 1		.744	
NEP 14		.741	
NEP 13		.675	.392
NEP 15		.573	
NEP 16		.555	
NEP 15 1		.501	
NEP 16 1		.497	
NEP 13 1		.476	
NEP 9 1		.466	
NEP 11 1			
NEP 10			.763
NEP 10 1			.763
NEP 11			.612
NEP 9		.432	.563
NEP 12			.504
NEP 12 1			.475

4.1.3. Factors that Might Affect Pro-Environmental Attitude

4.1.3.1. Gender: The effect of gender on pro-environmental attitude was analyzed by the independent samples t-test. Although female students always scored higher on the scales than male students, only the differences in the NEP (I), NEP (II), and LTG (I) were significant at the .05 level (Table 4.5).

Table 4.5. Effect of gender on NEP scale and its subgroups

	t	df	Sig.	Mean Difference	Std. Error Difference
NEP (I)	2.930	49	.005	4.11	1.404
NEP (II)	2.069	49	.044	3.47	1.678
BON (I)	.944	51	.349	.61	.649
BON (II)	.384	49	.703	.27	.709
LTG (I)	3.085	52	.003	2.24	.725
LTG (II)	1.830	50	.073	1.37	.751
HON (I)	1.869	51	.067	1.41	.755
HON (II)	1.883	50	.065	1.71	.910

4.1.3.2. Environmental Course and Environmental Activities: The effect of taking an environmental course was analyzed by the independent samples t-test. Although, there were slight differences in scales' and subscales' scores between students that did and didn't attend in environmental courses, none of them were significant on the .05 level.

The relationship between the NEP scales and participation in environmental activities was also investigated by independent samples t-test. Those, who participated in environmental activities, had relatively higher scores on NEP and its subscales. Yet, none of the differences were statistically significant at the .05 level.

4.1.2.3. Other Factors: Other factors that might affect EA, investigated here, were: (1) place of residence, (2) departmental affiliation, and (3) GPA. The effects of the place of residence and GPA on the NEP scales and subscales were tested by one-way ANOVA. No significant effect was detected at the .05 level.

The effect of having a minor or major science teaching degree on proenvironmental attitude was analyzed by the independent samples t-test. There was not a clear pattern of differences and none of them were significant. Similarly, GPA of the students, tested by one-way ANOVA, didn't have a significant effect on the scores of the NEP scales and the subscales.

4.2. Results Related to Environmental Knowledge

4.2.1. Descriptive Statistics of Environmental Knowledge Test

Environmental knowledge of prospective teachers was measured by the EKT. The test was administered twice, at the beginning (I) and at the end of the term (II). The questions and percentages of right answers are presented in Table 4.6 . The item number 13 was eliminated from further analysis because of the very high percentage of correct answers to it (95%), which rendered it uninformative. Scores for questions related and unrelated to environmental experiments, and total scores of the tests (EKT I and II) are presented in Table 4.7.

Table 4.6. Percentages of correct responses to each item on EKT.

Items	Correct Responses (I) [%]	Correct Responses (II) [%]
1) Which environmental problem is resulted from chemical reactions containing sulfide?	67.3	80.0
2) Which main ions cause hardness of water?	23.6	49.1
3) If a chemical was exposed to a certain dose that do not cause any harm, this means that the dose is below ___.	70.9	85.5
4) The chemicals that lead to decomposition of stratospheric ozone are __.	32.7	45.5
5) What percent of the generated energy in Turkey produced in nuclear power stations?	54.5	56.4
6) According to the given paragraph, which statement is true?	61.8	63.6
7) Which type of waste has the highest proportion within domestic wastes?	36.4	32.7
8) What does E. coli density in water indicate?	63.6	78.2
9) Which has the higher water permeability?	30.9	50.9
10) What is the main reason of acid rain?	27.3	36.4
11) Forty years ago, the population of the world is _____.	43.7	49.1
12) Which choice is an example of an adaptation in the process of evolution?	36.4	61.8
13) After consuming of paper office materials, they are used in newspaper publication and production of paper bags. What can be the whole process called?	94.5	100
14) What is the bad effect of 'phosphate' in water?	20.0	63.6
15) Which environmental problem that is resulted from dangerous wastes, affects human health the most seriously?	32.7	41.8
16) Which statement does <u>not</u> represent a function of 'humus' in soil?	16.4	27.3
17) Which is an example of an environmental hazard caused by acid rain?	65.5	61.8
18) Which statement(s) below are among the benefits of re-cycling towards environment?	70.9	52.7
19) Which statement is true?	50.9	74.5
20) According to the given paragraph, the reason of dying of fish in Sakarya River is_____.	25.5	43.6
21) Since 1980s, there has been an 50 % increase in skin cancer cases in Britain. The main reason of this situation is _____.	61.8	65.5

Table 4.7 Descriptive characteristics of group of questions on EKT. (Scores for questions related and unrelated to environmental experiments are presented separately.)

	Related		Unrelated		EKT	
	(I)	(II)	(I)	(II)	(I)	(II)
Mean	6.62	8.51	3.29	3.69	9.91	12.20
Percent correct	47.3	60.8	47.0	52.7	47.2	58.1
SD	1.72	1.95	1.49	1.65	2.31	2.64

4.2.2. Factors that Might Affect Environmental Knowledge

4.2.2.1. Gender: Unlike in the case of pro-environmental attitude, no anticipated pattern of environmental knowledge was observed between male and female students (Table 4.8). The effect of gender on environmental knowledge was analyzed by the independent samples t-test.

The only significant result was observed for the Unrelated Questions (I), where male students scored higher than females (t [n = 55] = 2.564, p =.013). Effect of gender on EK is presented on Table 4.9 .

Table 4.8. Descriptive characteristics of environmental knowledge scores according to genders.

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Related (I)	Female	29	6.69	1.734	.322
	Male	26	6.54	1.726	.338
Related (II)	Female	29	8.90	1.819	.338
	Male	26	8.08	2.038	.400
Unrelated (I)	Female	29	2.83	1.311	.243
	Male	26	3.81	1.524	.299
Unrelated (II)	Female	29	3.38	1.399	.260
	Male	26	4.04	1.865	.366
EKT (I)	Female	29	9.52	2.278	.423
	Male	26	10.35	2.314	.454
EKT (II)	Female	29	12.28	2.419	.449
	Male	26	12.12	2.917	.572

Table 4.9. Effect of gender on environmental knowledge scores

	t	df	Sig.	Mean Difference	Std. Error Difference
Related (I)	.324	53	.748	.15	.467
Related (II)	1.576	53	.121	.82	.520
Unrelated (I)	-2.564	53	.013	-.98	.382
Unrelated (II)	-1.492	53	.142	-.66	.442
EKT (I)	-1.337	53	.187	-.83	.620
EKT (II)	.223	53	.824	.16	.720

4.2.2.2. Other Factors: To investigate possible effects of taking environmental courses and participating in environmental activities on environmental knowledge, independent samples t-test was used. However, no significant difference was found.

Place of residence, department affiliation and GPA of prospective teachers were also analyzed. One-way ANOVA was used to test for effects of GPA and place of residence on environmental knowledge. Again, no significant results were detected at .05 level.

4.3. Correlation between Environmental Knowledge and Environmental Attitude

Correlation between environmental knowledge and environmental attitude of prospective teachers was investigated by computing Pearson *r* coefficient. The results are presented in Table 4.10 . Only one statistically significant correlation was found ($r = .313$, $p > .05$). That is, there was a significant relation between related questions scores in EKT (I) and scores of LTG dimension in NEP scale (I). By referring Table 4.10, one could conclude that there was not an association between environmental knowledge and environmental attitude.

Table 4.10. Correlations between NEP and EKT scores

		NEP (I)	NEP (II)	BON (I)	BON (II)	LTG (I)	LTG (II)	HON (I)	HON (II)
Related (I)	r	-.202	-.175	-.147	-.202	-.313	-.246	.024	.036
	Sig. (2-tailed)	.156	.219	.293	.156	.021	.079	.865	.802
	N	51	51	53	51	54	52	53	52
Related (II)	r	.148	.035	.019	-.031	.163	-.052	.088	.126
	Sig. (2-tailed)	.300	.810	.891	.831	.239	.715	.529	.372
	N	51	51	53	51	54	52	53	52
Unrelated (I)	r	.077	.125	-.016	.158	.138	.268	.061	-.121
	Sig. (2-tailed)	.591	.384	.910	.267	.319	.055	.665	.391
	N	51	51	53	51	54	52	53	52
Unrelated (II)	r	.024	-.116	.086	.084	-.019	-.038	.061	-.242
	Sig. (2-tailed)	.867	.419	.542	.560	.889	.789	.664	.083
	N	51	51	53	51	54	52	53	52
Total (I)	r	-.102	-.051	-.119	-.049	-.143	-.010	.057	-.052
	Sig. (2-tailed)	.477	.723	.397	.732	.301	.943	.685	.715
	N	51	51	53	51	54	52	53	52
Total (II)	r	.124	-.048	.067	.030	.108	-.063	.102	-.060
	Sig. (2-tailed)	.386	.740	.634	.833	.438	.658	.469	.675
	N	51	51	53	51	54	52	53	52

4.4. Effect of Environmental Education Program on Environmental Attitude and Environmental Knowledge

The overall change of EA and EK, and their significances were computed with Paired Samples t-test and presented on Table 4.11 . After application of EEP, significant changes were got between pre- and post-tests.

Table 4.11. Effect of EEP on EA and EK

Pairs	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
EKT I – EKT II	-2.29	2.780	.375	-6.111	54	.000
Related I – Related II	-1.89	2.079	.280	-6.746	54	.000
Unrelated I – Unrelated II	-.40	1.628	.220	-1.822	54	.074
NEP I- NEP II	-1.81	5.472	.798	-2.266	46	.028
BON I – BON II	-.37	2.205	.315	-1.166	48	.249
LTG I – LTG II	-.84	2.738	.383	-2.199	50	.033
HON I - HON II	-.50	2.667	.377	-1.326	49	.191

It could be concluded that there was a positive EA change after EEP (t [n = 46] = - 2.266, p = .028). When scores of each dimension of NEP were taken into account, only 'Limits to Growth' dimension resulted in a significant change (t [n = 50] = -2.199, p= .033).

5. CONCLUSION

Before the application of the program, two variables; EA and EK were selected. According to Elliott (1999), the definitive goal of EE was to develop individuals who would act positively by demonstrating responsible behavior toward their environment. In consequence, REB were studied.

On pre-tests, an encouraging finding for a developing country, which is at the very first stages of EE (Tuncer et al., 2005) was concluded in this study: Prospective teachers had pro-environmental attitudes. This is an encouraging finding in the sense that; one of the goals of EE was said to develop an environmentally concerned population (UNESCO-UNEP, 1976). Moreover, findings related to EA and factors of EA were found to be consistent with other Turkish studies on prospective teachers and university students respectively (Özmen et al., 2005; Şama, 2003). However, EK level of prospective teachers were found to be low in the study and this finding is also consistent with previous environmental literacy studies.

The study indicated that there was a gender difference in EA of prospective teachers. It was found that females scored significantly higher on LTG dimension which was related to limited resources of the Earth and related anxiety and concern about the issue. This finding was consistent with Milfont and Duckitt's study (2004) such that; women had significantly higher scores on "Preservation" dimension of EA which included intent of support, enjoyment of nature, limits to growth and care with resources factors.

After the application of the program, statistically significant differences were concluded in EA and EK of prospective teachers. It was found that the difference in EA of prospective teacher was stemmed from LTG dimension. Hence, this program could be considered as successful for developing EA to some extent. To sum up, it could be stated that the program seemed to be working for this sample.

5.1. Limitations of the Study

A Turkish instrument to measure EK of prospective science teachers in accordance with the environmental experiments of the program was not found in the literature. Hence, an environmental knowledge test was designed by the researcher. The psychometric properties of the test were not studied. This was a limitation for the study.

Another limitation of the study was the time constraint. The treatment was carried out during a laboratory application course for prospective science teachers and the whole program took eight weeks. Since, the same instruments were used at the beginning and end of the study, the subjects might remember the questions in such a relatively short period of time. Hence, their scores on EK test might be affected. Another limitation about time constraint is that; although a significant difference in EA and EK of the subjects, no further measurement has been done whether the changes were long-lasting or not.

5.2. Suggestions for Further Research

This study was an attempt to train prospective teachers about environmental issues and possible activities and methods that can be applied in primary school science classes. The program included six environmental experiments that were related to subjects of different grades.

First of all, to improve this program, more environmental experiments and activities should be included and the program should be arranged as a three- year-long environmental program (namely, 6^{th}, 7^{th} and 8^{th} grades) that addresses the needs of every grade equally. And, the environmental experiments should address all dimensions of NEP other than LTG. Moreover, to work on long-term effects of the program, the tests should be applied after some time of the treatment. Consequently to have more permanent results, a longitudinal study should be applied.

Secondly, in order to generalize the results of the study, it should be carried out with a larger number of prospective science teachers, science teachers, and primary school students after improvement of the limitations. Actually, primary school students will be the

ultimate target group of the study, and teachers and prospective teachers have the transitional roles for applying the program. It would be expected to have more definite changes in EA of children due to inverse effect of age on EA (Arcury, 1990).

Present science teachers have their experience with the previous curriculum, its content, and advised methods, and have difficulty in applying the new curriculum. So, this environmental program can be applied to science teachers as an in-service training program.

Another suggestion is that more Turkish instruments should be designed for academic and practical purposes. For instance, Turkish knowledge tests about general environmental issues seem to be a deficiency in the literature.

Besides, there should be more emphasis on environmental issues in science teaching courses in education faculties. Because, it was proved that teachers receiving prospective EE preparation were found to feel more confident about implementing EE in their future classes (Lane et al., 1995). However, faculties have their own load of required and elective courses. So, it is difficult to open EE courses in most education faculties. But, programs embodied in the teacher training schedule would be more practical. In this sense, the study supported the idea of inclusion of EE in teacher training curriculum rather than opening EE electives (Powers, 2004). Hence, more programs and activities should be placed in science teaching courses in education faculties.

The proposed programme might be suitable for a laboratory course. But, it is suggested that in Turkey, teacher training courses should be enriched with supporting outdoor activities that enable prospective teachers to gain nature-experiences and broaden their environmental viewpoint.

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APPENDIX A:
DEMOGRAPHIC INFORMATION SHEET &
ENVIRONMENTAL ATTITUDE SCALE

APPENDIX B:

ENVIRONMENTAL KNOWLEDGE TEST

APPENDIX A

ÇEVRESEL TUTUM ÖLÇEĞİ

Bu ölçek, çevre ile ilgili tutumları ölçmek amacı ile hazırlanmıştır. Çalışma sırasında kimliğiniz gizli tutulacaktır. Sizin hakkınızdaki bilgiler sadece belirli farkları tespit etmek için istenmiştir. İş birliğiniz için şimdiden teşekkür ederim.

Arş. Gör. Zerrin Doğança

1) ID numaranızın son 4 basamağı : _ _ _ _

2) Okulda geçirdiğiniz dönem sayınız:

8'den fazla (4) 7-8 dönem (3) 5-6 dönem (2) 4 veya 4'ten az (1)

3) GPA:

3.5-4 (5) 3- 3.5 (4) 2.5- 3 (3) 2- 2.5 (2) 2'nin altı (1)

4) Cinsiyetiniz: K (0) E (1)

5) Öğrenim gördüğünüz program:

İlköğretim Matematik Öğretmenliği (1) Fen Bilgisi Öğretmenliği (2)

6) Öğrenim hayatınız boyunca hiçbir çevre dersi aldınız mı? Evet (1) Hayır (0)

7) Daha önceden herhangi bir çevre etkinliğine katıldınız mı veya çevre kuruluşuna üye misiniz? (Evet ise lütfen açıklayınız.)

Evet (1) Hayır (0)

---

8) Yaşamış olduğunuz yer;

Büyük Şehir (1) Şehir (2) Kasaba veya köy (3)

(Not: Eğer önceden yaşadığınız yerler farklı kategorilerde ise; size uygun olan *birden fazla* kategoriyi işaretleyebilirsiniz.)

	Her bir ifadeyi okuduktan sonra, buna ne derece katıldığınızı gösteren sütuna ait olan ve ifadenin hizasında bulunan kutucuğun içine "X" şeklinde işaretleyiniz. Bir ifadeyi okuduktan sonra aklınıza ilk geleni işaretleyiniz.	Tamamen katılıyorum (5)	Katılıyorum (4)	Kararsızım (3)	Katılmıyorum (2)	Kesinlikle katılmıyorum (1)
9	*Doğanın dengesi çok hassastır ve kolayca bozulabilir.*					
10	*İnsanların doğaya müdahalesi genellikle felaketlere yol açar.*					
11	*İnsanlar varolmayı sürdürmek için doğa ile uyum içinde yaşamak zorundadır.*					
12	*İnsanlar çevreyi ciddi şekilde suistimal etmektedir.*					
13	*Dünyanın barındırabileceği insan sayısına yaklaşmaktayız.*					
14	*Dünya bir uzay gemisi gibidir; çok sınırlı yeri ve kaynakları vardır.*					
15	*Ekonomik büyümenin sınırları vardır; sanayileşen toplumlar bunları aşamaz.*					
16	*Sağlıklı bir ekonomiye sahip olmak için endüstriyel büyümenin kontrol edildiği istikrarlı bir ekonomiye sahip olmalıyız.*					
17	*İnsanlar doğaya hakim olmak üzere yaratılmıştır.*					
18	*İnsanların çevreyi ihtiyaçlarına göre değiştirmeye hakkı vardır.*					
19	*Bitki ve hayvanlar öncelikle insanlar tarafından kullanılmak üzere vardır.*					
20	*İnsanlar doğal çevrelerine uyum sağlamak zorunda değildir, çünkü onu ihtiyaçlarına göre yeniden yapabilirler.*					
21	*Bitkilerin ve hayvanların da en az biz insanlar kadar yaşama hakkı vardır.*					
22	*Doğanın dengesi modern sanayi ülkelerinin etkileriyle baş edecek kadar güçlüdür.*					
23	*İnsanlar özel yeteneklerine rağmen, hala doğanın kurallarına tabidirler.*					
24	*İnsanlığın karşı karşıya kaldığı söylenen 'ekolojik kriz' fazlasıyla abartılmaktadır.*					
25	*İnsanlar doğanın geri kalanına hükmetmek için yaratılmışlardır.*					
26	*Eğer her şey şimdiki seyirinde giderse; çok yakında büyük bir ekolojik felaket yaşayacağız.*					

APPENDIX B

ID numaranızın son 4 basamağı : _ _ _ _

ÇEVRESEL BİLGİ TESTİ

Bu test, bilimsel bir çalışmada kullanılmak amacıyla hazırlanmıştır. Çalışma sırasında kimliğiniz gizli tutulacaktır. Sizin hakkınızdaki bilgiler sadece belirli farkları tespit etmek için istenmiştir. İş birliğiniz için şimdiden teşekkür ederim.

Arş. Gör. Zerrin Doğança

1) Aşağıdaki çevre sorunlarından hangisi sülfürün katıldığı atmosferdeki kimyasal reaksiyonlar sonucunda gerçekleşmektedir?

a) Küresel ısınma
b) Fotokimyasal duman
c) Ozon tabakasındaki delikler
d) Asit yağmurları

2) Sudaki sertliğe neden olan başlıca iyonlar hangileridir?

a) Hidrojen ve fosfat
b) Sodyum ve klor
c) Nitrojen ve sülfür
d) Kalsiyum ve magnezyum

3) Bir kimyasala her hangi bir zarar vermeyecek dozda maruz kalınıyorsa, bu doz _____ altında demektir.

a) Akut zehirlenme dozu
b) Kişisel duyarlılık dozu
c) Kronik zehirlenme dozu
d) Eşik sınırı

4) Stratosferik ozonun yıkımına neden olan kimyasallar _____ .

a) Dizel motorlardan çıkan eksoz gazları
b) Düşük kalite kömür ve yağın yakılması sonucu çıkan gazlar
c) Soğutma cihazlarınındaki gazlar ve deodorantlar
d) Atık yakma tesislerinden çıkan gazlar

5) Türkiye'deki enerjinin % kaçı Türkiye'deki nükleer enerji santrallerinde üretilmektedir?

a) % 0 b) % 5 c) % 10 d) % 33

6. soruyu aşağıdaki paragraftan yararlanarak cevaplayınız.

'Avrupa'da yaşayan bir kelebek türü (peppered moth) gündüzleri ağaç gövdelerinde dinlenirken, geceleri yiyecek arar. Bu kelebekler avcılardan korunmak için, ağaç gövdeleri üzerinde farkedilmeyecek renklere sahiptirler. Sanayi devriminden önce, sadece açık renkteki kelebekler gözlenirken, 1848'de İngiltere'de ilk siyah kelebek gözlemlenmiştir. 50 yıllık sürede, koyu renkli kelebek sayısı, açık renklilerin sayısının 2 katına ulaşmıştır.'

6) Yukarıdaki paragrafta geçen durum hakkında, aşağıdaki önermelerden hangisi doğrudur?

a) Sanayi geliştikçe, kömür kullanımı artar ve ağaç gövdeleri daha koyu bir renk alır. Değişen çevre koşulları, açık renkle doğan kelebeklerin de yaşamları süresince renklerinin koyulaşmasına neden olur.
b) İlk siyah kelebekler değişen hava koşulları ile koyu renge sahip olmuştur.
c) Bu durumdaki adaptasyon; değişen çevre koşullarına uyum sağlayarak siyah renge sahip olmak ve ağaç gövdelerinde kamufle olabilmektir.
d) Sanayi devrimi sonrasında, siyah renkli kelebekler farklı bölgelerden göç etmişlerdir.

7) Evsel çöplerin oluşturduğu atıklar dikkate alındığında, aşağıdaki maddelerden hangisi yüzde olarak en yüksek değere sahiptir?

a) Yemek atıkları
b) Tahta
c) Kağıt atıklar
d) Plastik atıklar

8) Sudaki E.coli yoğunluğunun raporu aşağıdakilerden hangisinin göstergesidir?

a) Suyun asitliğinin
b) Sudaki biyolojik kirleticilerin
c) Sudaki fiziksel kirleticilerin
d) Sudaki kimyasal zehirlerin

9) Hangisinin su geçirgenliği en fazladır?

a) Killi toprak (clay)
b) Kum
c) Çamur
d) Humus

10) Asit yağmurlarının başlıca nedeni nedir?

a) Güç santralleri
b) Suni gübre
c) Çeşitli çözücüler
d) Trafik

11) 40 yıl önce, dünyanın nüfusu _____

a) Yaklaşık bugünkü kadardı.
b) Bugünkünden biraz daha azdı.
c) Bugünkünden yaklaşık 2 kat daha azdı.
d) Bugünkünden yaklaşık 10 kat daha azdı.

12) Aşağıdakilerden hangisi 'evrimsel süreçteki adaptasyon'a örnek olabilir?

a) Yaz aylarında, evcil hayvanların tüylerinin traş edilmesi ve sıcağa uyum sağlamaları
b) Kış aylarında, ayıların ve bazı hayvanların kış uykusuna yatmaları
c) Askere giden kişinin yapılan eksersizlerle daha kaslı bir yapıya sahip olması ve bulunduğu ortama uyum sağlaması
d) Değişen estetik anlayışına uyum sağlamak için, insanların estetik ameliyat olmaları

13) Eğer kağıt ofis malzemeleri kullanıldıktan sonra, gazete basımında ve kese kağıdı üretiminde kullanılıyorsa; bu işlemlerin tümü aşağıdakilerden hangisine örnektir?

a) Atıkların arıtılmasına
b) Kirlilik önlemeye
c) Atık geri dönüşümüne
d) Çöp toplama alanlarında tasarrufuna

14) Fosfatın sudaki hayata olan kötü etkisi aşağıdakilerden hangisidir?

a) Kansere neden olur.
b) Balıkların kısır kalmasına neden olur.
c) Suyu bulanıklaştırır.
d) Balıkların nefessiz kalmasına neden olan algleri besler.

15) Tehlikeli atıkların neden olduğu ve insan sağlığını <u>en ciddi</u> boyutta etkileyen çevre sorunu aşağıdakilerden hangisidir?

a) Hava kirliliği
b) Yeraltı sularına bulaşma
c) Habitatların yok olması
d) Çöp toplama alanlarındaki patlamalar

16) Aşağıdaki önermelerden hangileri topraktaki humusun işlevlerinden değildir?

a) Besin sağlamak
b) Toprağın pH değerini artırmak
c) Nem sağlamak
d) Toprağın havalanmasını sağlamak

17) Aşağıdakilerden hangisi asit yağmurlarının çevreye verdiği zararlara bir örnektir?

a) İnsanların görme yetilerinde azalma
b) Ormanların tahrip olması ve dolayısıyla bölgedeki canlı yaşamının olumsuz bir şekilde etkilenmesi
c) Yağışlar sonucu, su habitatlarının iyon bakımından zenginleşip, alg populasyonlarının artması
d) İnsanlarda cilt kanseri riskinde artış

18) Aşağıdakilerden hangileri kağıtların geri dönüşümünün çevreye olan katkılarındandır?

I. Ağaçların korunması
II. Daha fazla kaliteli kağıt kullanabilme
III. Su tasarrufu
IV. Elektrik tasarrufu
V. Çöp toplama alanlarında yer kazanımı
VI. Geri dönüşümün tesislerinin etrafındaki su alanlarındaki canlı sayısındaki artış

a) I, II, III, IV
b) I, III, IV, V
c) III, IV,V, VI
d) I,III, IV, V, VI

19) Aşağıdaki önermelerden hangisi doğrudur?

a) Eşik değerini aşmış bir zehirli madde çıkışı durumunda, küçük bir çocuğun göreceği zarar yetişkinlere göre daha fazla olacaktır.
b) Her zehirli madde için belirlenen eşik değerlerinin konmasındaki asıl amaç; ağır boyutda yaşanabilecek rahatsızlıkları önlemektir.
c) Tekrarlanan aralık veya dozlarda zehirli bir maddeye maruz kalma, akut zehirlenmeyle sonuçlanır.
d) Zehirli maddelerin kişiye zarar verme dozu, kişiler arasında farklılık göstermez.

20) Mart 1992'de, 9000 ton şeker pekmezi (şeker kamışının arıtılması sırasında geride bırakılan yoğun ve koyu şurup) Tayvan'daki Mekong nehri üzerinde bir silo tarafından sulara bırakıldı. Etkilen 600 km uzunluğundaki kısımda, nehrin kirlenenen herbir kilometresinde, yaklaşık yarım ton balık öldü. Benzer bir kaza Eylül 1994'te Sakarya nehri üzerinde de yaşandı. Balıkların ölme nedeni _____.

a) Şeker şurubunu ayrıştıran bakterilerin, sudaki tüm oksijeni tüketerek, balıkları boğmasıdır.
b) Şeker şurubunu ayrıştıran bakteriler hastalanması ve balıkları öldürmesidir.
c) Şeker şurubunun yıkımı balıkları öldürecek toksinlerin oluşturmuştur.
d) Şeker şurubu mavi-yeşil popülasyonunun arttırmıştır. Bunların salgıladıkları toksinler de balıkları öldürmüştür.

21) 1980'den beri, İngiltere'de cilt kanseri vakalarında % 50 artış olmuştur. Bu durumun asıl nedeni_____.

a) Ozon tabakasının delinmesi
b) Trofosferik ozon oluşumu
c) Küresel ısınma
d) Asit yağmurları