THE EFFECTS OF PROJECT-BASED LEARNING ON ENVIRONMENTAL LITERACY

by

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ABSTRACT

THE EFFECTS OF PROJECT-BASED LEARNING ON ENVIRONMENTAL LITERACY

The aim of the present study was to explore the effects of project-based learning on 9th grade students' environmental literacy and science process skills. Environmental literacy is the key to protect environment and find solutions to environmental problems. The sample of this study was 78 students from a vocational and technical high school for girls. One of the classes was randomly assigned as experimental group (called Group PB, N=40) and taught the topic 'environmental problems' through project-based learning method. They worked in groups to develop their own projects using scientific method and science process skills for an environmental problem they chose. The other group (called Group TC, N=38) learned about the same topic with teacher-centered instructional method. The two teaching methods were implemented by the researcher. The data collection tools utilized for the study were Environmental Literacy Test (ELT) that consisted of three parts, namely, knowledge, attitude, behaviour, and Science Process Skills Test (SPST). Both tests were given before and after the treatments and semi-structured interviews were conducted with eight students from each class. According to the analysis of ELT-Pre, ELT-Post, SPST-Pre and SPST-Post, it was found that Group TC improved their scores in environmental knowledge and attitude components of environmental literacy, but Group PB improved their scores in all the components (environmental knowledge, environmental attitude, and environmental behavior) of environmental literacy and science process skills. According to the comparison of the Post-tests, Group PB students performed better than Group TC students in all tests. In the interviews, Group PB students mentioned many themes and codes that belong to environmental literacy components and science process skills, which indicated that they developed a more enriched point of view than Group TC students. Furthermore, Group PB students gained lots of social skills such as self-confidence, group work, loving lessons, etc. as a result of project-based learning.

ÖZET

PROJE TABANLI ÖĞRENMENİN ÇEVRE OKURYAZARLIĞI ÜZERİNE ETKİSİ

Bu çalışmanın amacı proje tabanlı öğrenme metodunun 9. sınıf öğrencilerinin çevre okuryazarlığı ve bilimsel süreç becerilerine etkisini incelemektir. Çevre okuryazarlığı, çevreyi korumak ve çevre problemlerine çözüm bulmak için anahtardır. Çalışmaya mesleki ve teknik liseden 78 öğrenci katılmıştır. Sınıflardan biri rastgele olarak deney grubu (Group PB, N=40) seçilmiş ve çevre problemleri konusunu proje tabanlı öğrenme metoduyla öğrenmişlerdir. Öğrenciler grup olarak kendi belirledikleri bir çevre problemini çözebilmek için projeler geliştirmiş, böylece bilimsel yöntem ve bilimsel süreç becerilerini kullanmışlardır. Diğer sınıf (Group TC, N=38) ise aynı konuyu öğretmen merkezli olarak işlemiştir. Çalışmada ön test ve son test olarak çevre bilgisi, çevreye karşı tutum ve çevresel davranış alt testlerini içeren çevre okuryazarlığı testi ve bilimsel süreç beceriler testleri uygulanmıştır. Ayrıca uygulamanın öncesi ve sonrasında her gruptan seçilen 8 öğrenciyle yarı-yapılandırılmış görüşmeler yapılmıştır. Yapılan ön test ve son test analizlerine göre, Group TC öğrencilerinin sadece çevre bilgisi ve tutumunda artış görülürken, Group PB öğrencilerinin tüm testlerde gelişme gösterdiği görülmüştür (çevre bilgisi, çevre tutumu, çevresel davranış, bilimsel süreç becerisi). Son testler karşılaştırıldığında Group PB öğrencilerinin bütün testlerde ve alt testlerde Group TC öğrencilerine göre anlamlı bir şekilde üstün başarı gösterdiği görülmüştür. Görüşme sonuçlarına göre, Group PB öğrencileri Group TC öğrencilerine göre daha geniş bir açıdan bakarken, çevre okuryazarlığı ve bilimsel süreç becerilerine ait çok daha fazla kod ve tema ortaya çıkarmışlardır. Ayrıca Group PB öğrencileri görüşmelerde, proje tabanlı öğrenme sayesinde kendine güven, grup çalışması, derslere karşı olumlu bakış açısı gibi çok sayıda sosyal beceriler kazandıklarını belirtmişlerdir.

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LIST OF SYMBOLS

Df	Degrees of freedom
F	Frequency
M	Mean
N	Number of participants
T	t Value

LIST OF ACRONYMS / ABBREVIATIONS

Asymp. Sig.	Asymptotic Significance
BAS	Scientific Research and Science Process Skills Objectives
ELT	Environmental Literacy Test
EnvAtt	Environmental Attitude
EnvBeh	Environmental Behavior
EnvKnow	Environmental Knowledge
Group PB	The Treatment Group Which Received the Unit With Project-Based Learning Method
Group TC	The Treatment Group Which Received the Unit With Teacher-Centered Instruction
Int.	Interview
PBL	Project-based Learning
RQ	Research Question
Sig.	Significance
SPS	Science Process Skills
SPST	Science Process Skills Test
UNESCO	United Nations Educational, Scientific and Cultural Organization

1. INTRODUCTION

Humans have been affected by the environment and they have also affected the environment since their existence on the world. For a long time, they were happy with what environment gave and got along well with it, because the population was not so crowded and they didn't have enough technology to fight with the environment (Yıldız *et al.,* 2000). With the industrial revolution, population started to grow fast and people's needs for the environment and the sources started to increase. This situation led to the most important cause of the environmental problems that the world deals with. At first, people could not realize the extent of the environmental problems. After the realization of reducing sources, the damages for environment came out as environmental pollution. In the 20th century, people started to become more sensitive about the environment and they started to search for the solutions to the environmental problems.

The main cause of the environmental problems is a thought that people are the owners of the world and have the right to use nature as they own it. Environmental problems can't be solved only with technological, political, economical precautions. The main solution can be to change the life styles of people's (Selvi, 2007). Environmental education should be for life long and the main goal of it should be to raise environmental literate citizens (Salmon, 2000). Environmentally literate people have the *environmental knowledge* as the first step, then has *attitudes* including concern, sensitivity and responsibility in order to get active. Being active for environment was called the *environmental behavior* component of environmental literacy by Roth (1992) and he explained it as changing knowledge and attitude into action. The present study focused on these three environmental components; environmental knowledge, environmental attitude and environmental behavior as many researchers. In addition, the four levels of environmental education were adopted in this study, as being similar to the study of Hungerford (1980). For first level, teacher gave necessary concepts and terms before the projects in order to build environmental knowledge. By asking students to find out environmental problems around them; their awareness and values improved and all of these belonged to second level. Students found out solutions to these environmental problems as the same with third level and finally they applied the solutions and represented

the results so that all levels were completed. By this way, this study was developed in accordance with the aims of an environmental education curriculum should have.

Only knowing about ecological concepts or having positive feelings about environment can't solve environmental problems. The main aim should be implementing solutions after getting informed and motivated about finding out these solutions. The implementation part can be done with project-based learning approach, because project-based learning approach leads students to deal with real life problems, improves their problem solving skills, and suggests ways to apply their knowledge and skills (Korkmaz, 2004).

Educators have a desire for their students to gain different types of skills, knowledge, behaviors. Therefore, there would be a lot of confusion because of different views, approaches and characteristics in education. Curricula show direction and state the aims, goals and objectives for educators and students. Three different types of objectives, namely; science-technology-society-environment relations; scientific research and scientific process skills; communication skills, attitudes and values were included in 2007 Secondary School Biology Curriculum. In the present study, science process skills were investigated. According to 2007 Secondary School Biology Curriculum, there were 20 objectives in total on scientific research and science process skills and five of them were listed in 'environmental problems' topic. Using project-based learning method, the present study showed that 12 different scientific research and science process skills objectives could be added to the listed five objectives in environmental problems topic. Environmental literacy is an ongoing process and science process skills are needed throughout this process. Both science process skills and project-based learning give students the opportunity to connect their knowledge with real life situations (Lloyd *et al*., 2000).

People frequently face with environmental problems in their daily lives, they become aware of them and getknowledge from different sources like media or families. The focus of the present study was environmental education in schools, which was presented by biology curricula. Salmon (2000) emphasized the importance of environmental education in schools. According to him, environmental literacy acquired in schools will be permanent

and it can be adapted to various environmental problems that have the possibility to change over time. Hsu (2004) stated that environmental problems which occur around the students take their attention and this awareness motivates them to take action for those problems. This study combined these two ideas of the researchers. It was conducted in a region of İstanbul that has irregular urban development and very low level of green area per meter, and thus the students had serious concerns about the environmental problems in their region, as stated by Hsu (2004). Beside these environmental problems, students' parents had low socio-economic status and education level and environmental education is intentionally offered in schools.

The revision in environmental topics was done in curricula which were used between years 2007-2013. The term "literacy" entered the curricula with 'biology literacy'. Another very important term, "environmental literacy" has never been added to biology curricula, but it should be introduced as the main aim of the environmental education before it is too late as it is in the world. Unfortunately three different types of objectives, the relation among science-technology-society-environment; scientific research and science process skills; communication skills, attitudes and values were removed with 2013 Secondary School Biology Curriculum and also 'literacy' term has been removed from biology curricula since 2018 (MoNE 2013c; MoNE 2018). In this study, the importance of environmental literacy, project-based learning and science process skills terms are emphasized and this situation supported Stefani Hines' (cited in Chepesiuk, 2007, pp.499) words which is: *'Literacy is a never-ending process. Like any form of education, environmental literacy must never stop, and it has to be promoted and encouraged at all levels and sectors.'*

2. LITERATURE REVIEW

This chapter of the study presents the review of previous research studies relevant to the present study. Three main sections are included in this chapter: Environmental literacy, project-based learning and science process skills. In the first part, the definition and the components of environmental literacy are explained. Additionally, information about environmental education and its place in Turkey is given. Following that, research studies on environmental literacy around the world and in Turkish context are presented. In the second part, the definition and features of project-based learning are given with its phases, benefits and the relevant research studies. In the third part, the definition of science process skills and the types are provided, which is concluded with the research studies on science process skills.

2.1. Environmental Literacy

2.1.1. Definition of Environmental Literacy

Literacy is defined as the ability of writing and reading to communicate with written and non-written symbols (Daudi and Helmlich, 1997). Beside this general definition, literacy concept is described as the skills to have knowledge and use this knowledge in every step of life in order to solve problems and have success in what is aimed (OECD, 2000). There are several types of literacy: scientific literacy, mathematics literacy, environmental literacy, media literacy, digital literacy, etc. Some of them, such as environmental and civic literacy, financial and economic literacy and awareness, business and entrepreneurial literacy and media literacy skills are listed among 21st century skills (Kaufman, 2013). The aim of this part is to define and clarify what it means to be environmentally literate.

After United Nations Education, Scientific, and Cultural Organization (1977) accepted environmental literacy as the major aim of environmental education, environmental literacy has received attention of many researchers. Charles E. Roth used

Environmental Literacy concept for the first time in 1968. Roth defined environmentally literate person who has feelings and skills for human-environment relationship.

Environmental literacy has been described in various ways by different researchers. Orr (1990) defined environmental literacy as understanding of the relationship between people and natural environment. In 1992, Roth developed his environmental literacy definition and added observable behavior concept to basic skills, understandings and feelings. According to him, environmental literacy is the ability of showing environmental knowledge as behaviors. After this definition, the term 'environmental behavior' gained more attention and environmental literacy was explained as transferring environmental knowledge to environmental behavior by several researchers including Clair's (2003), who asserted that environmental literacy was the combination of knowledge and action. Another researcher, Morrone *et al,* (2001) defined environmental literacy as transferring environmental values, attitudes and skills into action and by this way he supported the idea that environmental literacy doesn't mean only environmental knowledge.

2.1.2. Components of Environmental Literacy

Environmental literacy intends to establish awareness of making the world a better place by protecting our resources for ourselves and all of the other species. A person can't become environmentally literate by having factual knowledge; there are behaviors and attitudes that work for environmental sustainability (Kibert, 2000). In order to reach a common conception of environmental literacy and make it clear, researchers worked on its components. Six components, environmental sensitivity, knowledge, skills, attitudes and values, personal investment and responsibility, and active involvement were defined by Disinger and Roth (1992). In studies, environmental sensitivity, attitudes and values were classified as 'affects'; personal investment and responsibility were named as 'behavior' (Roth, 1992). By this way, four components appeared as knowledge, skills, affect and behavior. Roth (1992) defined environmental knowledge component as not only having ecological knowledge, but also knowledge about environmental terms and knowing the relation between natural systems and environment. 'Affect' component is not only about sensitivity towards environment and environmental problems. It is about taking social ethic and moral values into consideration while making decisions and acting responsible for the

environment. ‘Skills’ component is the ability of using knowledge and attitudes in solving environmental problems. Last component, ‘environmental behavior’ has been defined as a concrete proof of knowledge, affect and skills. It is the active involvement part in the solution step of environmental problems (Roth, 1992).

After 2000, studies about environmental literacy have started to use attitude component instead of using both affect and skill components as done by Hungerford and Volk (2003) and Kibert (2000). As a result, three main components as knowledge, attitudes and behaviours appeared. Erten (2005) defined environmental attitude as all positive or negative thoughts and feelings about the behaviors for environment. Getting ready to solve environmental problems because of the anger and fear that was caused by the same problems was given as an example for this definition.

The main aim of environmental education is to develop environmental literacy in students. Environmentally literate students should combine knowledge with values, attitudes and skills and turn them into action because the environmental problems can be different, but the environmental literacy of the students is infinite (Salmon, 2000). In this study, knowledge, attitude (including sensitivity and concern) and behavior components were studied as can be seen in the studies conducted by Hungerford and Volk (2003) and Kibert (2000). Knowledge is the part that differentiates between the environmental education in school and in family or social learning, thus the effects of learning methods should be assessed on this component. Second component, attitudes are defined as positive or negative feelings of an individual for an object, a situation or a fact. In order to measure and evaluate the attitudes that have effects on learning and the way of life is important in every step of education (Üredi and Üredi, 2005). The main reason of choosing project-based learning method is to focus on the action part that means environmental behaviour as third component, because project-based learning is an effective method for making students participate the process and become active (Erdem, 2002). Coşkun *et al.* (2013) emphasized the importance of effective methods in education for developing cognitive and emotional awareness. Also in the same study, it was stated that if students have emotional awareness then they will be encouraged to take action for environment that means to have environmental behavior component of environmental literacy.

2.1.3. Environmental Education

Many educators and researchers stated that having environmentally literate citizens is the basic aim of Environmental Education (Disinger, 1983; Chu *et al*, 2007).

Disinger (1983) reported that, Stapp made the first definition of environmental education in 1969 and explained its aim as raising people who know about environment and its problems, who are aware of these problems' solutions and who want to find solutions for them. International studies helped environmental education to improve and the proof for this can be suggested as the increase in the number of conferences and meetings. During the 'International Working Meeting on Environmental Education in the School Curriculum' which was held in 1970 in Nevada, the definition of environmental education was accepted as using behaviour and decision making words in addition to attitude, knowledge and skills terms (IUCN, 1970, n.p.). After five years, Belgrad Charter was held in 1975. The aim of this meeting was to build a global environmental education framework.

One of the most important steps was taken in Tblisi, Georgia in 1977. It was organized by the United Nations Education, Scientific, and Cultural Organization (UNESCO) and the United Nations Environment Program (UNEP). Tblisi document has a crucial impact on environmental education. The qualifications of environmental education were listed and published in this document. According to Tblisi Declaration (1977), environmental education includes different subjects and disciplines, it gives importance to the sources and its limits of environment, taking responsibility and being involved in the process is important, it positions the education in the center and refers to the environmental literacy components (UNESCO, 1977, p.27).

The Tbilisi Objectives were always centered in all of the UNESCO Meetings like Moscow (1987) and Thessaloniki (1997). With the help of these meetings, a worldwide definition of environmental education was developed.

It was believed that adding environmental education into curricula will help solve environmental problems, but for the last 40 years, environmental education have not been

able to be successful at changing attitudes and behaviors to get rid of the damage given to the environment and environmental problems (Saylan and Blumstein, 2011). The issues in environmental education are generally added to science or geography curricula in most countries in the world (Stanisic and Maksic, 2014). According to North American Association for Environmental Education (2016), environmental education encourages students to think, decide and change their lifestyles. It is stated that environmental education has benefits such as enabling the development of knowledge and skills to solve complex environmental problems and also contributes to academic success (NAAEE, 2016). The same understanding is acceptable for our country as Erten (2012) stated in her study that environmental education is a tool to educate students for increasing environmental attitude and environmentally friendly behaviour.

2.1.3.1. Environmental Education in Turkey. In Turkey, The Ministry of National Education (MoNE) is responsible for all educational services in the country except higher education. The course named 'Environment' is offered as a lesson in primary schools between 1992-1997 years, but then it started to become a part of science lessons. In the high school biology curriculum implemented between years 2007-2013, environmental topics were highlighted and more time was devoted to them in the new curricula than the old ones (Bilgi, 2008). Before the curriculum implemented between 2007-2013, biology and geography curricula included environmental topics but they did not include issues about environmental problems and protecting the environment. These courses were full of factual information such as ecological terms and facts that fail to make students turn skills into action for environment. These topics did not take students attention and did not improve students' attitudes towards environment (Uzun and Sağlam, 2005). After 2007, biology, chemistry and geography programs included environmental topics. In biology lesson, different topics about environment such as environmental problems, Atatürk's understanding of nature and environment, structure of ecosystems, energy flow and cycles in ecosystems, importance of ecosystems, community ecology, population ecology, biome, environmental rehabilitation, studying environmental problems according to ethical, political, and environmental issues and sustainable development were spread through 9th grade to 12th grade as spiral approach. In that 9th grade biology curriculum, the last unit was 'Conscious Individual- Livable Environment' which has topics such as 'Environmental Problems' and 'Ataturk's Understanding of Nature and Environment'. The

main goals of this unit are to recognize the adverse effects of human activities on the environment, to develop solutions to these problems, to understand the impact of environmental problems on human health, to become biology literate (MoNE, 2007). Furthermore, this unit included objectives regarding science-technology-society-environment relations; scientific research and science process skills; communication skills, attitudes and values. In the secondary school biology curriculum implemented between 2007-2013, the concept of environment was included with increased number of topics and various objectives. Theoretical part of environmental education was tried to reach international standards with this curricula, but implementation part is the key point that will produce environmentally literate citizens for our country and the world. This study was conducted based on the Secondary School Biology curriculum implemented between 2007-2013. However in 2018, biology curriculum was revised again. With this change the word 'literacy' did not take part in biology curriculum any more. Also there were no objectives classified as science-technology-society-environment relations, scientific research and scientific process skills, communication skills, attitudes and values (MoNE, 2018) included in this curriculum. Because of this situation, students or teachers do not become aware of science process skills objectives as easily as they did in previous curricula. Our study topic 'Environmental problems' took place in new curricula again, but not in 9th grade, it is in 10th grade curriculum. Spiral approach isn't used for environmental issues in current curricula any more.

2.1.4. Research Studies on Environmental Literacy

After the acceptance of the main aim of the environmental education as having environmentally literate citizens (Roth, 1992), the popularity of environmental literacy studies increased. Over the past 30 years, environmental literacy has been questioned by environmental education researchers. In order to measure students' environmental literacy levels, various instruments were developed and used. In most of these studies, the effects of several demographic characteristics were investigated. Gender was considered as the most popular demographic characteristics (Özsoy, 2010). In the studies of Bord and O'Connor (1997); Robinson and Crowther (2001), the concern, sensitivity and action components of environmental literacy were found to be higher in females, but the knowledge component was found to be higher in males. In some studies, the effects of

different instructions on environmental literacy were investigated. These studies were helpful in getting information about improving environmental literacy that is the main aim of the present study.

Wills (1999) studied with high school students and developed Secondary School Environmental Literacy Instrument (SSELI) which included knowledge, affective, skill and behavior components to investigate students' environmental literacy. The results were analyzed focusing on age, ethnicity, grade level and gender. The results of this study showed that, students had moderate level of environmental knowledge, awareness and attitudes, and limited level of environmental behavior and ability in using environmental knowledge

Barraza and Cuaron (2004), in their study conducted with the participation of primary school students in Mexico and England, investigated the familiarity with environmental terms and to what extent the student understood the terms. In the first part, the students were asked about the familiarity with environmental concepts like recycling, global warming, ozone layer, etc. In the second part their understanding of these concepts was assessed with a multiple choice test. As a result, they found a significant relationship between children's familiarity and understanding. Another result showed that students had low to moderate level of environmental literacy. The level of hearing the terms, knowing the meanings were very low. The sources they learnt from were reported as television or teachers. Parents and books had a low ratio, science clubs had the lowest ratio as being a source of learning.

Hsu (2004) studied with college students and investigated the effects of an environmental education course on college students' responsible environmental behavior and also investigated environmental literacy components of locus of control, environmental responsibility, intention to act, perceived knowledge of environmental issues, and perceived knowledge of and skills in using environmental action strategies. The design of this study was quasi-experimental design where one group received environmental education course, the other control group received research methods course. The results of study showed that environmental education course had a significant positive effect on the environmental literacy variables.

Chu and Lee (2006) studied how environmental literacy developed in Korean students. They investigated the variables of environmental literacy and the effect of grade level on their environmental literacy. Participants were selected from 3rd, 7th and 10th grade. Environmental Literacy Instrument for Korean Students was developed and used in this study. This instrument included four scales as environmental knowledge, attitude, skills and behavior. It was found that environmental behavior and attitude; environmental skills and knowledge were correlated significantly. As a result, 3rd grade students had more positive attitudes than 7th and 10th grade students. Tenth grade students had the highest level of sensitivity towards environment. Also, the effect of parental background and gender were found to be at the highest level in 3rd grade students, as the age negatively correlates with the effect of parental background. Especially, environmental behavior was found to be getting more difficult to shape as students get older.

Wright (2006) investigated the effect of constructivist approach on students' environmental literacy. He conducted a pre-and post-test quasi-experimental design. He gave a pre-test of environmental literacy instrument to 183 post-secondary science students. He assessed the participants' knowledge, beliefs, opinions and self-perceptions. One group participated in the course in a constructivist environment that included brainstorming, active participation and group works whereas the control group participated in a traditional environment. According to pre-tests there wasn't significant difference between two groups, but the pre-test and post-test comparison showed a significant difference in each group. When two groups were compared with each other, there was no significant difference, both groups showed the same improvement, so the course was not found to help them improve.

The relationship between environmental literacy components was investigated in some studies in order to find out whether change in one variable affects the other. With this idea, teaching methods and environmental education curricula can be shaped. From this perspective, Negev *et al.* (2008) investigated Israeli students' environmental literacy. They studied the environmental environmental knowledge, attitudes and behavior of 1591 6th grade students from 39 schools and 1530 12th grade students from 38 schools. Researchers developed two surveys for different grades including similar topics and content. There were four sections: environmental background information and environmental behaviour,

awareness, attitudes and willingness to act, knowledge and its sources and open-ended questions. The results showed that there was no significant correlation between knowledge and behavior. Regarding the effect of parents' educational background, it was found that they were effective on students' attitude and behavior but not effective on their knowledge. This study showed that giving only factual environmental knowledge fails to change students' environmental behaviour and to make them become environmentally literate. Knowledge can be improved via books and lessons, but environmental behaviour can be improved with the help of parents instead of environmental knowledge.

2.1.4.1. Research Studies on Environmental Literacy in Turkey. The importance and attention given to environmental education is increasing day by day. Most of the studies about environmental literacy focused on demographic variables such as gender or parental background. Only a few studies were conducted to investigate the effects of different instructional methods. Yılmaz, Boone and Anderson (2004) studied the knowledge of 458 elementary and middle school students on environmental issues. Students took an Attitude Towards Environmental Issues Scale (ATEIS) and the results were compared according to gender, grade level, science achievement, socio economic status and school location. Gender did not have a significant effect on students' attitudes in elementary school, but female students were found to be more concerned than the males in middle school. Fourth grade students had more positive attitude towards environment than 5th and 6th grade students, which was connected with the literacy that young students have. However, it was also found that 7th and 8th students had higher level of positive attitude than 5th and 6th grade, thus it was stated that this could happen because of the learning and discussing opportunities or the reasons behind this result should be investigated in further studies. Socio-economic status did not have any significant effect on the environmental attitude level of middle school students but in elementary school, the students who had higher socio-economic status had more positive environmental attitudes.

Gender was one of the most popular variables in Turkey's environmental literacy studies. In one of such studies, Ökesli (2008) investigated primary school students' environmental literacy in Bodrum. Totally 848 students of 6th grade participated in this study and took Environmental Literacy Questionnaire including the components of environmental literacy, knowledge, attitude, use and concern components. According to

this study, students' knowledge level was not adequate but they have concern and attitudes towards environment. They were aware of the importance of the human's behavior that affects environment. When the relationships between components were studied, the strongest correlation was found between environmental attitude and environmental use; environmental use and environmental concern. Environmental use was described as students' feelings that include responsibility and the willingness to do something for the environment. On the other hand, the students who thought they were knowledgeable and interested in the environment had parents who were more knowledgeable and interested in the environment. Also this study showed that female students had more positive attitudes and more concerned about the environment than the male students, even though both genders had the same level of environmental knowledge.

A similar study was conducted in a private school in Ankara by İstanbullu (2008). She investigated 6th grade students' environmental literacy by using Environmental Literacy Questionnaire of Kaplowitz and Levine (2005). The effect of mothers' education level on students' environmental literacy in terms of the components of knowledge, attitude, use and concern were studied and found no significant effect. On the other hand, the relationships between the four components of environmental literacy dimensions were studied and 'attitude and use' and 'use and concern' were found to be strongly correlated, which was also reported by Ökesli (2008). In addition parents' involvement was found to be effective on students' environmental concerns, attitudes and uses.

Along the same line, Tuncer *et al. (*2009) conducted a study with the participation of pre-service teachers. The purpose of their study was to investigate the relation between pre-service teachers' environmental knowledge, attitude and concerns, and their interests in environmental problems such as involvement in outdoor activities, parents' interest and involvement in the environmental activities. The same instrument "Environmental Literacy Questionnaire (ELQ)" developed by Kaplowitz and Levine (2005) was used. The instrument included the four components of environmental literacy, knowledge, attitudes, uses and concerns items. Demographic data (gender, field of study, parents' level of education and employment status) was also collected. The results of the study indicated that environmental background of pre-service teachers was positively correlated with the environmental literacy and its components. It was also found that male students had higher

scores on knowledge dimension whereas females had higher scores on environmental attitude, use and concern.

Özsoy (2010) investigated the effect of eco-school program on elementary school students' environmental literacy levels and views on environment. Eco-school program is similar to developing projects for environmental issues, but it is different in that it includes a committee about environmental education that received instruction about the application. The aim of the program was to create awareness of sustainability issues both in school and at home (Özsoy, 2010). In this study, there were 316 6th, 7th and 8th grade students from two different schools. One of the schools was assigned as control group and the students in this school received traditional school instructional method. The other school, experimental group, received eco-school program. Environmental literacy questionnaire was used to determine students' environmental literacy levels. This questionnaire included four components of environmental literacy, knowledge, attitudes, use and concern. On the other hand, researchers used draw and explain method to learn students' views about this program, they asked students to draw what they think about environment. At the end of the treatment, researchers conducted interviews with the students and teachers. As a result, it was found that there were significant differences between control and experimental groups in favour of the experimental group at all grade levels and all the components of environmental literacy between control and experimental group in the favour of experimental group. Regardin the analysis of drawings, it is observed that there were 59 codes in pre-drawings, whereas 13 more codes emerged in the post-drawings. The researchers concluded that educational experiences expanded students' views about environment. Analysis of the drawings also showed that students' views about the environment focused on three main themes: clean, dirty and both clean and dirty environment. Depending on the results that emerged from the views of elementary school students on the environment, students developed more understanding about environmental problems with the help of eco-school applications. According to interviews, the researcher claimed that students were aware of the characteristics and importance of eco-schools. Eco-school teachers supported that the process of eco-school application made students become more active and provided a healthy and productive learning environment.

Karakaya (2016) studied the effect of outdoor education implementation on environmental literacy of 7th grade students. In her mixed method study, she assessed students' environmental literacy with Elementary School Environmental Literacy Instrument before and after the treatment as pre and post-tests. One group was taught by current teaching methods and experimental group was exposed to outdoor education method where students were actively joined in the process. The results revealed significantly meaningful differences between the control and experimental groups' environmental literacy components in the favour of experimental group.

Two research studies about the environmental literacy are included in the following section, because they investigate the effect of project- based learning method on environmental literacy as the present study does.

The research studies on environmental literacy have mostly focused on the environmental literacy of primary school students or pre-service teachers. With the secondary school biology curriculum implemented between 2007-2013, environmental education became more important in biology lessons, studying the aim of environmental education that is called 'environmental literacy' (Roth, 1992) will add different perspectives and objectives to this process.

2.2. Project-Based Learning

Project-based learning is a method about teaching and learning that is designed to motivate students for investigation of authentic problems (Moursund, 1997).

Project-based learning includes three words that explain the term clearly. First term is '*learning'* that takes attention to the learner, not the teacher. The other term is *'project'* that means design, imagine, plan and cooperate instead of working individually. '*Based*' term is showing that project is not an aim, but a process. It emphasizes that the project is not a product of learning, it occurs within the learning process (Erdem and Akkoyunlu, 2002).

Project-based learning is a multidisciplinary model that takes students to the center and where the students deal with real world experience (The Challenge 2000 Multimedia Project, 1997). In project-based learning, the roles of students and teachers change where students play an active role in learning process, whereas teachers stay behind and help them as guides to develop their own projects that they can use in their real lives (Gaer, 1998). In this way, students construct and direct their own knowledge, improve their creativity, choose cooperating way when they face with a problem and families join learning process actively (Erdem, 2002). According to Toolin (2004), there are two parts of project-based learning. One of them is creating questions or problems and finding activities to solve these problems to create a project development process. Second one is producing a communication web and getting solutions for the problem with new ideas.

Einstein stated '*It is the supreme art of the teacher to awaken joy in creative expression and knowledge.'* Then considering the definitions and the features of project-based learning can help teachers while they are performing their art because students think that taking part in every step of the project from the planning to the end is enjoyable and interesting (The Challenge 2000 Multimedia Project, 1997).

2.2.1. The Phases of Project-Based Learning

Planning and controlling the process is important in project-based learning, because teachers, students, and also parents should be aware of what next step will be (Moursund, 1997). For designing the learning process Katz and Chard (2000) described projects as stories, with a beginning, middle, and end that correspond to the three phases of projects. The three phases in project- based learning method are as follows**:**

- Beginning: After deciding the topic, teacher discusses about the topic with students in order to learn their pre-knowledge and experience. Things to know can be asked via questions. There can be brainstorming about what students can do.
- Developing: Students start investigating various sources and brainstorming to find possible answers that they determined in the beginning part. Teacher can help students by providing resources. Students can write, draw, experiment, observe or

go to a trip. Teacher can provide an environment that help different groups to communicate with each other about their works.

- Ending: Teacher prepares the environment for presentations which will be given completely by the students. The results of the projects can be in different shapes like drama, poster, game, story, etc. Sometimes the products of a project can be a start of another project.

Yavuz (2006) studied about the evaluation of the effect of project-based learning model on chemistry education students' environmental knowledge and attitudes towards environment. He listed the steps that teachers should follow in project-based learning as:

(i) Decide on the project topic
(ii) Prepare a timeline
(iii) Organize the activities
(iv) Prepare an evaluation plan
(v) Start the project with students
(vi) Help finishing the project and presenting the products.

2.2.2. The Benefits of Project-Based Learning

Project-based learning (PBL) improves the quality of learning and motivates the students to join the process. On the other hand, students get prepared for the work life by gaining the skills like cooperating, time management and decision making (Moursund, 1999). The benefits of project-based learning were listed below (Korkmaz, 2002):

- Improves and enhances students' learning skills.
- Teaches students to learn to construct their own knowledge that they need to handle real life problems. This supports lifelong learning.
- Increases attendance in group works and cooperating in the learning activities. This makes students a part of the process.
- Suggests students various ways for reflecting their knowledge.
- Lets students use their different dimensions of intelligence (kinesthetic, spatial, etc.).

- Gives families, teachers and administrators meaningful information about students' performance.
- Make students combine real life experience with their performance and products.
- Improves students' problem solving skills and problem based learning skills.
- Provides chance for students to apply their knowledge and skills with projects. These activities make the learning permanent.
- Makes students get different kind of skills like;

(i) Vital Skills: Managing a meeting, making plans, etc.
(ii) Technology Usage: Using computer, television, video-recorder,etc.
(iii) Science Process Skills: Observing, measuring, predicting, formulating, etc.
(iv) Self-control Skills: Setting goals, time-management, etc.
(v) Attitudes: Willingness to learn and the idea of learning for future.

According to Erdem (2002), project-based learning,

- Gives students opportunities for combining different disciplines.
- Makes students become professionals of the subjects.
- Gives the ability to work independently or in a group with minimum help.
- Guides students about how to feel self-confidence and high self-esteem with the thought of success
- Improves students' evaluation skills as they start to evaluate themselves or their friends.
- Makes students feel like they are a part of the school as they have positive attitudes.

Beside lots of advantages, some disadvantages are listed as follows:

- Project-based learning can take longer time than traditional methods. Therefore, time management should be done professionally.
- Students or teachers can need economical support for their projects.
- Students can have hard time while evaluating themselves or friends and this can effect their objectivity.
- If students don't come up with a product as expected, than their attitudes towards the lesson may change (Doğay, 2010; Görecek, 2007; Yıldırım, 2011).

Kokotsaki *et al.* (2016) reviewed the literature on project-based learning. After investigating PBL studies from different levels of education and evaluating its advantages and limitations, some suggestions about the process are listed.

First suggestion is about the *support* of two kinds. One was for students to be guided about different topics like time management or technology use. The other support is for the teachers, which is about professional development and economical support. It is stated that teachers can be supported by the school administration.

Group work is emphasized another suggestion in the study. It is stated that successful grouping and sharing responsibilities in a fair way than will make the process better.

Independent work of students is important in PBL, but some knowledge and skills should be gained before they start developing the project process and this is called the *balance between the instruction and independent inquiry method.*

Project developing process should be *watched and recorded* carefully for a successful self and peer-evaluation.

Autonomy is another important term in PBL because students start to take their responsibility of learning and control their own learning process.

2.2.3. Research Studies on Project-Based Learning

The review of literature on the method has shown that the main focus of research has been on the skills that the method provides for the students and the effectiveness of project-based learning.

Lifelong learning and project-based learning are important milestones about education. With the thought of the combining these two terms; project-based learning and lifelong learning, Clark (2000) conducted a study in which he explained the conditions and chances for making a student lifelong learner. The researcher examined the rationale of the spirit, material, and method of education behind the project approach. He stated that

curiosity, creativity and communication which are the important components of project-based learning affect students' cognitive and social skills.

Project-based learning is not only about educational issues, it also plays role in social issues (Heckendorn, 2002). Because of the idea that schools are in communities, but not of the communities, Bouillion and Gomez (2001) studied the relationship between real life problems and school-society cooperation as the students from secondary school prepared activities for Chicago River Project. They observed the river and discovered the reasons of river pollution. They shared this information in school journal. After this share, activities such as cleaning the river and spreading the idea for keeping environment clean started. With this study, it is understood that project-based learning is suitable for real life problems and school-society cooperation. By this way, students can understand and learn the environment better. In conclusion, it is stated that the benefits of the project- based learning were not only about education, but also social benefits can be provided with these types of studies.

However, project-based learning method positions students in the center and teachers play a critical role in managing the process. Thus, the experiences of teachers and the problems they experienced in project-based learning is important for the researchers. Influenced by these ideas, Rosenfeld and Yehuda (2001) studied the usage of project-based learning method by science teachers. Teachers took 30 hours of workshop about the method and they tried to implement it. After this process tests and interviews were conducted. According to the results, three points were highlighted. First of all, teachers had positive attitudes about using this method. Second, there are some difficulties like time management, assessing students or managing students and the last point is that teachers need support when utilizing this method for their science classes. In another study, an answer was searched by Toolin (2004) for the question of what teachers can do to improve the project-based learning process. He studied the factors that affect project-based learning process. It was found that master education, teaching experience, experience in project-based learning activities and cooperation with other teachers are the factors that are important for the process.

Filcik *et al*. (2012) investigated the effects of project-based learning on achievement and efficacy of secondary school mathematics students and study lasted for two years. In this study, two different schools were chosen as control and experimental group. Experimental group was a private school that organized all the classes based on a curriculum designed according to project-based learning. In the control group school, traditional learning methods were used. Students' self-regulation, self-efficacy and learning strategies were assessed with surveys in the beginning and at the end of each year. After two years of the study, it was seen that experimental school students performed better in every variables except effort regulation. PBL students outperformed Non-Project-based learning students about learning motivational gains significantly and used more learning strategies than the control group. They showed significantly higher self-efficacy in mathematics. Non Project-based learning group had some negative changes about control of learning beliefs and test anxiety.

Afriana *et al.* (2016) used project-based learning by combining with science, technology, engineering, mathematics (STEM) in order to assess scientific literacy. This was a quasi-experimental study and the sample was 56 students from 7th grade. Half of the students (28) were experimental group receiving the air pollution theme with project-based learning method and the other half was control group who was taught by traditional methods. After the post-tests, it was seen that project-based learning combined with STEM enhanced students scientific literacy. Experimental groups' knowledge, competence and scientific attitude were medium level but, control groups' levels were low. Experimental group was more motivated about the air pollution subject and became aware about saving the environment.

2.2.4. Research Studies on Project-Based Learning in Turkey

In Turkey, there are many studies about project-based learning method but most of them are about primary school students. Different variables and different disciplines were investigated by the researchers. In one of the studies, Korkmaz (2002) focused on the effect of project-based learning creative thinking, academic risk taking and problem solving skills. He conducted an experimental study with 7th grade students in science and technology class, in which one group received traditional method and the other received

project-based method. The results showed that there was a significant difference between the creative thinking, problem solving and academic risk taking levels of two groups in the favor of experimental group. On the other hand, there was no significance difference between male and female students regarding above mentioned skills. The same experimental design was used by Gültekin (2005) for the evaluation of different skills as high cognitive and cooperation skills. In addition to this, the researcher used quantitative and qualitative methods together in his study. The researcher used pre-test, post-test and interviewed 5th grade students in social studies. The group who received project-based learning was found to increase academic success, cognitive and cooperation skills. It was also stated that learning became more permanent and enjoyable for the students in this group. A different experimental design was used in the study of Çıbık (2006). He investigated the effect of project based learning on 7th grade students' logical thinking abilities and attitudes towards science course. Following the administration of logical thinking and attitude towards science course tests as pre-tests, one group received project-based learning and the other group received traditional learning. There was a significant difference between two groups' post-test scores of logical thinking abilities and attitudes towards science tests in the favor of experimental group.

In line with Rosenfeld and Yehuda (2001) mentioned above, Girgin (2003) conducted a study to evaluate the method from the students' perspectives. The study showed that project-based learning increased students' motivation and made learning permanent. On the other hand, this method led students to acquire skills such as cooperating, working individually, creativity and presentation. Students had opportunity to have real life experiences while learning. Similar results were found by Yıldız (2004) in his study conducted with private high school students in science and technology course. The results showed that project-based learning increased students' responsibility and learning process skills. Additionally, students were active in the process, improved their motivations and started investigating data from different sources. Yıldız (2004) also stated that project-based learning increased inquiry skills of the students. Yıldırım (2007) studied the inquiry skills and the factors affecting these skills in project-based learning method. According to the self evaluation and group evaluation forms, students found themselves skilled about investigation. The problems about the process were stated as the lack of experience and money.

Some research studies on project-based learning conducted in Turkish context have had a specific focus on environmental education. Morgil *et al.* (2004) investigated the effect of project-based learning on 6th grade students' knowledge on environmental education. The researchers gave a pre-test including questions on pollutions of soil, water, air and energy saving. Groups of six students prepared projects about each topic that took place in pre-test. After the project development process, it was observed that students who prepared projects enhanced their knowledge about environment. In another study in the same year, they added the environmental responsibility component to knowledge component. Morgil *et al.* (2004) studied the effects of project-based learning on environmental education. After students had their project, 35 open-ended questions were asked them about environmental knowledge. An environmental responsibility test including 13 questions was administered. Results of the study showed that project based learning increased students' environmental knowledge and responsibility. The researchers then tried environmental awareness component with environmental knowledge component. Morgil, Yavuz and Oskay (2006) investigated the effects of project-based learning on environmental knowledge and awareness levels by asking 14 project questions to 63 students. According to the knowledge and awareness tests, project-based learning increased students' knowledge and awareness levels. Yavuz (2006) dealt with more variables and studied the effects of project-based learning on environmental knowledge, attitude and behaviour of pre-service chemistry teachers. Pre and post-tests were applied to students before and after the project based learning process. There was a significant improvement in these variables for experimental students.

In another study that combined project-based learning and environmental education, Doğanay (2010) studied the effects of project-based learning on students' success in ecology unit. Environmental literacy pre-test was applied to 10th grade students for experimental and control groups so that the beginning levels were compared. Then experimental group received project-based learning method while control group received traditional method. According to post-test analyzes, meaningful difference was found in academic achievement levels in the favor of experimental group.

Benzer (2010) studied the effect of a lesson designed with project-based learning method on environmental literacy. The lesson was environment education and the sample

was 74 preservice teachers. The environmental literacy of those students, namely, environmental awareness, knowledge, attitude, sensitivity, solving problem and behavior components which are basic for the students in the fields of primary school science education were assessed. Assessment instruments, cases and self-evaluation questionnaires were administered before and after the treatments. Only experimental group took example events and self-evaluation questionnaires. The results showed that students had a low level of knowledge on environment before the treatments. However, it was found after the treatment that the experimental group students performed significant development in all components mentioned, wheras the control group students showed improvement only in knowledge component. According to the results of cases, experimental group students could reflect all of the environmental literacy components and it was seen in self-evaluation questionnaires that they could provide development on their scientific method, computer using, working together, creativity, self-confidence and various method and technique using skills.

Yucasu (2015) investigated the effect of project-based learning method on environmental literacy of 55 science pre-service teachers. In the study that lasted for fifteen weeks, the researcher used single group pre-test and post-test design and studied. Data collection instruments that measure environmental knowledge, attitude, sensitivity, behavior, awareness and problem solving skills were used, in addition to the semi-structured interviews conducted with each of the preservice teachers to learn their views about the course. As a result, project-based learning method had a positive impact on environmental literacy of pre-service teachers in all components. In addition, as a result of semi-structured interviews; pre-service teachers found project-based learning method effective in environmental education and told that they could conduct a scientific research.

Moursund (1999) states that project-based learning enable the students to be active and motivated in the process. The present study used project-based learning method in environmental education in order to make a difference in action part rather than only knowing environmental issues. Although, there are studies about environmental literacy components and project-based learning, the review of literature shows that the research that evaluates the effect of project-based learning on behavior component of environmental literacy and the research on the environemtal literacy of secondary school students is

limited. Therefore, the present study specifically aims to fill this research gap with its focus on behavior of secondary school students.

2.3. Science Process Skills

Science process skills are the ones that make students become active in lessons, lead them to take responsibilities, make science learning easier and represent investigation skills and methods for permanent learning (Çepni *et al*., 1997). The skills are the same as scientists use in their studies. On the other hand, science process skills are thinking abilities that students use in knowledge construction, problem solving and formulating the results. By giving these skills to students, teachers give them the chance of understanding the world. These skills are the fundamental components of scientific research and ideas (Lloyd *et al*., 2000).

In the Secondary Schools Biology Curriculum implemented between 2007-2013, the content was prepared according to constructivist approach. Objectives of the curriculum in the name of understanding, attitudes, skills and values were classified under three topics: 'Science -technology- society-environment objectives', 'communication skills, attitude and values objectives' and 'science process skills objectives'. Science process skills objectives (see Appendix F) are coded as BAS objectives in the secondary school biology curriculum (MoNE, 2007). According to the literature about project-based learning, the skills that students gain with this method can be seen parallel with these objectives. For instance, if the aim of project-based learning is to make students act like a researcher or a scientist (Korkmaz, 2004), the process of becoming a scientist should be studied, which includes science process skills. Thus, the present study can give us a chance to discover new ways for gaining science process skills in environmental units. The science process skills objectives were listed for this study 9th grade unit 'Conscious Individual- Livable Environment' in the curriculum but these objectives didn't take part in the 2018 Secondary School Biology Curricula (MoNE, 2018). It can be stated that the list of science process skills objectives is necessary for teachers to plan their lesson and set their goals. This could be a focus for a further study to be conducted to see the effect of nonexistence of these objectives in curriculum.

According to Harlen (1999), there are two groups of science process skills. These are basic science process skills and integrated science process skills. In each group, there are different types of skills that are classified according to the cognitive development. The skills to acquire at younger ages are called ‘basic science process skills’ and the skills to acquire at older ages are named as ‘integrated science process skills.

2.3.1. Basic Science Process Skills

Basic science process skills are the skills that prepare students for investigation. Continuity is an important feature of science and thus not only learning scientific knowledge but also the ways to reach this knowledge should be learnt. In this way, students can question the truth themselves and learn that every truth can change. Students should go thorugh all of the steps of these skills as they need them in daily life. Basic science process skills are observing, classifying, measuring, recording and communication. The definitions of these skills are listed below:

- Observing: It is investigating the objects or events with sense organs and some tools that help these organs. An effective observation does not only mean watching, it also means focusing with a specific aim and watching in a systematic way (Temiz, 2001).
- Classifying: Students make classifications and group objects, criterions and events according to their observations (Padilla and James, 1984). This process helps them to connect their pre-knowledge with new knowledge. Students can give a shape and order to the mass of knowledge (Çepni *et al*., 1997).
- Measuring: It is defining an event’s or objects’ dimensions with standard or non-standard measurement or prediction (Çepni *et al*., 1997). It is an action of adding quantitative observation to the students’ qualitative observations.
- Recording: Students encounter a lot of data during their study. The data are recorded in different forms that everyone can understand. These forms make it easy to use them later. Recording data prepares a basement for using data and formulating models. Drawing a table, a graphic, taking photographs, voice recording or writing a report are the behaviors about data recording skills (Temiz, 2001).

- Communication: Sharing the data that students gained from their observations with other students. They define the data gained through words and graphics (Çepni *et al.*, 1997). In communication step, students try to explain the processes in their study in their discussions with their group peers.

2.3.2. Integrated Science Process Skills

These skills lead students to think, question and investigate more. These are higher order cognitive skills that follow basic skills. The skills are predicting, identifying of variables, formulating hypotheses, changing and controlling variables, experimenting, interpreting data and formulating models.

- Predicting: Depending on a proven example, predicting the result of an event that will occur in future (Padilla and James, 1984). It is about making predictions according to data. The difference of this step from only guessing is depending on experience and data (Temiz, 2001).
- Identifying of variables: Defining all of the factors that may affect the process. In other words, finding out the factors that can change or stay same in different conditions (Arthur, 1993).
- Formulating Hypotheses: Defining a way of solution and expecting some results for the scientific process. This solution should be testable. (Temiz, 2001).
- Changing and controlling variables: The strategy in this process is changing one variable and observing the differences in other variable according to this change. The reason of this process is the possibility of the effect of the other variables on the result (Çepni *et al*., 1997).
- Experimenting: Experimenting is integrated with other processes. It includes using tools, controlling variables, getting data, recording data, interpreting data, arriving a result and reporting (Çepni *et al*.,1997)
- Interpreting Data: This process is the ability of organizing data and finding relationships between them (Arthur, 1993). If data is interpreted well, it gets easier to find a result and the result becomes consistent.

- Formulating Models: Models are used in science education by teachers to explain scientific facts and used by students to show their understanding levels. Formulating model is a complex process and should be incrementally acquired. Data is shown with graphs, pictures or presentations. There can be more than one way of formulating model to show the same thing (Başdağ, 2006).

2.3.3. Research Studies on Science Process Skills

Science process skills can be related to various variables in educational research studies. These skills can be used in different lessons in developing different skills. There are two different cases; science process skills affect issues or science process skills get affected by issues. The effect of issues on science process skills was exemplified in Baker and Piburn's study (1991). They investigated 9th grade students' science process skills, cognitive development and attitude changes during a scientific literacy course. It was seen that literacy course improved students' cognitive development and science process skills but changed their attitudes towards school negatively. It can be inferred from the study that scientific literacy has a relationship with science process skills and this proposed study aims to investigate other literacy type, environmental literacy, and to understand its impact.

The relationship was also found between science process skills and scientific creativity. Aktamış and Ergin (2007) conducted a study with 7th grade students in science course and used scientific creativity and science process skills tests that include open ended questions. According to the analyses, a positive significant relationship was found between science process skills and scientific creativity. German *et.al.* (1996) studied with the participants from the same age range, 7th grade students, and attempted to define the factors affecting the design of an experiment. The results showed that formulating hypothesis, defining the variables and formulating model skills of science process skills helped students to design an experiment.

Another aspect in research studies have been the teachers' views about science process skills. For example, Lloyd *et.al.* (2000) focused on this issue in their study. They aimed to develop science process skills of primary schools in England and improving their teachers' self-confidence. Results showed that teachers were aware of these skills and gave

importance but they failed to implement what they knew, which indicates that knowledge is not enough by itself for success in science process.

2.3.4. Research Studies on Science Process Skills in Turkey

The studies that are most relevant to the present study can be summarized as the ones conducted on the effect of learning methods on science process skills. In Altunsoy's (2008) study, an experimental design was used to assess the effect of inquiry-based learning approach on students' science process skills, academic achievements and attitudes in secondary biology teaching. There were 36 students from two different classrooms. One of them received traditional teaching method including presentations, questions and lecture, whereas the other group received inquiry based approach. According to science process skills pre and post-tests, there was a significant difference between groups in favour of inquiry based approach group. The same method was used in Gültekin's (2008) study, in which the researcher studied the effect of project-based learning applications on 6th grade students' view of nature of science, science process skills and attitudes. According to the science process skills tests, 6th grade students improved their science process skills with project-based learning method.

Şenyüz, Kanlı and Arslan (2008) studied the effect of science and technology curriculum on improving 7th grade students' science process skills and compared the curriculum used till 2007 and the curriculum used between 2007-2013. They found that 2007 Science and Technology Curriculum which was prepared according to constructivist approach, focusing on individual differences, defining and classifying science process skills, connecting unit and science process skills objectives was more effective than the previous curriculum in improving science process skills. To the best knowledge of the researcher, there has been no other study comparing curricula implemented before 2018 and 2018 curricula from this viewpoint.

Acar (2011) studied the effect of project-based learning on scientific process skills and attitude towards biology with the participation of 68 pre-service students from 2nd class. Design of the study was experimental and pre-post test design was used. Experimental group students prepared and implemented their projects but control groups

received no different treatments. The scale of scientific skill process and the scale of attitudes towards biology were used as data collection instruments in the study. There found to be a significant difference between the science process skills scores of the groups in favor of experimental group, but there was no significant difference between groups in terms of attitudes towards biology.

Kargın (2017) studied the effect of problem solving method on students' attitudes towards science, science process skills and achievement. Sample was 49 students from 6th grade. Mixed model was applied in the study. In the quantitative part of this mixed method study, pre-test and post-test design with experimental and control groups was used and a case study was used in the qualitative part of the research. The effect of problem solving method on students' achievement differed according to the units. It was significant in 'Systems in Our Body' and 'Particle Theory of Matter' units but not significant in 'Speed and Electrical Conduction'. The groups' attitudes towards biology were not significantly different but their science process skills were significantly different in favour of experimental group. The results of this study suggested that the problem solving method was more effective on enhancing students' knowledge and improving their science process skills than traditional method.

Science process skills should be acquired by the students to understand the world and find creative solutions to the problems (Çepni *et al.*, 1997). These are the skills that they need for environmental problems studied in 'Conscious Individual- Livable Environment' unit's 'Environmental problems' topic. The method implemented in the experimental group was project-based learning, therefore, the students could act like scientists in investigating the environmental problems and finding solutions in their projects.

3. SIGNIFICANCE OF THE STUDY

People may have an impact on the earth positively or negatively. In order to make the world a better place, human beings should be aware of their impacts on the environment. In order to reduce environmental problems, increasing the number of environmentally literate citizens is important. Thus, education in schools has an aim of raising environmentally literate generations. Recognizing that educating environmentally literate citizens is needed to solve current environmental problems and to prevent the ones that might happen in the future; ways of improving the quality of environmental education and environmental literacy should be investigated.

Project-based learning aims to encourage students to teach and learn how to solve real life problems (The Challenge 2000 Multimedia Project, 1997). As Moursund (1999) stated, project-based learning helps students to ignore the discrimination between learning and implementing and encourages them to do both. Thus students improve their environmental behaviors by turning their knowledge and skills into action, where the use of project-based learning can play a key role in improving these skills. The Secondary School Biology Curriculum implemented between years 2007-2013 focused on the environmental topics and spread these topics to all grades in order to increase the level of environmental literacy.

The studies on environmental literacy conducted in Turkey and around the world are mostly on the effect of demographic variables on environmental literacy or they aim to evaluate environmental literacy of a population. Furthermore, in recent years, the importance of having environmentally literate students has started to increase. One way of doing this is implementing project-based learning method that focuses on students and gives them opportunity to direct the process (Moursund, 1999). Combining project-based learning and environmental education, the present study becomes significant with its potential to be useful to produce students who act like scientist and environmentalist. The examples of studies about the effect of project based-learning on environmental literacy are mostly about primary school students or pre-service teachers. Thus, another signifancant point of the study lies in its targeted sample, high school students. Project-based learning

was found to be effective on 9th grade students' environmental literacy levels, so the study should encourage teachers, administrators and non-governmental organizations for the implementation of project-based learning in environmental topics.

This study is not only about environmental literacy, but it also explores the effect of project-based learning method on science process skills. The objectives about science process skills in Secondary School Biology Curriculum implemented between years 2007-2013 were removed with 2018 Secondary School Biology Curriculum. Studying science process skills could be a good feedback about showing the necessity and usefulness of the removed scientific research and science process skills objectives included in 2007 Secondary School Biology Curriculum.

Furthermore, this study is significant in that it enhances our understanding of students' views about environmental literacy components, science process skills and the project-based learning method deeply, which gives the chance to understand the missing points in environmental education. Finally, the information generated from the findings of the study will contribute to the pool of knowledge on environmental education in Turkey.

4. THE PURPOSE OF THE STUDY

The purpose of this study was to compare the effects of project-based and teacher-centered learning on 9th grade students' level of environmental literacy and science process skills. In addition, students' views and developments in environmental literacy components and science process skills were investigated deeply with qualitative methods.

4.1. Research Questions

The following research questions guided this study:

1. Is there a significant difference between the environmental literacy of 9th grade biology students who learnt the topic of environmental problems by project-based learning (Group PB) and teacher-centered instruction (Group TC) in terms of the components of
    a. environmental knowledge,
    b. environmental attitude,
    c. environmental behavior?
2. Is there a significant effect of project-based learning on 9th grade students' environmental literacy, in terms of the components of
    a. environmental knowledge,
    b. environmental attitude,
    c. environmental behavior?
3. Is there a significant effect of teacher-centered instruction on 9th grade students' environmental literacy, in terms of the components of
    a. environmental knowledge,
    b. environmental attitude,
    c. environmental behavior?
4. Is there a significant difference between the Science Process Skills of 9th grade biology students who learnt the topic of environmental problems by project-based learning (Group PB) and teacher-centered instruction (Group TC)?

5. Is there a significant effect of project-based learning on 9th grade students' Science Process Skills?
6. Is there a significant effect of teacher-centered instruction on 9th grade students' Science Process Skills?
7. To what extent, 9th grade biology students perceive that project-based learning or teacher-centered instruction affect their environmental literacy?
8. To what extent, 9th grade biology students perceive that project-based learning or teacher-centered instruction affect their science process skills?
9. What are students' views about the project-based learning method?

4.2. Statement of the Research Hypotheses

In this study it is hypothesized that:

1.
    a. There is a significant difference between the Environmental Knowledge Post-Test scores in favor of Group PB students.
    b. There is a significant difference between the Environmental Attitude Post-Test scores in favor of Group PB students.
    c. There is a significant difference between the Environmental Behavior Post-Test scores in favor of Group PB students.
2.
    a. There is a significant difference between Environmental Knowledge Pre-test and Post-test scores of 9th grade biology students who learnt the topic of environmental problems by project-based learning method (Group PB).
    b. There is a significant difference between Environmental Attitude Pre-test and Post-test scores of 9th grade students who learnt the topic of environmental problems by project-based learning method (Group PB).
    c. There is a significant difference between Environmental Behavior Pre-test and Post-test scores of 9th grade students who learnt the topic of environmental problems by project-based learning method (Group PB).
3. There is a significant difference between the Science Process Skills Post-Test scores in favor of Group PB students.

4. There is a significant difference between Science Process Skills Pre-test and Post-test scores of 9th grade biology students who learnt the topic of environmental problems by project-based learning method (Group PB).

5. METHODOLOGY

The methodology section of the study comprises of sample, research design and procedure, instruments and data analysis which are described in the following sub-sections.

5.1. Sample

The participants of this study were 9th grade students from a vocational technical high school. According to the school type and policy, all of the 78 subjects of the study were female students with average age of 15. The students had two class-hours (40 minutes each) of biology lessons per week. The reason behind the selection of this school as the research setting was that the researcher was biology teacher working in this school and was able to provide the treatment herself.

The school in which the present study was conducted was located in in Esenler, İstanbul. Esenler consists 16 squares with a population of 464557 people. It is highly affected by migration waves in our country. Because of The Great Istanbul Bus Terminal's being very close to Esenler District, district's being in a central position and job opportunities, Esenler has become a migration receiving center. It is observed that the ratio of population increase in Esenler is higher when compared with the ratio of population increase of Istanbul. Increasing of population in such a fast pace brings some problems. Non-planned urbanization and shortages of parks-gardens are the biggest ones of these problems. Education and Health services are among the other problems of local community. Fast population increase and urbanization brought along change and development (Karakuzulu *et al*., 2010). The families of the students in that school had a low level of socio-economic status and low educational levels, which may have an affect students' environmental literacy negatively according to the results reported in previous studies (Negev *et al*., 2008; İstanbullu, 2008). To the best knowledge of researcher, students do not receive any environmental education from their families, thus school plays the most important role in their environmental knowledge, attitude and behaviors.

In this study there were one experimental group and one control group. Sampling method was convenient sampling, because the subject of interest in this research, 'Environmental Problems' was a topic included in the 9th grade biology curriculum and the researcher was the only biology teacher of this grade level. Two of the five classes that were taught biology by the same teacher were selected for the study in the second semester of 2011-2012 academic year. The most similar classrooms based on the scores gained in the very last biology exam were chosen. The classes were randomly assigned as experimental and control groups. The experimental group included 40 students and the control group included 38 students according to the school policy.

5.2. Research Design and Procedure

This study investigated the effects of project based learning on 9th grade students' environmental literacy and science process skills. The study was conducted in May and June, 2012 in accordance with the sequence of 9th grade biology curriculum. Classes were formed at the beginning of the academic year, students were not assigned to experimental and control groups randomly in this study and quasi-experimental design was used (Gay, 1987). In addition, one of the classes was randomly assigned as control group called Group TC; whereas the other class was randomly assigned as experimental group and named as Group PB. Combination of both types of data, questionnaires and tests as quantitative data and interviews as qualitative data were used in order to provide a better understanding of the research problems. The research design of the study is outlined in Table 5.1.

Table 5.1. Research design of the study

Groups	Pretest	Treatment	Posttest
Group PB	ELT	Project-Based Learning Method	ELT
	SPST		SPST
	Interviews		Interviews
Group TC	ELT	Teacher-centered Instructional Method	ELT
	SPST		SPST
	Interviews		Interviews

In the beginning, one student from four project groups of six students and two students from each of two crowded project groups of seven students were selected randomly and interviewed by the researcher. In total, there were eight students who joined the interviews from experimental group. To learn about the views of the students in the control group, eight students were randomly selected.

First interview questions included two topics. First group of questions was to investigate students' environmental literacy according to each environmental literacy component. Second group of questions investigated students' scientific process skills. Interviews were completed in 10 to 15 minutes. Each interview was conducted individually in a quiet area of the school by the researcher.

One week after the interviews, all of the students from experimental and control group were administered environmental literacy test and the science process skills test with one day time interval. Each test was completed in one class hour (40 minutes).

Before the treatment, the students were informed about developing projects and scientific method steps. After the interviews, tests and information, treatment part of the study started. Group TC students learned 'Environmental Problems' topic of 'Conscious Individual-Livable Environment' unit through teacher-centered instruction. Teacher and books were the knowledge suppliers in this method. Students could join the process by asking or answering questions. Group PB students received this course through a project based learning method following lesson plans and worksheets. Students developed their own projects by cooperating with each other. Students in groups developed a project about what they can do for an environmental problem. The products of the implementation were environmental action projects. All the process was student centered and they to produce the best project and prepared a poster. According to the jury's decision, best three projects were selected and they won medals and different types of gifts.

Students were the main characters of the process, teacher acted like a guider. Students followed up the features of the project based learning method such as teamwork, directing the projects according to their own interests and taking advantages of different disciplines while correlating knowledge with real life experiences (Korkmaz, 2002).

Students were required to be active participants by doing, drawing, researching, measuring, comparing, finding, deciding, discussing, criticizing, imagining etc. in the process. Developing an environment project is an interdisciplinary task including mathematics, literature and geography. Students used all of these disciplines' skills and got help from other disciplines' teachers.

After the treatment, the interviews were conducted with the same students by directing three groups of questions for experimental group. First and second group of questions about environmental literacy and science process skills were the same with the previous one. Differently, Group PB students were asked to evaluate the project-based learning by questioning what they gained and the effect of this project on their daily life.

Last step of the design was the administration of post-tests. ELT-Post and SPST-Post were administered to the students again.

Procedure*:* In the control group, biology instruction was traditionally designed. Mainly teacher explained the concepts, gave information about the subjects, sometimes discussion method was used. Textbooks and notebooks were used as the main sources. Teacher used blackboard, PPTs in lessons and made students watch videos two times in the treatment period. Teacher asked students to read related subject from the textbook before the class. Before the class, brief information about the day's topic was given by the teacher. In order to encourage students to learn she emphasized the importance of these subjects in real life and the necessity to learn about them for our world. After explaining the subject, she asked related questions. At the end of the lesson, the teacher briefed the topic to clarify it for students. In addition, before coming to next class hour, students were asked to study next subtopics. At the beginning of next class hour, the students were asked to tell what they learnt in the previous lesson.

The aim and content of the lessons including the science process skills objectives listed 2007 Secondary School Biology Curriculum are given below in Table 5.2 for Group TC. Science process skills objectives are coded as BAS in Turkish Secondary School Biology Curriculum (see Appendix F).

Table 5.2. Aim and Content of the Lessons (Group TC)

Lesson	Aim	Task	Objectives
1st	Learning environmental terms and environmental problems.	• Teacher will give definitions of environmental terms. • Discussion about what is an environmental problem. • Students will watch a famous short movie about the effects of people on environment.	
2nd	Studying the reasons of the environmental problems and their results.	• Knowledge about the water pollution will be given by the teacher. • Students will read air pollution from their textbooks and take notes to talk about it. • Students will be responsible of radioactive pollution and food pollution topics for the next lesson.	BAS 7
3rd	Studying the reasons of the environmental problems and their results.	• Students will discuss about radioactive pollution and food pollution	
4th	Studying the reasons of the environmental problems and their results.	• Teacher will give information about erosion by using power point slides. • Students will discuss about the solutions for this environmental problems.	BAS 13
5th	Studying the reasons of the environmental problems and their results.	• Students will watch a movie about global climate change. • They will be responsible for preparing a presentation about acid rains.	BAS 7
6th	Studying the reasons of the environmental problems and their results.	• The presentations of acid rain will be held. • Students will be responsible of the topic about the effect of people on environmental problems from the textbook for the next lesson.	
7th	Questioning the role of the people in occurrence of environmental problems	• Students will discuss about the topic. • Teacher will give information at the end of the lesson. • Students will be responsible for the topic of the effects of environmental problems on human health.	BAS 7
8th	Investigating the effects of environmental problems on human health	• Students will discuss about the human health. • Talk about the solutions. • Teacher will give brief information about the topics.	BAS 13

In the experimental group, project-based learning instruction was used. Before applying the project-based learning, information about projects and scientific method were given by using power-point slides. Students had an idea about what they will do in this

process. Weekly project evaluation forms and final project evaluation form were introduced to students and the students were asked to learn every steps and criteria.

Six groups were formed for the project-based learning. Four of them involved seven and two of them involved six students. The students were grouped according to their biology grades in the previous semester.

The aim and content of the lessons including the science process skills objectives listed 2007 Secondary School Biology Curriculum are given below in Table 5.3. Science process skills objectives are coded as BAS in Turkish Secondary School Biology Curriculum (see Appendix F).

Table 5.3. Aim and content of the lessons (For Group PB)

Lesson	Aim	Task	Objectives
1st	Stating the environmental problem that students will work on .	• Making observations in the area. • Find out the problem that gives harm to environment mostly. • Collect some documents that will prove the problem, like photographs.	BAS 1 BAS 3 BAS 4 BAS 12
2nd	Finding solution to this environmental problem	• Individually students will write suggestions about solving this problem in their reports and bring them to classroom. • They will discuss about the suggestions and decide on the best one that they will work on.	BAS 3 BAS 13
3rd	Collecting data about the problem.	• Students will find their own ways to get reliable data from several resources. They can use questionnaires, interviews , official data, internet, etc.	BAS 6 BAS 7 BAS 9
4th	Analyzing the data.	• Every student will write a report about data they collected and share with group partners.	BAS 19 BAS 20
5th	Deciding the action they will conduct to solve this environmental problem.	• They will evaluate the findings and take the ones that will be beneficial for them. They will write an action plan individually combining all of the things they've got so far. In the classroom, they will discuss about the action plans and construct the final action plan.	BAS 9 BAS 11 BAS 15

Table 5.3. Aim and content of the lessons (cont.)

Lesson	Aim	Task	Objectives
6th	Implementing the project	• All of the group members will have their own responsibilities. • They will do their tasks according to their action plan. • They will collect documents, evidences in order to show the difference of their project on environmental problem.	BAS 15 BAS 16
7th	Evaluating the project	• They will write a report about their project. This report will tell us if the Project worked and made a difference between the start and the end. • List all of the benefits of the Project. • Explain the effect of the Project on daily lives of the people who live in there.	BAS 17 BAS 23
8th	Presenting the project.	• Students will prepare a presentation about their project and share it with other students. • They will prepare a poster about their Project that include pictures, graphs, etc.	BAS 26 BAS 27

Six environmental problems were found out by the groups according to their observations in the area they live. These problems are; water waste, lack of green space, visual pollution, waste batteries, living conditions of stray animals and people's lack of environmental awareness.

Information about each group's study is given below.

Water Waste Group: After the observations made by the students in this group in the area they live and their school, they decided that people failed to pay attention to saving water. After their research about the subject, they realized that water waste was one of the most important environmental problems in the world and they decided to search for some solutions. The students thought that making people aware of this problem and taking their attention is the best way to save water. Students kept watching the school restrooms and collected data about how many students visited there in break times and kept time while the tap was running. They calculated how much water drained in one minute and with this information they calculated the total amount of water used in one day. They wrote a report about their data and decided to make people aware as a campaign. Posters about water saving were prepared and hanged on the restroom walls where students could see while

they were using taps. Beside this, they asked for help from a profession, the manager of İSKİ (İstanbul Water and Sewerage Administration). He gave a seminar about saving water and the importance of water to 9th grade students. In order to see the effects of their project, they collected the same data from the restrooms by keeping time. They reported the results and told that their project worked and the amount of water per student decreased after the project. They prepared a presentation and a poster about their study and the importance of their project since it could affect everyone's daily lives.

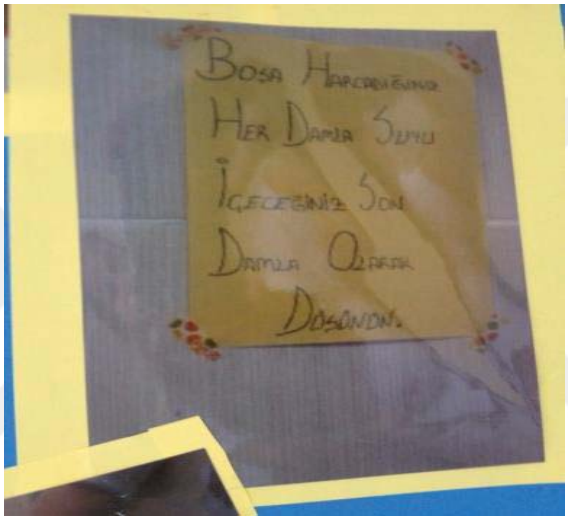

Figure 5.1a. Water Waste Group



Figure 5.1b. Water Waste Group



Figure 5.1c. Water Waste Group

Green Space Group: This group's members decided that lack of green space was one of the serious environmental problems experienced in Esenler. They proved this with their literature research and found out that Esenler was the area that had the least green area in İstanbul. They collected data about the amount of oxygen that one tree could produce. They decided to plant different kind of trees to school's garden and shared the responsibilities with group members. After they provided everything they needed for planting, they got permission from the school administration and planted the trees themselves. They prepared a report and a poster. They calculated how much oxygen could be produced with the help of the project and also discussed about the other benefits of the green areas to animals and people.



Figure 5.2a. Green Space Group



Figure 5.2b.Green Space Group



Figure 5.2c. Green Space Group

Visual Pollution Group: After deciding that visual pollution was a serious problem that occurs in Esenler, the students in this group proved it with photographs, supported this idea with the surveys they prepared and administered to the students of the school. They chose an area in the school that discomforts students with its view and decided to change it. After sharing the responsibilities of the project, they cleaned, tidied and painted the area. After that they drew something beautiful on the wall in order to make people pleased seeing that wall. They took the photographs of the area before and after the change they

made. They conducted the same surveys after the study and shared the results with a presentation and a poster.



Figure 5.3a. Visual Pollution Group



Figure 5.3b. Visual Pollution Group



Figure 5.3c.Visual Pollution Group

Battery Recycling Group*:* After observing the area and school, the students in this group decided to study about the battery recycling. They proved this environmental problem with the photographs of the randomly thrown batteries. They collected data about the amount of harm that one battery gave to nature. They started a campaign to collect batteries as a solution for this problem. With the help of the school administration, they put a prize of class trip and this prize motivated the students about this project. A huge and unexpected amount of batteries nearly two large size trash bags was collected with this project. They reported the benefits of the projects and declared the amount of harm they prevented with the help of this project.

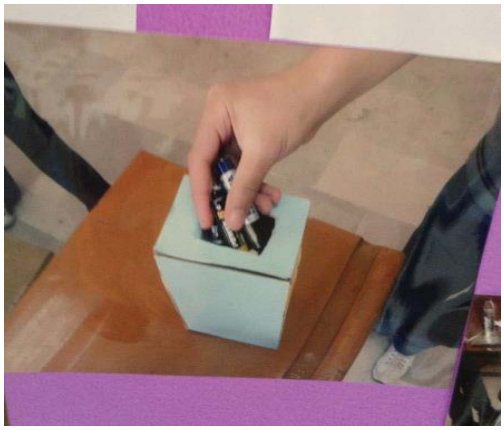

Figure 5.4a.Battery Recycling Group

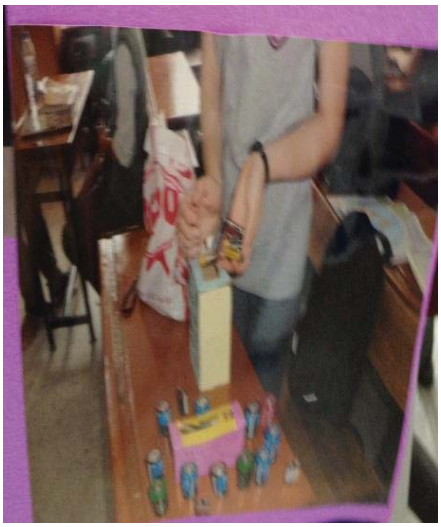

Figure 5.4b. Battery Recycling Group



Figure 5.4c. Battery Recycling Group

Animal Houses Group: This group of students observed in some areas that people improved conditions for animals by providing food and safe living areas for animals. Unfortunately, Esenler was not such an area as proved in their study. They decided to start a campaign as designing animal houses and create places for animal food. They designed houses for cats, dogs and birds themselves. Also they made it themselves with the materials they could find. They placed the animal houses to the areas that they thought needed. After the project, they interviewed with the people living in this area and asked for their opinions about this project. They told that the opinions of the people changed with

this project in a positive way. Beside this, the animals living in the streets benefitted the help of the group.



Figure 5.5a. Animal Houses Group



Figure 5.5b.Animal Houses Group

Awareness Group: This group's students observed the harming actions of people living in that area for the environment. They proved these behaviors with some photos and decided that this happened because of the lack of environmental awareness. They prepared and administered a survey investigating the level of environmental awareness and conducted it with the parents of the students. After they recognized that they continued in a right way according to the survey results, they decided to start a campaign that would improve people's environmental awareness. They prepared brochures about the environmental issues and sent them to the students' houses. They organized a seminar about environmental issues and invited the same parents. After all these actions, they

conducted the same survey to the same parents and saw that their projects worked. In the end, they presented their project and prepared their poster.



Figure 5.6a. Awareness Group



Figure 5.6b. Awareness Group

After all of the groups finished their projects, they wrote their project reports and gave them to the researcher. All the groups presented their posters to a jury at the school. Jury members were four teachers from the same school. There was one teacher of Turkish literature as he was an expert in using language and effective presentation. The other jury members were geography and chemistry teacher since both disciplines were related to the environmental issues. The last member of the jury was the researcher as the biology teacher herself. Jury evaluated the projects according to the criteria in project evaluation form (Appendix E). Best three projects were awarded their gifts and took medals from the teachers.



Figure 5.7a. Groups' Presentations



Figure 5.7b. Groups' Presentations

5.3. Instruments

In order to gather data, three measuring instruments were used in this study; Environmental literacy test (ELT), science process skills test (SPST) and interviews. The descriptions of the instruments are given in Table 5.4.

Table 5.4. Description of the instruments

Instruments	Number of Items	Sample Item
Environmental Literacy Test: This test is composed of 3 sub-tests:		
I. Environmental Knowledge	20	Which choice below is one of the main causes of acid rain?
II. Environmental Attitude	18	I feel responsibility about preventing environmental problems.
III. Environmental Behavior	15	I don't buy any product which is harmful for environment.
Science Process Skills Test	10	Doctors noticed that if certain bacteria were injected into a mouse, it developed certain symptoms and died. When the cells of the mouse were examined under the microscope, it was seen that the bacteria did not spread through the body of the mouse, but remained at the area of infection. It was therefore thought that the death is not caused by the bacteria but by certain toxic chemicals produced by them. Which of the statements below provides a possible explanation for the cause of death of the mouse?
Interviews	8	Do you have concerns about the environment when you think about the future world generally?

* *one more interview question was asked only Group PB students.*

5.3.1. Environmental Literacy Test (ELT)

Environmental literacy has three components: Environmental knowledge, environmental attitude and environmental behavior. These components were chosen according to the studies conducted after 2000s such as Hungerford (2003) and Kibert (2000) did. Therefore, in order to assess three different environmental literacy components, ELT was constructed with the combination of three different instruments which were previously used in different studies.

5.3.1.1. Environmental Knowledge Component of ELT (ELT-EnvKnow). The knowledge component of the test consisted of 20 multiple choice items assessing students' knowledge of environmental issues.

In her thesis, Varışlı (2009) used an environmental knowledge test which was developed for 8th grade students. The test was found to be suitable for the curriculum and the level of students in this study. This test was constructed from three different tests. Eight suitable questions were taken from 11 questions of NEETF/Roper Survey (Coyle, 2005) that was translated into Turkish and adapted by Tuncer, Tekkaya, Sungur, Cakiroglu, Ertepinar and Kaplowitz (2009). Ten questions were from a previously adapted version (Alp, 2005) of instrument developed by Leeming and Dwyer (1995). Two questions were taken from Vlaardingerbroek and Taylor's (2007) study. Totally a test with 20 questions was constructed by Varışlı (2009). There were five choices. One of them is correct, three of them are incorrect. The fifth option was added as 'I don't know' in order to prevent students guess the answer. Correct answer is coded as 1 and incorrect answer is coded as 0. Students could take maximum 20 and minimum 0 scores from this test. Higher scores meant higher knowledge about environmental issues and ecological concepts. The reliability of the environmental knowledge test was reported as 0.68 by using Cronbach alpha coefficient in Varışlı's (2009) study.

5.3.1.2. Environmental Attitude Component of ELT (ELT-EnvAtt). This instrument has 18 Likert-type items in order to assess environmental attitude of the students. Kışoğlu (2009) developed this environmental attitude instrument for pre-service teachers, but all of the items were found to be appropriate for 9th grade students according to the researcher and two science educators. The ELT-EnvAtt was a five point likert scale that ranged from 'I strongly disagree' (1) to 'I strongly agree' (5). Coding of negative statements were reversed as one point for 'I strongly agree' and five points for 'I strongly disagree'. Maximum score could be 90 and minimum score could be 18 according to this scale. It was aimed to see students' feelings and values about the environment with this instrument.

The ELT-EnvAtt included five subcategories (factors), responsibility, concern, awareness, support and sensitivity of the environmental attitudes. Table 5.5. summarizes the number of items asked in each subcategory.

Table 5.5. The names and numbers of items of the factors that compose attitude component (Kışoğlu, 2009).

Factor	Number of Items
Responsibility	6
Concern	4
Awareness	3
Support	2
Sensitivity	3

The cronbach alpha coefficient of attitude component was found by Kışoğlu (2009) as 0.77, which indicated the reliability of the instrument.

5.3.1.3. Environmental Behavior Component of ELT (ELT-EnvBeh). In order to determine how often 9th grade students behave responsible for the environment, this instrument of the same researcher (Kışoğlu, 2009) was used for the behavior component. There were 20 environmental behavior sentences and students chose one response from three choices. Three points was given for the option ‘every time’, two points was given to ‘sometimes’ and one point was given for the answer ‘never’. In the study with pre-service teachers, the reliability of behavior component was found to be 0.79 by using Cronbach alpha coefficient. For content validity, the opinions of two science educators were asked and they found five of the statements not suitable for assessing high school students’ environmental behaviors because this test was originally prepared for pre-service teachers. After removing these five statements, the reliability coefficient was found 0.71 in pilot study. Pilot study was conducted with another 9th grade class that was selected randomly from the same school. Table 5.6. gives information about how many items each factor of behavior appeared in this test.

Table 5.6. The names and the number of items of the factors that compose behavior component (Kışoğlu, 2009)

Factor	Number of Items
High level affective behaviors	4
Protecting natural balance behaviors	3
Social behaviors	4
Conscious behaviors	1
Saving behaviors	2
High level cognitive behaviors	1

5.3.2. Science Process Skills Test (SPST)

This science process skills test was adapted by the researcher from the previously used tests, specifically, the ones used by Monica (2005) and Serin (2009). Some of the items were translated from Monica's study into Turkish and some new items were developed according to the science process skills objectives listed in the Secondary School Biology Curriculum implemented between 2007-2013. The objectives suggested by the curriculum for the unit covered in this study were taken as the base while developing the instrument. This instrument includes ten items with four choices. Students will take one point if their answer is true and zero point in case their answer is false. Students could get maximum ten points and minimum zero point. Each item serves for a step of scientific process and for an objective of science process skills objectives in curriculum. After sharing this instrument with experts for validity, it was piloted and the reliability coefficient was found as 0.76. Pilot study was conducted with another 9th grade class that was selected randomly from the same school (See Appendix B).

5.3.3. Interviews

Semi-structured interviews included eight questions (three of them have two sub-questions) for both experimental and control groups. After the treatments, an extra question about the project was asked to Group PB students. Interview questions were developed by the researcher after asking two science educators for their opinions. Interviews were conducted with eight students from each class. The interviews were audio recorded,

listened and transcribed by the researcher. Each interview took 10 to 15 minutes. Before and after the treatment, researcher interviewed the participants from experimental and control groups. There were totally 32 interviews; as 16 pre and 16 post-interviews. The selection of students was explained in the design section.

Two groups of questions were asked during the interviews. First group was about understanding the perception of students regarding environmental literacy concepts. Second group of questions were about science process skills. Researcher asked the students to explain the steps they followed when they faced with an environmental problem and how they wanted to come over it. After the treatment, the same questions were asked to the same students. In addition, there was one more group of questions asked to experimental group students. Researcher asked them to evaluate their experiences and perceptions about project-based learning.

The description of the interview questions are summarized in Table 5.7.

Table 5.7. The description of the interview questions

Questions	**The Focus of the Question**	**Interview Question**
1st Question	Environmental knowledge (the definition of environmental concepts and ecological issues)	What comes to your mind when you hear the word 'environment'?
2nd Question	Environmental attitude (support factor)	When you think about the region where you live, 'Esenler', are you happy with the environment?
3rd Question	Environmental attitude (awareness factor)	What do you want to change for the environment in Esenler?
4th Question a)	Environmental attitude (responsibility factor)	Do you think that you have a positive effect on the environment?
4th Question b)		Do you think that you have a negative effect on the environment?
5th Question a)	Environmental attitude (concern factor)	Do you have concerns about the environment when you think about the future world in general?'

Table 5.7. The description of the interview questions (cont.)

Questions	The Focus of the Question	Interview Question
5th Question b)	Environmental attitude (concern factor)	What are your concerns about the environment? (to the students who answered the first part 'yes')
6th Question a)	Environmental attitude (sensitivity factor)	Are you interested in the environmental issues?
6th Question b)	Environmental behavior	What do you do as a person who is interested in environment?
7th Question	Scientific method steps, science process skills.	Think about a problem. This can be an environmental or any other scientific problem. How can you get information about the problem to find out the cause of it in the beginning?
8th Question	Scientific method steps, science process skills.	Which steps do you follow after you find out the cause of the problem?'
9th Question *Only for Group PB students	Evaluating Project-based learning.	In your opinion, what values did this project add to you?

5.4. Data Analysis

Since the study has a mixed method design, both quantitative and qualitative analyses are used. In this section, the analysis of data gathered from ELT, SPST and student interviews is explained.

5.4.1. Quantitative Analysis

Quantitative data obtained from ELT and SPST were analyzed to answer the research questions.

Both parametric and non-parametric statistics were used according to the data distribution. The mean scores of each pre and post-tests were found and put in the results

section in order to give idea about the level of the students. In order to decide whether a parametric or a non-parametric test is appropriate, first normality of the distribution of the scores was checked by using Shapiro-Wilk Test since the number of participants was less than 50.

If the scores were not found to be normally distributed, in order to check whether or not Group PB and TC were similar, a non-parametric test, Mann-Whitney U test was used to compare the mean scores of the groups. Then, Wilcoxon Signed Rank test was used in order to see the improvement of each group from pre to post-tests.

If the scores were found to be normally distributed, a parametric test, namely Independent Samples T-test was used to compare the mean scores of the groups. Then, Paired Samples T-test was used to statistically compare the scores for the analysis of the improvement for each group.

'Effect size' (also known as 'strength of association') for each pos-test analysis were calculated in order to see the relative magnitude of the differences between means, or the amount of the total variance in the dependent variable that is predictable from knowledge of the levels of the independent variable.

For Mann-Whitney U Test, effect size (r value) means, .1= small effect, .3= medium effect, .5=large effect.

For Wilcoxon Signed Rank Test, effect size (r value) means, .1= small effect, .3= medium effect, .5=large effect.

For Independent Samples T-test, effect size (Eta squared) means, .01=small effect, .06=moderate effect, .14= large effect.

For Paired Samples T-test, effect size (Eta squared) means, .01=small effect, .06=moderate effect, .14= large effect (Cohen, 1988).

Table 5.8 shows which statistical method was used for each research question and which groups were compared.

Table 5.8. Statistical analysis procedures for research questions

Research Question	Dependent Variable	Compared Treatments	Statistical Analysis
RQ1a	Environmental Knowledge	ELT-EnvKnow-Pre and ELT-EnvKnow-Post scores of Group PB and Group TC	Mann-Whitney U Test
RQ1b	Environmental Attitude	ELT-EnvAtt-Pre and ELT-EnvAtt-Post scores of Group PB and Group TC	Independent Samples T-test
RQ1c	Environmental Behavior	ELT-EnvBeh-Pre and ELT-EnvBeh-Post scores of Group PB and Group TC	Mann-Whitney U Test
RQ2a RQ3a	Environmental Knowledge	ELT-EnvKnow-Pre_ELT-EnvKnow-Post scores of Group PB ELT-EnvKnow-Pre_ELT-EnvKnow-Post scores of Group TC	Wilcoxon Signed Rank Test
RQ2b RQ3b	Environmental Attitude	ELT-EnvAtt-Pre_ELT-EnvAtt-Post scores of Group PB ELT-EnvAtt-Pre_ELT-EnvAtt-Post scores of Group TC	Paired Samples T-test
RQ2c RQ3c	Environmental Behavior	ELT-EnvBeh-Pre_ELT-EnvBeh-Post scores of Group PB ELT-EnvBeh-Pre_ELT-EnvBeh-Post scores of Group TC	Wilcoxon Signed Rank Test
RQ4	Science process skills	SPST-Pre and SPST-Post scores of Group PB and Group TC	Mann-Whitney U Test
RQ5 RQ6	Science process skills	SPST-Pre_SPST-Post scores of Group PB SPST-Pre_SPST-Post scores of Group TC	Wilcoxon Signed Rank Test

5.4.2. Qualitative Analysis

In ‘’Instruments’’ section, information about the interviews was given. As it was expected to get more detailed information for the study with the interviews, this qualitative data collection strategy was chosen (Creswell, 2013).

There were 32 audio recorded semi-structured interviews including questions about environmental literacy, science process skills and project-based learning, which were listened and transcribed by the researcher. After reading the transcripts many times, data was coded by open coding. Similar codes were placed into categories and the emerged categories formed the themes. In order to find inter-rater reliability of a qualitative study, the data should be analyzed by multiple coders, this is called ‘inter-coder agreement’ in literature (Creswell, 2013). Data were reviewed by the advisor and a graduate student in Secondary School Science and Mathematics Education in this study and 85% agreement was established.

Frequency distribution was analyzed and compared between both pre- and post-interviews for each group; between two groups’ post-interviews. In order to clarify the analysis, some examples from both groups’ pre- and post-interviews were given in the results section.

6. RESULTS

6.1. Analysis of Environmental Literacy Test (ELT)

In order to investigate the effect of project-based learning on environmental literacy, the test scores of 78 students were statistically compared.

Environmental Literacy Test (ELT) was administered as ELT-Pre and ELT-Post before and after the implementation as described in the 'Methodology' section. Students can't become environmentally literate only by having factual knowledge, there are behaviors and attitudes that work for environmental sustainability (Kibert, 2000). In order to reach a common conception of environmental literacy, researchers worked on its components (Wills, 1999; Negev, et al., 2008; Donovan, 2001). In this research, three components of environmental literacy; environmental knowledge, environmental attitude and environmental behavior were investigated by administering three different tests.

6.1.1. Environmental Knowledge Component of ELT (ELT-EnvKnow)

In order to answer this research question, ELT-EnvKnow was used in pre- (called ELT-EnvKnow-Pre) and post-tests (called ELT-EnvKnow-Post). In order to assess the students' level of environmental knowledge, they were asked 20 items related to their environmental knowledge. Each of them included one correct, three incorrect and an 'I don't know' choice. The test's lowest possible score was zero and the highest possible score was 20.

6.1.1.1. Comparison of the Environmental Knowledge of Group PB and Group TC according to the ELT-EnvKnow-Pre Scores. In the ELT-EnvKnow-Pre, the mean scores of the participants of Group PB were found to be 8.75; and the scores of Group TC was found to be 8.79.

First normality of the distribution of the ELT-EnvKnow-Pre scores was checked in order to decide to use whether a parametric or a non-parametric test.

As given in Table 6.1, Shapiro-Wilk Test was used to check the normality of the distribution of the ELT-EnvKnow-Pre scores. Both Group PB and Group TC scores were not normally distributed ($p<.05$).

Table 6.1. Test of normality for Group PB and Group TC's ELT-EnvKnow-Pre scores.

	Groups	Shapiro-Wilk		
		Statistic	Df	Sig.
ELT-EnvKnow-Pre	Group PB	.801	38	.000
	Group TC	.828	38	.000

Since the scores were not found to be normally distributed, in order to check whether or not Group PB and TC were initially similar, a non-parametric test, namely Mann-Whitney U test was used to compare the mean scores of the groups in ELT-EnvKnow-Pre. The results of the statistical analysis showed that the groups were not significantly different from each other as shown in Table 6.2 ($p >.05$).

Table 6.2. Mann-Whitney U Test results of the Group PB and Group TC for ELT-EnvKnow-Pre questions.

Groups	**N**	**Mean Rank**	**Sum of Ranks**	**U**	**Z**	**P**
Group PB	40	39.54	1581,50	758.500	-.015	.988
Group TC	38	39.46	1499,50			

6.1.1.2. Comparison of the Environmental Knowledge of Group PB and Group TC according to the ELT-EnvKnow-Post Scores. After ensuring that the groups were comparable with each other, their scores on the ELT-EnvKnow-Post were statistically compared. In the ELT-EnvKnow-Post, the mean scores of the participants of Group PB was found to be 13.3; and the scores of Group TC was found to be 10.

In order to see the normality of the distribution of ELT-EnvKnow-Post, Shapiro-Wilk Test was used in Table 6.3. The groups were not normally distributed (p<.05). Therefore, again non-parametric test, Mann-Whitney U Test was used.

Table 6.3. Test of Normality for Group PB and Group TC's ELT-EnvKnow-Post scores.

	Group	Shapiro-Wilk		
		Statistic	Df	Sig.
ELT-EnvKnow-Post	Group PB	.943	38	.048
	Group TC	.903	38	.003

As shown in Table 6.4, the results of analysis showed that, Group PB and TR were found to be significantly different in the ELT-EnvKnow-Post (p <.05) with a medium effect size (r= .37). Therefore, the first hypothesis stating that Group PB students would perform better in ELT-EnvKnow-Post compared to Group TC students was retained.

Table 6.4. Mann-Whitney U Test results of the Group PB and Group TC for ELT-EnvKnow-Post scores.

Groups	**N**	**Mean Rank**	**Sum of Ranks**	**U**	**Z**	**P**
Group PB	40	47.05	1882,00	458.000	-3,028	.002
Group TC	38	31.55	1199,00			

6.1.1.3. Comparison of ELT-EnvKnow-Pre and ELT-EnvKnow-Post scores of Group PB and Group TC. ELT-EnvKnow-Post scores of Group PB and Group TC was statistically compared with Mann-Whitney U test in Table 6.4 and a significant difference between Group PB and Group TC was found. In this section, each group's ELT-EnvKnow-Pre and ELT-EnvKnow-Post scores were individually compared to check whether there was an improvement in the groups' environmental knowledge.

Table 6.5 presents the mean scores of participants on the ELT-EnvKnow-Pre and ELT-EnvKnow-Post. The mean ELT-EnvKnow-Pre scores of the students in Group PB was M=8.75 (SD=5.62). The mean of the ELT-EnvKnow-Post scores was M=13.30 (SD=3.87). The mean of the Group TC participants' scores on the ELT-EnvKnow-Pre was M=8.79 (SD=5.36) and the mean of the ELT-EnvKnow-Post scores was M=10.00 (SD=4.96).

Table 6.5. ELT-EnvKnow-Pre and ELT-EnvKnow-Post results for Group PB and TC.

		ELT-EnvKnow-Pre		**ELT-EnvKnow-Post**	
Group	**N**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Group PB	40	8.75	5.62	13.30	3.87
Group TC	38	8.79	5.36	10.00	4.96

Wilcoxon Signed Rank Test was applied since the scores of those groups were not normally distributed according to Table 6.1 and 6.3.

Table 6.6. Results of the Wilcoxon Signed Rank Test for ELT-EnvKnow-Pre and ELT-EnvKnow-Post questions of Group PB and Group TC

			N	**Mean Rank**	**Sum of Ranks**	**Z**	**Asymp. Sig. (2-tailed)**
Group PB	ELT-EnvKnow-Pre - ELT-EnvKnow-Post	Negative Ranks	0[a]	.00	.00	-5,317	**.000**
		Positive Ranks	37[b]	19.00	703.00		
		Ties	3[c]				
		Total	40				
Group TC	ELT-EnvKnow-Pre - ELT-EnvKnow-Post	Negative Ranks	1[a]	8.50	8.50	-4,538	**.000**
		Positive Ranks	27[b]	14.72	397.50		
		Ties	10[c]				
		Total	38				

a. ELT-EnvKnow-Pre > ELT-EnvKnow-Post b. ELT-EnvKnow-Post > ELT-EnvKnow-Pre c. ELT-EnvKnow-Post= ELT-EnvKnow-Pre

Table 6.6 shows that ELT-EnvKnow-Pre and ELT-EnvKnow-Post results of both Group PB and Group TC were significantly different from each other ($p<.05$). The effect size for Group PB's ($r=.60$) and Group TC's ($r= .52$) improvement were large. According to Wilcoxon Test, 37 students in Group PB and 27 Students in Group TC improved their ELT-EnvKnow-Pre scores in the ELT-EnvKnow-Post. Three students in Group PB and 10 students in Group TC took the same scores in ELT-EnvKnow-Pre and ELT-EnvKnow-Post. There weren't any students in Group PB who scored lower in ELT-EnvKnow-Post than ELT-EnvKnow-Pre, but one student in Group TC increased ELT-EnvKnow-Pre score in ELT-EnvKnow-Post.

6.1.2. Environmental Attitude Component of ELT (ELT-EnvAtt)

In order to answer this research question, ELT-EnvAtt was used as pre- (called ELT-EnvAtt-Pre) and post-tests (called ELT-EnvAtt-Post).

6.1.2.1. Comparison of the Environmental Attitude of Group PB and Group TC according to the ELT-EnvAtt-Pre Scores. In order to assess students' level of environmental attitude, they were asked 18 Likert-type items, which assessed the relationship between humans and the environment. The response options were given on five-point scales in which the choices ranged from one to five. Five points were assigned to "strongly agree", 4 to "agree", 3 to "undecided", 2 to "disagree" and 1 to "strongly disagree".

In ELT-EnvAtt-Pre, the mean scores of the participants of Group PB was found to be 55.50; and the scores of Group TC was found to be 55.81. In order to choose parametric or a non-parametric test, first normality of the distribution of the ELT-EnvAtt-Pre scores was checked. As given in Table 6.7, Shapiro-Wilk Test was used to check the normality of the distribution of the ELT-EnvAtt-Pre scores. Both scores of Group PB and Group TC were normally distributed ($p>.05$).

Table 6.7. Test of normality for Group PB and Group TC's ELT-EnvAtt-Pre scores.

	Group	Shapiro-Wilk		
		Statistic	Df	Sig.
ELT-EnvAtt-Pre	Group PB	.944	39	.050
	Group TC	.949	38	.084

Since the scores were found to be normally distributed, in order to check whether or not Group PB and Group TC were initially similar, a parametric test, namely Independent Samples T-test was used to compare the mean ELT-EnvAtt-Pre scores of the groups. The results of the test analysis showed that the groups were not significantly different from each other as shown in Table 6.8 ($p>.05$).

Table 6.8. Descriptive statistics and Independent Samples T-test Results for comparing ELT-EnvAtt-Pre Scores of Group PB and Group TC.

				t-test for Equality of Means		
Groups	N	Mean	Std. Dev.	t	Df	Sig. (2-tailed)
Group PB	40	55.59	11.60	-.087	75.00	.931
Group TC	38	55.82	11.25	-.087	74.99	.931

6.1.2.2. Comparison of the Environmental Attitude of Group PB and Group TC according to the ELT-EnvAtt-Post Scores. After ensuring that the groups were initially similar to each other ($p>.05$), their ELT-EnvAtt-Post scores were compared. In the ELT-EnvAtt-Post, the mean scores of the participants of Group PB was found to be 61.87; and the mean scores of Group TC was found to be 57.02.

Table 6.9. Test of Normality for Group PB and Group TC's ELT-EnvAtt-Post scores.

	Groups	Shapiro-Wilk		
		Statistic	Df	Sig.
ELT-EnvAtt-Post	Group PB	.969	40	.348
	Group TC	.962	38	.224

As seen from Table 6.9, the groups were normally distributed (p>.05). Therefore, again a parametric test, Independent Samples T-test was used to compare the environmental attitude post-test scores of the groups.

The results of analysis in Table 6.10 showed that, two classes were found to be significantly different (p<.05) in the ELT-EnvAtt-Post and the effect size was found to be nearly moderate (eta squared= .05).

Table 6.10. Independent Samples T-test results for comparing ELT-EnvAtt-Post scores of Group PB and Group TC.

Groups	N	Mean	Std. Dev.	T-test for Equality of Means		
				T	Df	Sig. (2-tailed)
Group PB	40	61.95	10.79	2.002	75.00	.049
Group TC	38	56.84	11.58	2.000	74.30	

6.1.2.3. Comparison of ELT-EnvAtt-Pre and ELT-EnvAtt-Post scores of Group PB and Group TC. ELT-EnvAtt-Post scores of Group PB and Group TC was statistically compared with Independent Samples T-test in Table 6.10 and a significant difference between Group PB and Group TC was found. In this section, ELT-EnvAtt-Pre and ELT-EnvAtt-Post for each group were compared to check whether or not there was an improvement in students' attitudes towards environment.

Table 6.11. ELT-EnvAtt-Pre and ELT-EnvAtt-Post results for Group PB and Group TC.

Groups	**N**	**ELT-EnvAtt-Pre**		**ELT-EnvAtt-Post**	
		Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Group PB	40	55.59	11.60	61.95	10.79
Group TC	38	55.82	11.25	56.84	11.58

Table 6.11 presents the mean scores of participants on the ELT-EnvAtt-Pre and ELT-EnvAtt-Post. The mean of the Group PB participants' scores on the ELT-EnvAtt-Pre was M=55.59 (SD=11.60). The mean of the Group PB participants' scores on the ELT-EnvAtt-Post was M=61.95 (SD=10.79). Table 6.7 and 6.9 showed that Group PB's ELT-EnvAtt-Pre and ELT-EnvAtt-Post scores were normally distributed so Paired Samples T-test was used to statistically compare the scores.

Table 6.12. Paired Samples t-test results of ELT-EnvAtt-Pre and ELT-EnvAtt-Post scores for Group PB.

Compared tests of Group PB	T	Df	Sig. (2-tailed)	Mean	Std. Deviation	Std. Error Mean
ELT-EnvAtt-Pre and ELT-EnvAtt-Post	-17.92	39	.000	-6.375	2.25	.356

As seen in Table 6.12, ELT-EnvAtt-Pre and ELT-EnvAtt-Post scores of Group PB were significantly ($p<.05$) different from each other and had large effect size (eta squared=.8).

Group TC's ELT-EnvAtt-Pre and ELT-EnvAtt-Post results were also given in Table 6.11. The mean score of Group TC's ELT-EnvAtt-Pre was 55.82 (SD=11.25), and ELT-EnvAtt-Post was 56.84 (SD=11.58). As Group PB participants, Group TC participants also achieved higher scores in the ELT-EnvAtt-Post. Again Table 6.7 and 6.9 showed that Group TC's ELT-EnvAtt-Pre and ELT-EnvAtt-Post scores were normally distributed so Paired Samples T-test was used to statistically compare the scores.

Table 6.13. Paired Samples T-test results of ELT-EnvAtt-Pre and ELT-EnvAtt-Post scores for Group TC

Compared tests of Group TC	T	Df	Sig. (2-tailed)	Mean	Std. Deviation	Std. Error Mean
ELT-EnvAtt-Pre and ELT-EnvAtt-Post scores for Group TC	-5.738	37	.000	-1.026	1.10	.179

Table 6.13 shows this increase; Group TC's ELT-EnvAtt-Pre and ELT-EnvAtt-Post scores significantly differed ($p<.05$) and had a large effect size (eta squared= .29).

6.1.3. Environmental Behavior Component of ELT (ELT-EnvBeh)

In order to determine how often 9th grade students' behave responsible for the environment, this instrument was applied to the students. There were 20 environmental behavior items and students chose one response from these three choices. Three points was assigned to 'every time', two points was assigned to 'sometimes' and one point was assigned to 'never' answers. To test this research question, ELT-EnvBeh was used in pre- (called ELT-EnvBeh-Pre) and post-tests (called ELT-EnvBeh-Post).

6.1.3.1 Comparison of the Environmental Behavior of Group PB and Group TC according to the ELT-EnvBeh-Pre Scores. In ELT-EnvBeh-Pre, the mean scores of the participants of Group PB was found to be 55.62; and the scores of Group TC was found to be 55.63.

Before analyzing the ELT-EnvBeh-Post questions, first it was investigated whether or not Group PB and Group TC were similar in ELT-EnvBeh-Pre. Non-parametric tests (Mann Whitney U) were used since the scores for two classes in ELT-EnvBeh-Pre were not normally distributed ($p<.05$) according to Shapiro-Wilk test as Table 6.14 indicated.

Table 6.14. Test of normality for Group PB and Group TC's ELT-EnvBeh-Pre

	Groups	Shapiro-Wilk		
		Statistic	Df	Sig.
ELT-EnvBeh-Pre	Group PB	.869	40	.000
	Group TC	.861	38	.000

Results of Mann-Whitney U Test were given in Table 6.15. Results showed that no significant difference between Group PB and Group TC in ELT-EnvBeh-Pre.

Table 6.15. Mann-Whitney U Test results of the Group PB and Group TC for ELT-EnvBeh-Pre questions.

Groups	**N**	**Mean Rank**	**Sum of Ranks**	**U**	**Z**	**P**
Group PB	40	39.75	1590.00	750.000	-.101	.919
Group TC	38	39.24	1491.00			

6.1.3.2 Comparison of the Environmental Behavior of Group PB and Group TC according to the ELT-EnvBeh-Post Scores. After ensuring that the groups were initially similar to each other, their ELT-EnvBeh-Post scores were compared.

In the ELT-EnvBeh-Post, the mean score of the participants of Group PB was found to be 60.8; and the mean score of Group TC was found to be 55.63.

In order to see the normality of the distribution of ELT-EnvBeh-Post, Shapiro-Wilk Test was used in Table 6.16.

Table 6.16. Test of normality for Group PB and Group TC's ELT-EnvBeh-Post

	Groups	Shapiro-Wilk		
		Statistic	Df	Sig.
ELT-EnvBeh-Post	Group PB	.850	40	.000
	Group TC	.860	38	.000

As seen from Table 6.16, the groups were not normally distributed ($p<.05$). Therefore, again a non-parametric test, Mann-Whitney U Test was used.

As shown in Table 6.17, the results of analysis showed that, Group PB and Group TC were found to be significantly different ($p<.05$) in the ELT-EnvBeh-Post and had a large effect size ($r= .55$). Therefore, the hypothesis saying that, Group PB students would perform better in ELT-EnvBeh-Post compared to Group TC students wasn't rejected.

Table 6.17. Mann-Whitney U Test results of the Group PB and Group TC for ELT-EnvBeh-Post questions

Groups	N	Mean Rank	Sum of Ranks	U	Z	P
Group PB	40	51.70	2068.00	272.000	-4.912	.000
Group TC	38	26.66	1013.00			

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6.1.3.3. Comparison of ELT-EnvBeh-Pre and ELT-EnvBeh-Post scores of Group PB and Group TC. In this section, each group's ELT-EnvBeh-Pre and ELT-EnvBeh-Post scores were individually compared to check whether or not there was an improvement in groups' environmental behavior. As indicated above (see Table 6.17), there was a significant difference between Group PB and Group TC in ELT-EnvBeh-Post.

Table 6.18 presents the mean scores of participants on ELT-EnvBeh-Pre and ELT-EnvBeh-Post.

Table 6.18. ELT-EnvBeh-Pre and ELT-EnvBeh-Post results for Group PB and Group TC.

Groups	N	ELT-EnvBeh-Pre		ELT-EnvBeh-Post	
		Mean	Std. Dev.	Mean	Std. Dev.
Group PB	40	55.75	3.91	60.80	3.94
Group TC	38	55.63	4.10	55.92	3.80

Wilcoxon Signed Rank Test was applied since the scores of those groups were not normally distributed (see Table 6.14 and 6.16).

As seen from the table 6.19 there was a significant difference between Group PB's ELT-EnvBeh-Pre and ELT-EnvBeh-Post scores and a large effect size (r= .54) but there was no significant difference between Group TC's ELT-EnvBeh-Pre and ELT-EnvBeh-Post scores and had a small effect size (r= .05).

According to Wilcoxon Test, 36 students in Group PB and 10 Students in Group TC increased their ELT-EnvBeh-Pre scores in the ELT-EnvBeh-Post. Three students in Group PB and 22 students in Group TC took the same scores in ELT-EnvBeh-Pre and ELT-EnvBeh-Post. There was one student in Group PB and six students in Group TC who obtained lower scores in ELT-EnvBeh-Post than they did in ELT-EnvBeh-Pre.

Table 6.19. Results of the Wilcoxon Signed Rank Test for ELT-EnvBeh-Pre and ELT-EnvBeh-Post questions of Group PB and Group TC

			N	Mean Rank	Sum of Ranks	Z	Asymp. Sig. (2-tailed)
Group PB	ELT-EnvBeh-Pre-ELT-EnvBeh-Post	Negative Ranks	1[a]	33.00	33.00	-4.836	**.000**
		Positive Ranks	36[b]	18.61	670.00		
		Ties	3[c]				
		Total	40				
Group TC	ELT-EnvBeh-Pre-ELT-EnvBeh-Post	Negative Ranks	6[a]	9.83	59.00	-.467	**.640**
		Positive Ranks	10[b]	7.70	77.00		
		Ties	22[c]				
		Total	38				

a. ELT-EnvBeh-Pre > ELT-EnvBeh-Post b. ELT-EnvBeh-Post > ELT-EnvBeh-Pre c. ELT-EnvBeh-Post= ELT-EnvBeh-Pre

6.2. Analysis of Science Process Skills Test (SPST)

This instrument includes 10 items with four choices. Students received one point if their answer was true, otherwise they got zero point. Each item serves for a step of scientific process and for an objective of science process skills objectives in curriculum.

To answer this research question, SPST was used in pre- (called SPST-Pre) and post-tests (called SPST-Post).

6.2.1. Comparison of the Science Process Skills of Group PB and Group TC according to the SPST-Pre Scores

In this section, the results of the analysis regarding whether Group PB and Group TC performed significantly different from each other in terms of Science Process Skills test was presented.

Before analyzing the SPST-Post questions, it was first investigated whether Group PB and Group TC were similar in terms of their answers in SPST-Pre.

Non-parametric tests were used since the scores in the SPST-Pre were not normally distributed ($p<.05$) according to Shapiro-Wilk Test as Table 6.20 indicated.

Table 6.20. Test of normality for Group PB and Group TC's SPST-Pre

	Groups	Shapiro-Wilk		
		Statistic	Df	Sig.
SPST-Pre	Group PB	.763	40	.000
	Group TC	.877	38	.001

Results of Mann-Whitney U test were given in Table 6.21. Results showed that no significant difference between Group PB and Group TC in SPST-Pre was found.

Table 6.21. Mann-Whitney U Test results of the Group PB and Group TC for SPST-Pre scores

Groups	**N**	**Mean Rank**	**Sum of Ranks**	**U**	**Z**	**P**
Group PB	40	38.60	1544.00	724.000	-.370	.711
Group TC	38	40.45	1537.00			

6.2.2. Comparison of the Science Process Skills of Group PB and Group TC according to the SPST-Post Scores

Before testing the SPST-Post scores of Group PB and Group TC, normality analysis was done by using Shapiro-Wilk test. Normality test results are given in Table 6.22.

Table 6.22. Test of normality for Group PB and Group TC's SPST-Post

	Groups	Shapiro-Wilk		
		Statistic	Df	Sig.
SPST-Post	Group PB	.932	40	.018
	Group TC	.901	38	.003

Since none of the score were distributed normally, non-parametric statistics, namely, Mann-Whitney U Test was used to compare the scores of the groups. As shown in Table 6.23, the results of the analysis showed that, Group PB and Group TC were found to be significantly different ($p<.05$) and had a medium effect size ($r= 0.31$) in the SPST-Post.

Table 6.23. Mann-Whitney U Test results of the Group PB and Group TC for SPST-Post questions

Groups	**N**	**Mean Rank**	**Sum of Ranks**	**U**	**Z**	**P**
Group PB	40	46.49	1859.50	480.500	-2.825	.005
Group TC	38	32.14	1221.50			

6.2.3. Comparison of SPST-Pre and SPST-Post scores of Group PB and Group TC

In this section, each group's SPST-Pre and SPST-Post were individually compared to check whether or not there was an improvement in groups' science process skills.

Table 6.24 presents the mean scores of participants on the SPST-Pre and SPST-Post

Table 6.24. SPST-Pre and SPST-Post results for Group PB and Group TC

		SPST-Pre		**SPST-Post**	
Group	**N**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Group PB	40	4.35	2.76	6.70	1.84
Group TC	38	4.34	2.50	5.08	2.54

Wilcoxon Signed Rank Test was applied since the scores of those groups were not normally distributed (see Table 6.20 and 6.22).

Table 6.25 shows the difference between each group's SPST-Pre and SPST-Post scores.

Table 6.25. Results of the Wilcoxon Signed Rank Test for SPST-Pre and SPST-Post scores of Group PB and Group TC

			N	Mean Rank	Sum of Ranks	Z	Asymp. Sig. (2-tailed)
Group PB	SPST-Pre-SPST-Post	Negative Ranks	0[a]	.00	.00	-5.199	**.000**
		Positive Ranks	35[b]	18.00	630.00		
		Ties	5[c]				
		Total	40				
Group TC	SPST-Pre-SPST-Post	Negative Ranks	14[a]	15.82	221.50	-.521	**.602**
		Positive Ranks	17[b]	16.15	274.50		
		Ties	7[c]				
		Total	38				

a. SPST-Pre > SPST -Post b. SPST -Post > SPST -Pre c. SPST -Post= SPST -Pre

As seen from Table 6.25 there was a significant difference between Group PB's SPST-Pre and SPST-Post (a large effect size, r= .58) but, there was no significant difference between Group TC's SPST-Pre and SPST-Post (a small effect size, r= .06).

According to Wilcoxon Signed Rank Test, 35 students in Group PB and 17 Students in Group TC increased their SPST-Pre scores in the SPST-Post. Five students in Group PB and seven students in Group TC took the same scores in SPST-Pre and ELT-SPST-Post. There were no students in Group PB who took lower scores in SPST-Post SPST-Pre, but six students in Group TC lowered their SPST-Pre scores in SPST-Post.

6.3. Findings Related to the Interviews

In order to determine the effect of independent variable (learning method) on the dependent variable (environmental literacy) in detail, pre- and post-interviews were

conducted. The same questions were asked to the participants before and after covering the 'Environmental Problems' topic. Only one question was added to Group PB interviews in order to obtain their opinions about the treatment. The interviews were conducted with 16 students randomly chosen from Group TC and Group PB (eight students from each group).

6.3.1. Analysis of Interview Question 1

The first interview question directed to sixteen students was: *'What comes to your mind when you hear the word 'environment'? - Çevre kelimesini duyunca aklınıza neler geliyor?'.* This question was mostly about the knowledge component of the environmental literacy. Students listed the words that they related with environment. The analysis of students' answers revealed five themes: *biotic, abiotic, man-made, general* and *environmental problems* as can be seen in Table 6.26. These themes were identified after listening the recordings and reading the transcripts several times (Creswell, 2013).

Table 6.26. Analysis of the first interview questions

Themes	Codes	Group PB Pre-Int		Group TC Pre-Int		Group PB Post-Int		Group TC Post-Int	
		Frequency	Total frequency	Frequency	Total frequency	Frequency	Total frequency	Frequency	Total frequency
Biotic	Animals	2	8	2	6	4	17	2	9
	Plants	2		1		4		2	
	Insects	1		-		-		-	
	Trees	1		-		2		1	
	Human	2		1		3		1	
	Birds	-		1		-		1	
	Grass	-		1		-		-	
	Living Things	-		-		2		-	
	Living Organisms	-		-		1		-	
	Microorganisms	-		-		1		-	
	Dogs	-		-				1	
	Cats	-		-				1	
Abiotic	Climate	1	3	-	4	3	15	-	4
	Water	1		-		4		1	
	Earth	1		1		1		1	
	Heat	-		1		-		-	
	Sea	-		1		-		-	
	Stone	-		1		-		-	
	Air	-		-		3		1	
	Oxygen	-		-		2		-	
	Non-living things	-		-		2		-	
	Atmosphere	-		-		-		1	

Table 6.26. Analysis of the first interview questions (cont.)

Themes	Codes	Group PB Pre-Int		Group TC Pre-Int		Group PB Post-Int		Group TC Post-Int	
		Frequency	Total frequency	Frequency	Total frequency	Frequency	Total frequency	Frequency	Total frequency
Environmental problems	Environmental pollution	1	1	-	0	3	10	2	4
	Global warming	-		-		2		-	
	Air pollution	-		-		2		1	
	Visual pollution	-		-		1		-	
	Water waste	-		-		1		-	
	Water pollution	-		-		1		1	
General	Nature	1	1	-	1	2	8	-	2
	Forest	-		1		-		-	
	Ecosystem	-		-		2		1	
	Ecology	-		-		1		-	
	World	-		-		3		1	
Total Number of Codes		17		17		56		24	

In the Pre-Interviews, two groups gave similar answers. Mostly they talked about only non-living components in the environment *(abiotic*) like air, forest or they talked about only living organisms (*biotic*) like animal or plant. Environmental problems theme was not popular in Pre-Int as only one student from Group PB talked about it. However, it was observed after the treatment that four students from Group TC and ten students from Group PB used codes from this theme. This situation could happen due to the 'environmental problems' topic of the unit. All of the students became aware of the problems, but it was observed that the students having developed projects used it more than the ones who learnt it through teacher-centered method. *General* theme had only one code from each group in Pre-Int. After the treatment, Group TC increased the number of codes up to two, whereas Group PB added seven codes and totally used eight codes in this theme.

The most important point is that Group TC students used code or codes from only one theme and only two students combined two themes in Post-Int, whereas Group PB students combined lots of codes from different themes after the treatment. The answers of Student 12 from Group TC and Student 3 from Group PB in Post-Int given below exemplify this situation.

The answer of Student 12 in Post-Int from Group TC included *plants* and *animals* codes from only *biotic* theme,

> "There are animals and plants in our environment, we can see them everywhere" *(Çevremizde hayvanlar ve bitkiler var, onları heryerde görebiliriz)* (Student 12, Post-Int).

The answer of Student 3 in Post-Int combined codes from different themes:

> "When I hear the word 'environment', I think of living and non-living things like animals, plants, water or air. I also know that there are environmental problems like water or air pollution. Actually, we can make our world a better place" *(Çevre kelimesini duyduğum zaman aklıma; hayvanlar, bitkiler, hava veya su gibi canlı veya cansız şeyler gelir. Ayrıca su ve hava kirliliği gibi çevre problemleri olduğunu da biliyorum. Aslında istersek dünyamızı daha iyi hale getirebiliriz)* (Student 3, Post-Int).

Student 3 from Group PB used,

- *animals* and *plants* codes from *biotic* theme,
- *air* and *water* codes from *abiotic* theme,
- *water pollution* and *air pollution* codes from *environmental problems* theme.

Totally there are six codes and three themes in this Post-Int answer.

6.3.2. Analysis of the Interview Question 2

The second interview question directed to sixteen students was as follows: *'When you think about the region where you live, 'Esenler', are you happy with the environment? - Yaşadığın bölge yani Esenleri düşündüğünde; çevreden memnun musun?'*

According to the answers, all of the students from both groups (16) stated in the interviews that they were unhappy about their environment.

6.3.3. Analysis of the Interview Question 3

Because all students stated that they were unhappy about the environment in Esenler, third question was directed to them. Third question was: '*What do you want to change for environment in Esenler? - Esenlerde çevre için neleri değiştirmek istersin?*. After listening the recordings and reading the transcripts several times, seven themes were identified. These themes are *people's behavior, people's attitude, green area, animals, air pollution, urbanization of the region, waste* and *environmental law*. The frequency of themes and codes are given in Table 6.27.

For *people's behavior* theme; both groups' total frequency numbers increased in post-interviews. Group PB's total number of codes was four in pre-interviews, which increased up to 14 in post interviews and Group TC's total number of codes was two in pre-interviews and it was 7 in post-interviews.

In *people's attitude* theme; before the treatment, the students in Group PB did not talk about any codes of attitudes and only one student from Group TC talked about it. After the treatment, there was no student from Group TC talking about attitudes. Actually, one student in Pre-Int did not mention it, but the students of Group PB used nine attitude codes in the post-interviews.

The equal numbers of codes (3) in *green area* theme were used by both groups in the pre-interviews. In the post-interviews, while the students of Group PB used seven codes, those in Group TC added only one code and totally used four codes about that theme. There could have been an effect of Green Area project on the increase of Group PB codes.

Animals theme was only used by Group PB students and the codes were stated after the treatments. The students in Group TC did not talk about any codes from *animals* theme in either pre or post-interviews. The students in Group PB did not use any codes in the pre-interviews but they used nine codes in the post-interviews. The effect of project-based learning, especially the project about animal houses might have made students aware about this theme.

In the pre-interviews, both groups used the same number of codes for *air pollution* (1), *urbanization of the region* (2) and *waste* (1) themes. Both groups increased the number of codes in post-interviews; Group TC students used two codes for *air pollution*, two codes for *urbanization of the region* and three codes for *waste* themes while Group PB students used four codes for *air pollution*, five codes for *urbanization of the region* and six codes for *waste* themes. The increase in the number of codes for both groups was expected because curriculum included these terms and students became aware of them after treatments. However, it was seen that Group PB students' total code numbers in Post-Int were higher in all these three themes.

Before the treatment, there was no students talking about any codes of the *environmental law* theme, but in the post-interviews two students from Group PB mentioned these codes.

The result of this interview question can be summarized as;

- The total number of codes in pre-interview was 11 for Group PB and 10 for Group TC. The total number of codes in post-interview was 54 for Group PB and 19 for Group TC.
- The total number of themes in Pre-Int was five for Group PB and six for Group TC. The total number of themes in Post-Int was eight for Group PB and five for Group TC.

Table 6.27. Analysis of the third interview question

Themes	Codes	Group PB Pre-Int		Group TC Pre-Int		Group PB Post-Int		Group TC Post-Int	
		Frequency	Total frequency	Frequency	Total frequency	Frequency	Total frequency	Frequency	Total frequency
People Behavior	Not throwing garbages to dustbins Spit to the ground Being rude Not using public transportations Give harm to animals Not using bicycle	2 1 1 - - -	4	1 - - - 1 -	2	4 1 1 3 3 2	14	3 1 1 2 - -	7
People Attitude	Make people love environment Make people more concern about environment Make people volunteer about environment Make people get environmental education Make people teach their children true behavior	- - - - -	0	1 - - - -	1	3 2 1 2 1	9	- - - - -	0
Green Area	Plant trees Create green areas Build parks	2 - 1	3	1 2 -	3	3 3 1	7	1 2 1	4
Animals	Houses for birds Houses for cats and dogs Food stations for animals	- - -	0	- - -	0	2 3 3	7	- - -	0
Air Pollution	Banning car exhaust Putting filters to car exhaust Arrangement for factories	1 - -	1	- - 1	1	1 1 2	4	1 - 1	2
Urbanization of the Region	Bad view of the buildings Architecture No space between buildings	1 - 1	2	2 - -	2	2 1 2	5	2 - 1	3
Waste	Putting rubbish bins Putting recycle bins	1 -	1	1 -	1	3 3	6	2 1	3
Environmental Law	Create an environment law Adding new laws about environment	- -	0	- -	0	1 1	2	- -	0

The answer of Student 13 from Group TC in the pre-interview is given below as an example of including only one theme (*people behavior*).

> "*I would love to change people for not throwing garbages to the dustbins and spitting to the grounds*" (İnsanlar yerlere çöp atmasınlarve tükürmesinler diye onları değiştirmek isterdim*)* (Student 13, Pre-Int).

As it is reflected in the answer, Student 13 used two codes, *throwing garbage to dustbins* and *spitting to the ground*, which belong to one theme, *people behavior*.

Also the answer of Student 6 from Group PB in pre-interview is an example of including only one theme (*urbanization of the region*):

> "I would love to change the buildings in Esenler, the buildings in the area look very bad" *(Esenlerdeki binaları değiştirmek isterdim, bölgedeki binalar çok kötü görünüyorlar)* (Student 6, Pre-Int).

Student 6 used one code *bad view of the buildings* that belongs to *urbanization of the region* theme.

The structure of the two groups' answers changed in post-interviews. While Group TC students used codes from one or two themes, Group PB students combined lots of codes from different themes. It can be understood from the answers of the same students (Student 13 and Student 6) in post-interviews,

> "People in Esenler are very rude against environment, I would love to change them. And also I would like to have more green area" (*Esenlerde insanlar doğaya karşı çok kaba davranıyor, onları değiştirmek isterdim. Bir de daha çok yeşil alan olsun isterdim).* (Student 13, Post-Int).

In Post-Int, Student 13 from Group TC used,

- *being rude* code from *people behavior* theme
- *create green area* code from *green area* theme.

She added one more theme to her answer in Pre-Int after the treatment and totally used two themes in Post-Int.

The answer of Student 6 is given below as an example of Post-Int answers of Group PB.

"First of all, I would like to educate people and make them teach the same things to their children. I would like to make houses for cats and dogs to live, I would like to make everyone use public transportations. I would like to remove the buildings with bad view and replace it with parks and green areas. There are lots of things I would like to change, this can happen with an environmental law that we organize" *(En başta insanları eğitmek isterdim ki onlar da aynı şeyleri çocuklarına öğretsin. Kedi ve köpekler için yaşanacak evler yapmak isterdim, herkes toplu taşıma kullansın isterdim. Kötü gözüken binaları kaldırmak, yeşil alanla değiştirmek isterdim. Değiştirmek istediğim çok şey var, bunlar anca düzenleyeceğimiz çevre kanunlarıyla gerçekleşebilir)* (Student 6, Post-Int).

Student 6 from Group PB used these codes and themes in Post-Int;

- *make people get environmental education* code and *make people teach their children true behaviors* code from *people attitude* theme
- *cats and dogs' house* code that belongs to *animal houses* theme
- *not using public transportation* code from *people behavior* theme
- *bad view of the buildings* code from *urbanization of the region* theme
- *create green area* code from *green area* theme
- *create an environmental law* code that belongs to *environmental law* theme.

In Post-Int, she increased the number of codes to 7 and increased the number of themes to 6.

6.3.4. Analysis of the Interview Question 4

The fourth interview question asked in the interview was *'Do you think that you have a positive effect on environment? - Çevre üzerinde olumlu etkiniz olduğunu düşünüyor musunuz?'*. After this question, they were asked *'Do you think that you have a negative effect on environment? - Çevre üzerinde olumsuz etkiniz olduğunu düşünüyor musunuz?'*

Table 6.28. Analysis of the fourth interview question (positive effect)

Groups	**N**	**Pre-Interview**		**Post-Interview**	
		Yes, I Think	No, I don't	Yes, I Think	No, I don't
Group PB	8	6	2	8	-
Group TC	8	5	3	5	3

Before studying the environmental problems topic, totally five students from two groups thought that they did not have a positive effect on environment. The number of

students from Group TC stayed the same as three in Post-Int, but after the treatment all of the students from Group PB (8) thought that they had positive effects on environment.

Table 6.29. Analysis of the fourth interview question (negative effect)

Groups	**N**	**Pre Interview**		**Post Interview**	
		Yes, I Think	No, I don't	Yes, I Think	No, I don't
Group PB	8	5	3	3	5
Group TC	8	4	4	5	3

Before the treatment, five students from Group PB thought that they had negative effects on environment and three students thought they did not. After the treatment, some students changed their minds and the number of the students who thought they did not have a negative effect on environment increased to 5.

Half of the students from Group TC (4) said that they had negative effects on environment in pre-interviews. After the unit, one student joined this group, so the number of the students who thought they had negative effects on environment increased.

6.3.5. Analysis of the Interview Question 5

This question was about students' environmental concerns. Environmental concern was an element of environmental attitude component that was assessed with environmental literacy test in quantitative part of this study.

6.3.5.1. Analysis of the first part of the question. The first part of the question was *'Do you have concerns about the environment when you think about the future world generally? - Gelecekteki dünyayı düşündüğünde, genel olarak çevre için endişelerin var mı?*

Table 6.30. Analysis of the fifth interview question (first part)

Groups	**N**	**Pre Interview**			**Post Interview**	
		Yes, I have	No, I don't	I don't know	Yes, I have	No, I don't
Group PB	8	7	-	1	8	-
Group TC	8	8	-	-	8	-

According to the Table 6.30, all of the students stated they had concerns about the environment before and after the treatment. Only in the pre-interview, one student from Group TC said 'no' for this question.

6.3.5.2. Analysis of the second part of the question. If students said *'Yes, I have concerns about the environment - Evet, endişelerim var*' as an answer to the first part of the question, the interviewer asked the second part of the question; *'What are your concerns about the environment - Çevreyle ilgili endişelerin nelerdir?'*

According to students' answers, codes were written and six themes were identified. These themes are; *disaster scenarios, running out of natural resources, increase in pollution types, occurence of environmental problems, technology harm,* and *environmental awareness.*

According to the Table 6.31., total frequencies of codes and themes in pre-interviews were the same for these two groups, they used nine codes from five themes. After the treatment, Group PB used 23 different codes from five themes and Group TC used 17 codes from five themes. The number of themes used by Group PB in Post-Int was the same as the number in Pre-Int, but their types changed after the treatment. For example, they left the theme *'technology harm'* and used *'environmental awareness'*. Thus, it can be stated that Group PB students didn't think that technology was harmful for environment anymore and started to believe in environmental awareness for the future.

The frequency of '*disaster scenarios'* theme was the same in pre (2) and post-interviews (2) for Group PB, whereas three students from Group TC used codes from that theme in Pre-Int, four students talked about it after the environmental problems topic in Group TC.

‘*Running out of natural sources’* theme had the same frequency (2) in pre-interviews in both group. In the post-interviews, students of Group TC only talked about four codes, but Group PB talked about eight codes.

Two groups have the same change for ‘*pollution type’* theme that they increased the frequency of codes from two to four. The ‘Environmental Problems’ topic had subsections for every pollution types so both groups had ideas about it with their knowledge they gained in their classes.

‘*Environmental problems’* theme was used by one student for each group in the pre-interview, but in the post-interview students of Group PB listed six codes, when Group TC listed only three codes. Group PB students’ research before choosing their projects helped them learn several environmental problems.

Two students from Group PB and one student from Group TC thought in the pre-interviews that using technology may harm environment, but students from Group PB changed their minds after the treatment and there was no student talking about it in the post-interviews. Students from Group TC didn’t change their minds, one more student was added to them, so two student talked about that theme. It is important to make students recognize that technology has lots of benefits for environment, world and human if they use it in a right way.

Last theme was ‘*environmental awareness’* and no students talked about it in the pre or post-interviews from Group TC, but three students from Group PB talked about the hope that people would start to become more environmental aware. With project-based learning method, students were not only passive receivers of knowledge, but they also gained some qualifications that belong to environmental literacy like environmental awareness, attitude or behavior. They started to have positive thoughts and hopes for the future environment.

Table 6.31. Analysis of the fifth interview question (second part)

Themes	Codes	Group PB Pre-Int		Group TC Pre-Int		Group PB Post-Int		Group TC Post-Int	
		Frequency	Total frequency	Frequency	Total frequency	Frequency	Total frequency	Frequency	Total frequency
Disaster Scenarios	World will be destroyed	-	2	-	3	-	2	1	4
	Life will end	1		-		-		-	
	Future is dark	-		1		-		-	
	People will find nowhere to live	1		1		1		2	
	Very bad things will happen	-		1		1		1	
Running Out of Natural Resources	Water will run out	1	2	-	2	2	8	1	4
	Green area/forest/trees will disappear	-		1		3		2	
	Oxygen will run out	1		-		2		1	
	Decline of biological diversity	-		1		1		-	
Increase in Pollution Types	Air pollution increase	1	2	1	2	2	4	2	4
	Water pollution increase	1		-		1		1	
	Visual pollution increase	-		1		1		1	
Occurrence of Environmental Problems	Acid rain	-	1	1	1	2	6	1	3
	Drought	-		-		1		1	
	Ozone layer depletion	1		-		3		1	
Technology Harm	Technological advancement will give harm to environment	2	2	1	1	-	0	2	2
Environmental Awareness	If people become more aware of environment, then good things will happen	-	0	-	0	3	3	-	0

The answers of Student 10 are given as examples from pre and post interviews of Group TC students for this question;

In pre-interview;

> "Buildings are very close to each other, every place is very crowded, in the future we may not find any place to live" *(Binalar birbirine çok yakın, her yer çok kalabalık, ilerde kendimize yaşayacak yer bulamayabiliriz)* (Student 10, Pre-Int).

In post interview;

> "*Esenler is very crowded, everywhere is full of houses. In the future there won't only be air pollution, also people won't able to find place to live*" *(*Esenler çok kalabalık, her yer ev dolu. İlerde hem hava kirliliği olacak kalabalıktan, hem de yaşayacak yer kalmayacak*)* (Student 10, Post-Int).

In Pre-Int, Student 10 talked about *people will find nowhere to live* code from *disaster scenarios* theme. After the treatment in Post-Int, she again used the same code, beside this she added *air pollution increase* code from *increase in pollution types* theme. As a result, she increased the total code and theme numbers from one to two.

The answers of Student 5 are given as examples from pre and post interviews of Group PB students for this question.

In pre-interview,

> "In the future, water resources can run out, by this way life will come to an end " *(Gelecekte su bitebilir, böylece hayat sona erer)* (Student 5, Pre-Int).

In post interview,

> "If people don't become conscious; air and water will be more polluted, acid rains will occur. If oxygen runs out, then biological diversity loss will occur. On the other hand, if people behave conscious, love environment, then everything can be good*" (İnsanlar bilinçlenmezse, hava ve su daha da kirlenir, asit yağmurları oluşur, oksijen biterse de biyoçeşitlilik azalır. Öbür taraftan, eğer insanlar bilinçli davranır, çevreyi severse her şey güzel olabilir)* (Student 5, Post-Int).

In Pre-Int, Student 5 used *water will run out* code from *running out of natural sources* theme and *life will end* code from *disaster scenarios* theme.

In Post-Int, she talked about

- *air pollution* and *water pollution* codes from *increase in pollution types* theme
- *acid rains* code from *occurrence of environmental problems* theme
- *oxygen will run out* and *decline of biological diversity* codes from *running out of natural sources* theme
- finally she used *if people become more aware environment then good things will happen* code that belongs to *environmental awareness* theme.

After the treatment, she increased the number of codes from two to six and increased the number of themes from two to four.

After talking about the numbers of codes and themes, it can be summarized as; in the pre-interview, Student 10 from Group TC talked about the structure of the place she lived. She warned about the closeness of the buildings, had concern about not finding any place to live. After the unit, in the post-interview, her concern did not change, she talked about the building and the crowd in the area she lived again. In addition, she talked about air pollution that she learnt from the unit. The only difference after the treatment was knowledge that she learnt.

Student 5 had a very negative point of view in pre-interview that could be understood from the disaster scenario concern she had. She talked about running out of water and its negative effects in a disaster scenario, but in post-interview, she added environmental awareness and connected everything to it. Her concerns were from various themes like pollutions, resources, environmental problems. She was the only student to talk about biodiversity. Also, she changed her views positively with the hope of environmentally literate people. She did not use the word environmentally literate but being concious about environment and also loving environment are the components of environmental literacy.

6.3.6. Analysis of the Interview Question 6

The sixth interview question directed to 16 students was '*Are you interested in environmental issues? - Çevre konuları ile ilgili misin?*' If they answered this question

'Yes', then the interviewer asked the second part of the question; '*What do you do as a person who is interested in environment?* - Çevreyle ilgili bir birey olarak neler yapıyorsun?*'* It was aimed to see the level of environmental behavior with their opinions.

In the pre-interviews, four students from Group TC and five students from Group PB said that they were interested in environmental issues. After the unit, in the post-interviews, five students from Group TC and eight students from Group PB said they were interested in environmental issues. After writing the codes, four themes were defined by the researcher. These themes are *learning about environment, personal behaviors, help other people, taking active roles.*

The frequency of codes from these themes from both groups in pre and post-interviews are listed below in Table 6.32.

Table 6.32. Analysis of the sixth interview question (second part)

Themes	**Codes**	**Group PB Pre-Int**		**Group TC Pre-Int**		**Group PB Post-Int**		**Group TC Post-Int**	
		Frequency	**Total frequency**	**Frequency**	**Total frequency**	**Frequency**	**Total frequency**	**Frequency**	**Total frequency**
Learning About Environmental issues	Read news from the newspaper Read from the magazines Watch news from TV Learn from the books Watch documantaries	2 - 2 - -	4	2 - 1 - -	3	4 3 4 2 2	15	2 - - 1 1	4
Personal Behaviors	Don't throw rubbish around Don't waste water Don't harm animals Don't use deodorant Use environmentally friendly products Give importance to recycle	3 - - - - -	3	2 - - - - -	2	4 3 2 2 2 3	16	3 - - 1 - 1	4
Help Other People	Warn people about their mistakes Teach people what I know Make my family get the same habits with me Try to make people around me gain environmental awareness	1 - - -	1	1 - - -	1	4 2 2 2	10	2 - - -	2
Taking Active Roles	Volunteer for national environment projects Develop new environment projects in school	- -	0	- -	0	2 2	4	- -	0

In the pre-interviews; five students from Group PB who said that they were interested in environmental issues talked about eight codes from three themes. They did not use any codes from the '*active roles'* theme. There were four interested students from group TC and they talked about six codes from three themes. Again they did not use any codes from '*active roles'* theme.

In post-interviews; eight students from Group PB talked about 45 codes from all themes in total, but five students from Group TC used only ten codes from three themes. Again they did not use any codes from *'active roles'* theme.

Students from Group TC only added some codes like *using deodorant* or *recycle* that they learnt from the 'Environmental Problems' topic as can be seen in the answer of Student 12 in post-interview.

> "When I see a news about environment, I always watch it. Also I give importance to recycling, I seperate papers and plastics" *(Televizyonda çevreyle ilgili bir haber görürsem izliyorum her zaman. Ayrıca geri dönüşüme önem veriyorum, kağıtları ve plastikleri ayırıyorum)* (Student 12-Post-Int).

As reflected in the answer of Student 12 from Group TC, she used

- *watch news from TV* code from *learning about environmental issues* theme
- *give importance to recycle* code from *personal behaviors* theme.

She only used two codes from two themes in post-interview.

Answer of Student 7 is given as an example for the answers of Group PB Students in Post-Int;

> "Now, I am very interested about environmental problems. When I see a documentary I watch it and when I see a writing about environment in magazines or books, I read it. I don't waste water, I warn the people who give harm to environment and I tell things that I know about environment to my family. In future, I want to do more things. I want to develop new projects and work for environment" *(Çevre problemleriyle artık çok ilgiliyim. Ne zaman bir belgesel görsem izliyorum veya dergilerde veya kitaplarda çevreyle ilgili yazı görürsem okuyorum. Su israf etmiyorum, çevreye zarar veren insanları uyarıyor ve çevre hakkında bildiklerimi aileme anlatıyorum. İlerde daha da çok şey yapmak istiyorum. Yeni projeler geliştirip çevre için çalışmak istiyorum)* (Student 7- Post-Int).

She used

- *watch documentaries, read from the magazines, learn from the boks* codes from *learning about environmental issues* theme
- *don't waste water* code from *personal behavior* theme
- *warn people about their mistakes* code and *teach people what I know* codes from *help other people* theme
- *develop environment project* code from *taking active roles* theme.

She totally used seven codes from four themes in post-interview.

Students from Group PB stated that they became more interested in environment and added lots of codes (45) from all four themes to their answers in post-interviews. They listed lots of resources like TV, books, magazines, documentaries that they learnt about environmental issues because they used them when they were researching about their projects. They used codes like *protecting animals, saving water* or *environmentally friend products* because these were the terms that they studied in their projects. One project was about environmental awareness and they worked for teaching environmental issues to their families or friends so the number of codes in '*people behavior'* theme increased in post-interviews. Finally, only Group PB students talked about the '*active roles'* theme, because they got used to the terms 'volunteering' and joining 'projects'.

6.3.7. Analysis of the Interview Question 7

Another question asked to the students in the interviews was *"Think about a problem. This can be an environmental or any other scientific problem. How can you get information about the problem to find out the cause of it in the beginning? - Bir problem düşün. Bu çevresel veya bilimsel bir problem olabilir. Bu problemin başlangıçtaki sebebini bulmak için nasıl bilgi edinirsin?".*

The codes and themes of this interview question are listed in Table 6.33.

Table 6.33. Analysis of the seventh interview question

Themes	**Codes**	**Groups**			
		Pre-Int		Post-Int	
		Group PB	Group TC	Group PB	Group TC
About Science Process	Observation	1	1	7	3
	Research	2	1	1	1
Not About Science Process	Ask who knows about it	-	1	-	-
	Think about it	2	3	-	2
	Study about the subject	1	-	-	-
	I don't know	2	2	-	2

Before the treatment, one student from Group PB gave the *'observation'* answer as expected, and two students gave *'research'* answer, which is related with science process skills, but seven students used the code of '*observation'*, only one student answered *'research'* after the environmental problems projects. All answers given by the students were related with science process skills.

Two students in Group TC learnt '*observation'* skill after the treatment and three students gave the expected answer at the end. Also the number of the students who had no idea about this skill did not change.

6.3.8. Analysis of the Interview Question 8

After the seventh question, the interviewer asked interviewees: '*Which steps do you follow after you find out the cause of the problem? - Sebebini bulduktan sonra problemi çözmek için hangi basamakları izlersin?'.*

The distribution of the codes and themes can be seen in Table 6.34.

Table 6.34. Analysis of the eigth interview question

Codes	**Groups**			
	Pre-Int		Post-Int	
	Group PB	Group TC	Group PB	Group TC
Listed one steps	1	2	-	2
Listed two steps	1	-	2	3
Listed three steps	-	-	3	1
Listed four steps or more	-	-	3	-
No answer	1	2	-	1
Has no relation with steps	5	4	-	1

One Group PB student and two students in Group TC in Pre-Int and one student from Group TC in Post-Int did not answer the question, which was coded as '*no answer'*. The answer of Student 11 from Group TC is given as an example for this situation:

> "I don't have an idea about the steps that I will follow so I can't say anything.*" (Hangi basamakları izlemem gerektiği hakkında fikrim yok, o yüzden bir şey söyleyemeyeceğim)* (Student 11, Pre-Int).

Four students from Group PB, five students from Group TC in Pre-Int and one student from Group TC in Post-Int gave answers that did not include any scientific steps, so it was coded as '*has no relation with steps'*. The answer of Student 1 from Group PB is given as an example below:

> "I read lots of books and I study hard to reach a conclusion" *(Çok kitap okurum ve sonuca ulaşmak için çok çalışırım)* (Student 1, Pre-Int).

The answer of Student 14 from Group PB is an example of including scientific method steps:

> "After observation, I make predictions and have a hypothesis. Then with studies, I collect data in order to learn if my hypotheise is true or not. After that I analyze my data and arrive a conclusion. I prepare a report about my study" *(Gözlem yaptıktan sonra, tahminlerde bulunur ve hipotez elde ederim. Daha sonra çalışmalarda bulunup hipotezim doğrumu diye veri toplarım. Sonra analiz yapar ve sonuca ulaşırım. Hipotezim doğru mu değil mi rapor hazırlarım)* (Student 14-Post-Int).

She listed scientific method steps as, *constructing hypothesis*, *testing hypothesis*, *collecting data*, *drawing conclusion* and *reporting*.

According to the Table 6.34, in the post-interviews one student gave no answer and one student gave an irrelevant answer from Group TC. There were no students from group PB using these codes in their answers in post-interviews. This showed that almost all students, except two, had an idea about scientific method and science process skills. There was no student from Group TC to be able to list *four steps or more* and only one student could list *three steps*. On the other hand, in Group PB, three students could list *three steps* and the other 3 students could list *four or more steps*. Group PB students followed these steps and used these skills in their projects, which indicates that they learned these skills.

6.3.9. Analysis of the Interview Question 9

Since this question is about the project, it was asked only to the students in Group PB. The question was '*In your opinion, what did you gain with this project?' - Senin görüşüne göre bu proje sana neler kattı?*

The answer of Student 2 is given below as a summary of the interviews:

> "With this project I became more sensitive about the environment and also became aware of environmental problems. After that I'm more careful with my behavior, if it is necessary I warn people around me. By the help of the project we've done, we learnt group work, thanks to people we interviewed we became very social. Thank you for showing us that how can a lesson be so enjoyable" (*Bu proje sayesinde çevreye karşı daha duyarlı hale geldim, çevre sorunlarının farkına vardım. Artık hareketlerime daha dikkat ediyorum, gerekirse çevremdekileri uyarıyorum. Yaptığımız araştırmalar sayesinde grup çalışması yapmayı öğrendik, görüştüğümüz insanlar sayesinde de çok sosyal hale geldik. Dersin bu kadar eğlenceli işlenebileceğini bize gösterdiğiniz için teşekkür ederiz)* (Student 2, Post-Int).

In her answer, she used eight codes from four themes:

- *sensitivity and awareness* codes from *environmental attitude theme*
- *acting more carefully, warning people* codes from *environmental behavior* theme
- *research* code from *science process skills* theme
- *group work, become social* and *learn that lesson can be enjoyable* codes from *social skills* theme.

The codes and themes of this interview question are shown in Table 6.35.

Table 6.35. Analysis of the ninth interview question

Themes	**Codes**	**Post Interview**	
		Frequency	Total Frequency
Environmental Attitude	Responsibility	1	7
	Concern	1	
	Awareness	3	
	Support	1	
	Sensitivity	1	
Environmental Behaviour	Acting more carefully	3	11
	Warning people	2	
	Recycling	2	
	Treating animals good	2	
	Don’t waste	2	
Environmental Knowledge	My knowledge increased	2	5
	Learnt new terms	3	
Science Process Skills	Using scientific method	3	9
	Research	3	
	Analyze	1	
	Finding solutions	2	
Social Skills	Get active	3	17
	Become social	4	
	Group work	2	
	Learn that lessons can be enjoyable	3	
	Self-confidence	2	
	Good time	3	

As a result of coding process, the themes about environmental literacy and science process skills appeared as expected. Also other personal social skills as socializing, self-confidence, getting positive thought about lessons were found as the life-long gains about the project-based learning.

7. DISCUSSION AND CONCLUSION

7.1. Discussion

This study investigated the effect of project-based learning on environmental literacy and science process skills. In the study, two instructional methods, project-based learning method and teacher-centered instruction, were compared. The effects of the two methods on students' environmental literacy and science process skills were evaluated.

The results were analyzed both quantitatively and qualitatively. Quantitative data came from Environmental Literacy Test (ELT) that includes three environmental literacy component (environmental knowledge, environmental attitude and environmental behavior) and science process skills test (SPST) used to assess science process skills. Both tests were administered as pre- and post-test. Qualitative data were obtained from semi-structured interviews conducted before and after each implementation. The interviews were transcribed and common patterns about environmental literacy and science process skills were analyzed qualitatively.

Participants of the study consisted of two classes of 9th grade students at a vocational technical high school for girls. In this study, there were one experimental group and one control group selected through convenient sampling. The two classes were chosen based on their scores on the last biology exam. The experimental group included 40 students and the control group included 38 students. As mentioned above, Group PB received 'environmental problems' topic with project-based learning method and Group TC received the same topic with teacher-centered instruction from the same teacher.

The analysis of the data collected in the study included three sections, the analysis of ELT, the analysis of SPST and the analysis of interviews. In order to analyze the data obtained in the study, four different statistical methods were used. First, the effects of each treatment on each dependent variable, namely environmental literacy and science process skills were examined using Paired Samples T-test in case the data were normally distributed. In cases where the data were not normally distributed, Wilcoxon Signed

Ranks Test was used for the same purpose. Second, two groups were compared with each other with respect to the changes in environmental literacy and science process skills using Independent Samples T-test or using Mann Whitney U Test depending on the normality of distribution of the data.. Finally, student interviews were analyzed qualitatively.

Research questions 1, 2 and 3 were about the effect of learning methods on environmental literacy. Before answering research question 1, ELT-Pre scores for each component (environmental knowledge, environmental attitude and environmental behavior) were analyzed and no significant differences were found between Group PB and Group TC. After ensuring the similarity between the groups, ELT-Post scores for each environmental literacy component were analyzed. According to the results, there were significant differences between environmental knowledge, environmental attitude and environmental behavior of the groups. The hypotheses stating that Group PB students would perform better in ELT-Post compared to Group TC students were retained.

Research questions 2 and 3 were discussed in order to investigate Group PB and Group TC students' progress from ELT-Pre to ELT-Post in terms of three components of environmental literacy, namely, environmental knowledge, environmental attitude and environmental behavior. Results of the analysis showed that ELT-EnvKnow-Pre and ELT-EnvKnow-Post scores of both Group PB and Group TC were significantly different from each other ($p<.05$). Thirty seven students from experimental group and 27 students from control group increased their mean scores with environmental knowledge post-tests. Improvement in both groups for knowledge component can be acceptable because students did not know these terms and they learnt them in this unit. Also better performance in experimental group was expected because it was reported that project-based learning made learning enjoyable and permanent (Gültekin, 2005).

For the environmental attitude component, a similar result was found. Both groups improved their scores from ELT-EnvAtt-Pre to ELT-EnvAtt-Post. The improvement in two groups seems logical because students heard of environmental problems for the first time and they became aware of them so their scores on the environmental attitude component of the ELT increased with this awareness. On the other hand, Group TC students' mean scores changed from 55.82 to 56.84 and Group PB students' scores

changed from 55.59 to 61.95. The difference between the mean scores showed that project-based learning increased students' motivation and real life experience by making them a part of the process (Girgin, 2003).

According to the analysis of environmental behavior component of the ELT; there was a significant difference between Group PB's ELT-EnvBeh-Pre and ELT-EnvBeh-Post scores. However, there was no significant difference between Group TC's ELT-EnvBeh-Pre and ELT-EnvBeh-Post scores. Only knowing something or feeling something do not activate the students. This difference might indicate that project-based learning increases creative thinking, academic risk taking, problem solving skills and cooperation skills (Korkmaz, 2002). These results are consistent with the results of previous studies (Yavuz, 2006; Doğanay, 2010); which might indicate that project-based learning had a significant effect on environmental literacy, no matter at which age they joined this process.

Research questions 4, 5 and 6 required the analyses of Science Process Skills Test. No significant difference was found between the SPST-Pre scores of Group PB and TC, but there was a significant difference between groups SPST-Post scores in favor of Group PB as an answer of research question 4. The research questions 5 and 6 were about whether both groups improved their Science process skills from the beginning to the end of the process. After the analysis, it was found that only Group PB students' pre and post scores were significantly different. Greater number of students increased their total scores and none of the students lowered their total scores. This result echoes the results of Gültekin's (2008) study in which he compared the effect of project-based and traditional learning on 6th grade students' science process skills. Science process skills should be acquired by the students to understand the world and find creative solutions to the problems (Çepni *et al*., 1997). These are the skills that they need for environmental problems that were studied in 'Environmental problems' topic. The method was project-based learning, so the students acted like scientists while investigating the environmental problems and finding solutions in their projects.

As a summary of quantitative studies; quasi-experimental design was used in this study. The two groups received different treatments (project-based learning and traditional learning methods) for the same unit with same teacher. The results of the research

indicated that both groups improved their environmental knowledge and environmental attitude that might have occurred because all of the students heard about the environmental problems and the terms for the first time. However, when two groups were compared, it was found that Group PB performed better than Group TC. This is expectable for Group PB, because it was known that project-based learning made the learning permanent (Gültekin, 2005). The level of environmental knowledge improved and also these projects made students join some informal learning environments which may have changed their environmental attitude (Çavuş *et al.,* 2013). The results for the environmental behavior component of ELT were different. Only Group PB students improved it as also found in other studies (Yavuz, 2006), because behavior can only be changed with real life experiences and joining the process (Keleş, 2007). The same situation was seen for science process skills of students. Group PB students performed better compared to Group TC students and they improved their SPS from the beginning to the end of the treatment. This might have occurred because these students used every step of scientific method and created their own projects to find solutions for environmental problems.

Finally, the interviews were analyzed and the themes and codes were identified in the data. Research question 7 was about the students' way of thinking about environmental literacy.

The first interview question was about the environmental knowledge component of environmental literacy and investigated groups' views and definitions about the term 'environment.' The answers were similar and mostly included codes from one theme in pre-interviews. In post-interviews, Group PB students combined many themes from *biotic, abiotic, environmental problems, man-made and general* themes after the treatment, but there was no change in code use of Group TC students.

The students' answers for second interview question showed that they were not happy with the environment before and after the treatment, this can be because of the socio- economic status of the people who lived there and the structure of the region. Esenler had the smallest green area in İstanbul and this might be a reason what makes people unhappy with their environment. After learning that all the students were unhappy with their environment, they were asked about the change in third question. In the pre-

interviews, both groups gave similar answers as can be understood from the total number of codes and themes. Group PB used eleven codes and five themes, whereas Group TC used ten codes and six themes. After the treatments, Group PB students added lots of codes from different themes and talked about 54 codes from eight themes while Group TC students could use 19 codes from five themes. Students from Group TC could add nine codes they learnt from the unit in *pollution types* and *waste* themes, but Group PB students had different point of views and added 43 more codes including *behavior* or *attitude* themes that can be related with environmental literacy. Another important point was students from Group PB talked about the *environmental laws* in the post-interviews.

Before the treatment, six students from Group PB and five students from Group TC thought that they had positive effects on environment according to 4th interview question. After the treatment, Group TC students did not change their minds and five students stated that they had positive effects on environment. However, the other three students stated that they did not think that they had a positive effect. On the other hand, all of the Group PB students (8) started to think that they had positive effects on environment, which shows and improvement because if they become aware of their effect on environment, they could get more responsible and sensitive about it. All of these terms like *'aware'*, *'responsible'* and '*sensitive'* are components of environmental literacy, which are desirable for the students to have. After the treatments, the number of students who thought they had negative effects on environment decreased from five to three in Group PB and increased from four to five in Group TC. This result for Group PB students might have occurred due to the projects, because they did something positive for the environment and learnt to be less harmful. Despite this, Group TC students' result may have occurred due to the unit. They learnt some environmental problems, and started to feel responsible for them.

For the first part of 5th interview question, all students from both groups (except one student from Group TC in pre-interview) stated that they had concerns about the environment. When they were asked to list their environmental concerns in second part of the question, two groups gave similar answers as they did in the pre-interviews and both group used 9 codes from 5 themes. After the treatment, Group TC students mentioned some information they learned in the unit such as types of pollution and used 17 codes. However, Group PB students added more codes that were a combination of different

themes and totally used 23 codes. *The damage caused by the technology* was the theme that both groups mentioned in pre-interviews, but in post-interviews while Group PB students left this idea, Group TC students talked about it again. Making students gain positive thoughts about the technology usage and also making them aware of the right way of technology use is important. Three students from only Group PB talked about the hope that the environmental awareness can create and some negative thoughts like disaster scenarios disappeared in the same group. Therefore, it can be stated that, these good hopes were the positive changes that project-based learning created.

Last interview question about environmental literacy was about whether they were interested in environmental issues. In Pre-Int, four students from Group TC and five students from Group PB said that they were interested in environment. After the treatment, in addition to these four students, one more student in Group TC uttered the same statement in Post-Int. In Group PB, all students (8) started to think they were interested in environmental issues.

Interview questions about environmental literacy generally showed that students from both groups talked about similar issues before the treatment, but Group PB students gave enriched and detailed answers in the post-interviews. They used lots of codes from different themes, they talked about different solutions for the environmental problems they studied in their projects. Maybe the most important part was that only students from Group PB talked about the active roles like being volunteer or being involved in the environmental projects. Environmental behavior is a vital component of environmental literacy and project-based learning helped students gain it. Elder (2003; cited in Benzer, 2010) states that environmental literacy is a process that starts with knowledge and awareness; and aims to adopt right behaviors by using attitude and sensitivity. He found the process similar to a ladder, to reach the top you should use every step. You can reach the top without skipping any steps and you can not be environmentally literate without reaching the top. According to this idea, the most important step is environmental behavior and students should pass every step like attitude and knowledge to reach it.

Research question 8 was about the students' way of thinking about science process skills. Seventh and eighth interview questions were asked to understand the effect of

instructional methods on science process skills from students' perspective. The analyzes of the answers of seventh interview question, which is about the beginning of the project and also scientific method, showed that most of the students gave *irrelevant answers* or *no answers* in the pre-interviews. In the post interviews, two students from Group TC did not answer the question and two students added the term *'observation'* to their answers as expected. On the other hand, all the students in Group PB answered this question and seven of them talked about the term '*observation'* as expected. Only one student answered this question as '*research'*, which was not an irrelevant answer for the process.

Eighth interview question was about scientific method steps. In Pre-Int, the groups could not list more than two steps as expected because they did not hear these terms before. In Post-Int, it was seen that Group TC students could not talk about the scientific method and science process skills deeply. One student could talk about three steps and none of them could talk about four or more steps. Beside this, one student gave an irrelevant answer. Students of Group PB were better in listing the steps in Post-Int, three students listed four steps or more, three students listed three steps and two students listed two steps. There was no student who gave irrelevant or inadequate answer. Group TC students only heard about the scientific method process and science process skills but Group PB students were active in process. They had to use these skills and steps for their projects. These results might have occurred due to their active role in project-based learning (The Challenge 2000 Multimedia Project, 1997). Students should build everything by themselves and work in a scientific way to find solutions to their environmental problems.

At the end of the interview, the interviewer tried to learn the Group PB students' opinions about the project-based learning in order to find answer to research question 9. Students' answers contained 49 codes from five different themes. They were very happy about studying with this method and listed many things they learnt in this process. When the codes were grouped as themes, the codes formed the themes as the components of the environmental literacy and the science process skills. In this way, students stated that they increased their knowledge about the environment that refers to *environmental knowledge* component of environmental literacy; students said they became *environmentally responsible, aware, concern, sensitive and supportive*. These are the factors that compose

environmental attitude component (Kışoğlu, 2009). Students talked about the habits and acts they adopted after the treatment, which can be related with *environmental behavior* component of environmental literacy. Beside this, they told that they learned some skills such as *analyzing, conducting a research, using scientific method and finding solutions* that belong to *science process skills* and this was the other focus of this study.

Environmental literacy and science process skills were the two dependent variables of the study. According to the answers provided for this interview question, some social skills like self-confidence; becoming active and social; loving lessons and group works; having good time were observed to be gained as a result of this study. This can be another evidence for the benefits of project-based learning as Korkmaz (2002) listed.

According to the post-interviews, Group PB students had different point of views about environmental problems and their solutions. In addition, they talked about the environmental literacy components and science process skills. Their answers included lots of codes from different themes. Besides implementing their projects, they learnt about the projects to be developed by the other groups, so they enriched their ideas more than the students of Group TC. The students of Group PB had the chance to use science process skills in their projects so only they talked about it in the post-interviews. Environmental behavior was the main focus of this study because environmental problems can not be reduced, if people do not turn their awareness and knowledge into actions (Nicklason, 2006). The main difference between the two groups was the environmental behavior component and this showed the importance of the project-based learning on environmental education. In addition to environmental literacy and science process skills, it was seen that Group PB students acquired some social skills with the help of project-based learning.

7.2. Limitations

This study was conducted in a vocational technical high school, so the research was implemented according to the time schedule of the school. Each class had two lesson hours (40 minutes each) of biology per week. First limitation of the study was timing, two lesson hours per week were not enough to create projects.

Research school included only female students, so there wre only female participants in the study. After ensuring the similarity between two groups with pre-tests, the effect of treatments was observed. Research with the participants from both genders could be more generalizable.

The type of the school was vocational high school and it was conducted with two nineth grade classes including 78 students. In order to generalize the results for the whole population, this study should be conducted with a larger sample who were selected from different types of schools.

Students who joined the study had families from low socio-economic status and all of them were living in the region near the school. The region where the school was located was very crowded and had lots of environmental problems, and this could have affected students' environmental concern, sensitivity, attitude and behavior levels.

The same questions were asked before and after the treatments. Students who finished the interviews left the school without having a chance to talk with their friends. If they had talked about pre-interview questions after all students finished, they might have kept pre-interview questions and other students' answers in mind.

7.3. Suggestions

In order to make the findings more generalizable and applicable to other cases, a larger study with a varied sample from private and state schools including both genders is needed.

Before the process, a brief knowledge about projects was given, but this was not enough and this situation made students waste time much more than expected. If students take courses about projects in the beginning of the year or any other time, this can be helpful for time management. Also group work in crowded classrooms was a little bit hard and creates class management problem which is a negative situation for timing.

According to the present and previous studies (Moursund, 1999; Doğanay, 2010; Yavuz, 2006), project-based learning has a positive effect on students' environmental literacy. However, two class hours of biology per week is not enough to apply this method in biology classes. Before the change made by the Ministry of National Education in the curriculum, there were three class hours of biology per week which was more suitable for this method.

In Secondary School Biology curriculum implemented between 2007-2013, environmental issues were spread through 9th grade to 12th grade as spiral approach (Çakır, 2009). However, 2018 Secondary School Biology Curriculum for nineth grade does not include environmental issues, which is covered in curriculum for 10th grade. Making students gain environmental literacy should start as early as it can be, also it should be continuous.

When conducting this study, 2007 Secondary School Biology curriculum was used and there were objectives called 'scientific research and scientific process skills'. The abbreviation for it was 'BAS'. With the help of these objectives, teachers could be more planned and organized for making students learn science process skills. These objectives should take place in the curriculum again to make students active in the process and act like scientists in solving scientific problems.

The word 'literacy' is not included in 2018 Secondary School Biology Curriculum anymore (MoNE, 2018). With this study, the importance of environmental literacy was emphasized again. For people, country, world and future; environmentally literate people should be trained, which can be achivable with the help of the education and educators.

REFERENCES

Acar, E. N., 2011, *Proje Tabanlı Öğrenmenin Fen Bilgisi Öğretmen Adaylarının Bilimsel Süreç Becerilerine ve Biyolojiye Yönelik Tutumlarına Etkisi*, Master Thesis, Çanakkale Onsekiz Mart Üniversitesi.

Afriana, J., A. Permanasari and A Fitriani, 2016, "Project Based Learning Integrated to STEM to Enhance Elemantary School's Students Scientific Literacy", *Jurnal Pendidikan IPA Indonesia*, Vol. 5, No. 2, pp. 261-267.

Aktamış, H. and Ergin, Ö., 2007, "Bilimsel Süreç Becerileri İle Bilimsel Yaratıcılık Arasındaki İlişkinin Belirlenmesi", *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi (H. U. Journal of Education),* Vol. 33, pp. 11-23.

Alp, E., 2005, *A Study on Students' Environmental Knowledge and Attitudes: The Effects of Grade Level and Gender*, Master Thesis, Middle East Technical University.

Altunsoy, S., 2008, *Ortaöğretim Biyoloji Öğretiminde Araştırmaya Dayalı Öğrenme Yaklaşımının Öğrencilerin Bilimsel Süreç Becerilerine ve Akademik Başarılarına Etkisi*, Master Thesis, Selçuk Üniversitesi.

Arthur, C., 1993, *Teaching Science Through Discovery*. Toronto: Macmillan Publishing Company.

Baker R. D. and M. Piburn, 1991, "Process Skills Acquisition, Cognitive Growth and Attitude Change of Ninth Grade Students in a Scientific Literacy Course ", *Journals of Research in Science Teaching*, Vol. 28, No. 5, pp. 423-436.

Barraza, L. and A. D. Cuaron, 2004, "How Values in Education Affect Children' Environmental Knowledge", *Journal of Biological Education,* Vol. 39, No.1, pp. 18-23.

Başdağ, G., 2006, *2000 Yılı Fen Bilgisi ve 2004 Yılı Fen ve Teknoloji Dersi Öğretim Programlarının Bilimsel Süreç Becerileri Yönünden Karşılaştırılması*, Master Thesis, Gazi Üniversitesi.

Benzer, E., 2010, *Proje Tabanlı Öğrenme Yaklaşımıyla Hazırlanan Çevre Eğitimi Dersinin Fen Bilgisi Öğretmen Adaylarının Çevre Okuryazarlığına etkisi*, Ph. D. Thesis, Marmara Üniversitesi.

Bilgi, M.G., 2008, *Ortaöğretim Kurumlarında Coğrafya Dersi Kapsamındaki Çevre Konularının Öğretiminde Aktif Öğretim Yöntemlerinin Rolü,* Ph. D. Thesis, Gazi Üniversitesi.

Bord, R. J. and R. E. O'Conner, 1997, "The Gender Gap in EnvironmentalAattitudes: The Case of Perceived Vulnerability to Risk", *Social Science Quarterly, 78(4),* 830-840.

Bouillion, L.M. and L.M. Gomez, 2001, "Connecting School and Community with Science Learning: Real World Problems and School-Community Partnerships as Contextual Scaffolds", *Journal of Research and Practice*, Vol. 26, pp. 709-722.

Chepesiuk. R., 2007, "Environmental Literacy: Knowledge For a Healthier Public", *Environmental Health Perspectives*, Vol. 115, No. 10, pp. 494-499.

Chu, H., E. Lee, H. Ko, D. Shin, M. Lee and B. Min, 2007, "Korean Year 3 Children's Environmental Literacy: A Prerequisite for a Korean Environmental Education Curriculum", *International Journal of Science Education, Vol.* 1, No. 16, pp. 731-746.

Chu, H., D. Shin, and M. Lee, 2006, "Korean students' environmental literacy and variables affecting environmental literacy", *Proceedings of the 2006 conference of the Australian Association of Environmental Education,* pp. 306- 315.

Clair, R. St., 2003, *Words for the world: Creating critical environmental literacy for adults,* New Directions for Adult and Continuing Education, 99, pp. 69-78.

Clark, A.M., 2000, The *Project Approach: Three Avenues of Engagement*, Eric Documents, No: ED 470894.

Cohen, J.W., 1988, *Statistical power analysis for the behavioral sciences* (2nd edn). Hillsdale, NJ: Lawrence Erlbaum Associates.

Coşkun Keskin S., G. Özcan, Ü. Umdu Topsakal and A. Öztuna Kaplan, 2013, "Students' cognitive awareness about the reasons of environmental problems", *World Applied Science Education Journal*, Vol. 283, pp. 378-381.

Coyle, K., 2005, Environmental Literacy in America: What Ten Years of NEETF/Roper Research and Related Studies Say about Environmental Literacy in the U.S. Washington, DC: National Environmental Education and Training Foundation, http://eric.ed.gov/PDFS/ED522820.pdf, accessed at August 2014.

Creswell, J. W., 2013, *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*, 3rd Edition, SAGE Publications, Los Angeles, CA.

Çavuş, R., Ü. U. Topsakal and A. Ö. Kaplan, 2013, "İnformal Öğrenme Ortamlarının Çevre Bilinci Kazandırmasına İlişkin Öğretmen Görüşleri: Kocaeli Bilgievleri Örneği", *Pegem Eğitim ve Öğretim Dergisi*, Vol. 3, pp. 15-26.

Çepni, S., A. Ayas, D. Johnson and M.F. Turgut, 1997, *Fizik Öğretimi*, YÖK/Dünya Bankası MEGP Hizmet Öncesi Öğretmen Eğitimi Yayınları, Bilkent, Ankara.

Çıbık Sert A., 2006, *Proje Tabanlı Öğrenme Yaklaşımının Fen Bilgisi Dersinde Öğrencilerin Mantıksal Düşünme Becerilerine Ve Tutumlarına Etkisi,* Master Thesis, Çukurova Üniversitesi.

Daudi, S.S., and J.E. Heimlich, 1997, *Environmental literacy: what does it really mean?,* EETAP Resource Library, http://eelink.net/eetap/info23.pdf, accessed at August 2014.

Disinger, J. F., 1983, *Environmental education's definitional problems*. No.2. Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Disinger, J. F. And C.E. Roth, 1992, *Environmental Literacy,* Eric Documents, No: ED 351201.

Doğanay, G., 2010, *Ekoloji Ünitesinin Öğrenilmesinde Proje Tabanlı Öğrenme Yönteminin Öğrenci Başarısına Etkisi,* Master Thesis, Gazi Üniversitesi.

Donovan, G., 2001, *Environmental Knowledge, Attitudes and Behavior Study of Texas State Envirothon Students and Twelfth-Grade Students From Three East Texas Districts,* MS Thesis, Faculty of the Graduate School of Stephen F. Austin State University.

Erdem, M., 2002, "Proje Tabanlı Öğrenme", *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* Vol. 22, pp. 172-179.

Erdem, M. And B. Akkoyunlu, 2002, "İlköğretim Sosyal Bilgiler Dersi Kapsamında Beşinci Sınıf Öğrencileriyle Yürütülen Ekiple Proje Tabanlı Öğrenme Üzerine Bir Çalışma", *İlköğretim Online, E-Dergi,* Vol. 1, No. 1, pp. 2-11.

Erten, S., 2005, "Okul Öncesi Öğretmen Adaylarında Çevre Dostu Davranışların Araştırılması", *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, Vol. 28, pp. 91-100.

Erten, S., 2012, "Türk ve Azeri Öğretmen Adaylarında Çevre Bilinci", *Eğitim ve Bilim,* Vol. 37, No. 166, pp. 88-100.

Filcik, A., K. Bosch, S. Pederson, and N. Haugen, 2012, "The Effects of ProjectBased Learning (PBL) Approach on the Achievement and Efficacy of High School Mathematics Students: A Longitudinal Study Investigating the Effects of the PBL Approach in Mathematics Education", *Proceedings of The National Conference On Undergraduate Research (NCUR) 2012 Weber State University, Ogden Utah March 29 – 31, 2012.*

Gaer, S., 1998, *Less Teaching and More Learning: Turning from Traditional Methods to Project Based Instruction*, http://www.ncsall.net/index.html@id=385.html, accessed at August 2013.

Gay, L. R., 1987, *Educational Research: Competencies for Analysis and Application*, 3rd.edn. London: Merrill Publishing.

Germann, J. Paul, R. Aram and G. Burke, 1996, "Identifiying Patterns and Relationships Among The Responses of Seventh Grade Students To The Science Process Skills of Designing Experiments", *Journal of Research in Science Teaching,* Vol. 33, No. 1, pp. 79-99.

Girgin, B., 2003, *Proje temelli öğrenme yönteminin Özel Konya Esentepe İlköğretim Okulu tarafından uygulanmasına yönelik bir değerlendirme*, Master thesis, Selçuk Üniversitesi.

Gültekin, M., 2005, "The Effects of Project-Based Learning on Learning Outcomes in the 5th Grade Social Studies Course in Primary Education", *Educational Sciences: Theory and Practice,* Vol. 5, No, 2, pp. 548-556.

Gültekin, Z., 2008, *Fen Eğitiminde Proje Tabanlı Öğrenme Uygulamalarının Öğrencilerin Bilimin Doğasıyla İlgili Görüşlerine, Bilimsel Süreç Becerilerine ve Tutumlarına etkisi*, Master Thesis, Marmara Üniversitesi.

Harlen, W., 1999, "Purposes and Procedures for Assessing Science Process Skills", *Assessment in Education: Principles, Policy & Practice,* Vol. 6, No. 1, pp. 129-144.

Heckendorn, R. B., 2002, "Building A Beowulf: Leveraging Research and Development Needs for Student Enrichment via Project Based Learning", *Computer Science Education,* Vol. 12, No. 4, pp. 255-273.

Hsu, S.J., 1997, *An Assessment of Environmental Literacy and Analysis of Predictors of Responsible Environmental Behavior Held By Secondary Teachers in Haulien County of Taiwan,* A Doctoral Dissertion, Graduate School of The Ohio State University.

Hsu, S., 2004, "The Effects of an Environmental Education Program on Responsible Environmental Behavior and Associated Environmental Literacy Variables in Taiwanese College Students", *The Journal of Environmental Education,* Vol, 35, No. 2, pp. 37-48.

Hungerford, H., R.B. Peyton and R.D. Wilke, 1980, "Goals for Curriculum Development in Environmental Education", *The Journal of Environmental Education,* Vol. 11, No.3, pp.42-47.

Hungerford, H. and T. Volk, 2003, "Notes From Harold Hungerford and Trudi Volk", *The Journal of Environmental Education,* Vol. 34, No. 2, pp. 4-7.

IUCN 1970, "Final report : International Working Meeting on Environmental Education in the School Curriculum", *International Working Meeting on Environmental Education in the School Curriculum,* Carson City, NV, US, 20 June-11 July 1970, 1970-06-20

İstanbullu, R. A., 2008, *Investigation of Environmental Literacy of Sixth Grades at a Private School,* Master Thesis, Middle East Technical University.

Kaplowitz, M. D. And R. Levine, 2005, "How Environmental Knowledge Measures Up at a Big Ten University", *Environmental Education Research, Vol. 11*, No. 2, pp. 143-160.

Karakaya, Ç., 2016, '*İnsan ve Çevre' Ünitesi İçin Sınıf Dışı Öğretim Uygulamasının Çevre Okuryazarlığı Üzerine Etkisi*, Master Thesis, Ondokuz Mayıs Üniversitesi.

Karakuzulu, K., F.T. Kızıloğlu and H. Gül, 2010, "Analysis of the Relationship Between Population Increase and Settlement in Esenler District", *TUCAUM 6th Geography Symposium*, 3-5 November 2010, Ankara, pp. 9-21.

Kargın, E. K., 2017, *Problem Çözme Yönteminin Ortaokul Öğrencilerinin Fen Bilimlerine Yönelik Tutum, Bilimsel Süreç Becerileri ve Akademik Başarılarına Etkisi*, Ph. D. Thesis, Uludağ Üniversitesi.

Katz, Lilian G., and S. Chard, 2000, *Engaging Children's Minds: The Project Approach*, (2nd ed.), Norwood, NJ: Ablex.

Kaufman, K. J., 2013, ''21 Ways to 21st Century Skills: Why Students Need Them and Ideas for Practical Implementation'', *Kappa Delta Pi Record*, Vol. 49, No. 2, pp. 78-83, DOI: 10.1080/00228958.2013.786594, accessed at June 2014.

Keleş, Ö., 2007, *Sürdürülebilir Yaşama Yönelik Çevre Eğitimi Aracı Olarak Ekolojik Ayak İzinin Uygulanması ve Değerlendirilmesi*, Ph. D. Thesis, Gazi Üniversitesi.

Kışoğlu, M., 2009, *Öğrenci Merkezli Öğretimin Öğretmen Adaylarının Çevre Okuryazarlığı Düzeyine Etkisinin Araştırılması*, Ph. D. Thesis, Atatürk Üniversitesi.

Kibert, N.C., 2000, *An Analysis of the Correlations Between Attitude, Behavior and Knowledge Components of Environmental Literacy in Undergraduate University Students*, Master Thesis, University of Florida.

Kokotsaki *et al.* , 2016, "Project- Based Learning: A Review of the Literature", *Improving Schools*, Vol. 19. No. 3, pp. 267-277.

Korkmaz, H., 2002, *Fen Eğitiminde Proje Tabanlı Öğrenmenin Yaratıcı Düşünme, Problem Çözme ve Akademik Risk Alma Düzeylerine Etkisi*, Ph. D. Thesis, Hacettepe Üniversitesi.

Korkmaz, H., 2004, *Fen ve Teknoloji Eğitiminde Alternatif Değerlendirme Yaklaşımları*, Yeryüzü Yayınevi, Ankara, pp. 79-92.

Lloyd, J.K., M. Braund, C. Crebbin and R. Phipps, 2000, "Primary Teachers' Confidence About and Understanding of Process Skills", *Teacher Development*, Vol. 4, No. 3.

MoNE, 2007, *Ortaöğretim 9. Sınıf Biyoloji Dersi Öğretim Programı*, Talim ve Terbiye Kurulu Başkanlığı, Ankara.

MoNE, 2013c, *Ortaöğretim Biyoloji Dersi (9, 10, 11 ve 12. Sınıflar) Öğretim Programı*, Talim ve Terbiye Kurulu Başkanlığı, Ankara.

MoNE, 2018, *Ortaöğretim Biyoloji Dersi (9, 10, 11 ve 12. Sınıflar) Öğretim Programı*, Talim ve Terbiye Kurulu Başkanlığı, Ankara.

Monica, K., 2005, *Development and Validation of a Test of Integrated Science Process Skills for the Further Education and Training Learners*, Master's Thesis, University of Pretoria, South Africa.

Morgil, İ., S. Arda, N. Seçken, S. Yavuz and Ö. Oskay, 2004, "The Influence of Computer-Assisted Education on Environmental Knowledge and Environmental Awareness", *Chemistry Education: Research and Practice- CERP*, Vol. 5, No. 2, pp. 99-110.

Morgil, İ, Ö. Oskay and S. Yavuz, 2004, "The Effects of Project-Based Learning Applications on Environmental Education", *33. International Symposium*

IGIP/IEEE/ASEE, Local Identity Global Awareness Engineering Education Today, 27-30 September 2004, Fribourg, Switzerland, pp. 80-84.

Morgil, İ., S. Yavuz and Ö. Oskay, 2006, "The Effects of Project-Based Learning Applications on Environmental Awareness and Knowledge", *Energy Education Science and Technology*, Vol.16, No. 1, pp. 9-19.

Morrone, M., K. Mancl and K. Carr, 2001, "Development of A Metric To Test Group Differences in Ecological Knowledge As One Component of Environmental Literacy", *The Journal of Environmental Education, Vol.* 32, No. 4, pp. 33-42.

Moursund, D., 1999, *Project-Based Learning Using Information Technology,* International Society for Technology in Education Publications.

Negev, M., G. Sagy, Y. Garb, A. Salzberg and A. Tal, 2008, "Evaluating the Environmental Literacy of Israeli Elementary and High School Students", *The Journal of Environmental Education,* Vol. 39, No. 2, pp. 3-20.

Nicklason, L.H., 2006, *Influence of Scientific Terminology on the Environmental Attitudes of College Students,* Master Thesis, Royal Roads University, Victoria, Kanada.

North American Association for Environmental Education, 2016, *Developing a State Environmental Literacy Plan*, https://naaee.org/n/elp/posts/NAAEEs-Guide-to-Developing-a-State-Environmental-Literacy-Plan, accessed at October 2018.

OECD, 2000, "Literacy in the Information Age: Final Report of the International Adult Literacy Survey", OECD, www.oecd.org, accessed at June 2014.

Orr, D.W., 1990, "Environmental Education and Ecological Literacy", *The Education Digest,* Vol. 55, No. 9, pp. 49-53.

Ökesli, F. T., 2008, *Relationship Between Primary School Students' Environmental Literacy and Selected Variables in Bodrum*, Master Thesis, Middle East Technical University, Ankara.

Özsoy, S., 2010, *Effects of Eco-school Application on Elemantary School Students' Environmental Literacy levels*, Ph. D. Thesis, Middle East Technical University, Ankara.

Padilla, J. M. and J. R. Okey, 1984, "The Effects of Instruction on Integrated Science Process Skill Achievement", *Journal of Research in Science Teaching*, Vol. 21, No. 3, pp. 277-287.

Robinson, M. and D. Crowther, 2001, " Environmental Science Literacy in Science Education, Biology & Chemistry Majors", *The American Biology Teacher*, Vol. 63, No. 1, pp. 9-14.

Rosenfeld, S. And B. Yehuda, 2001, " Project-based Learning in Science and Technology: A Case Study of Professional Development", *Proceedings of the IOSTE Symposium in Southern Europe.*

Roth, C.E., 1968, "Curriculum Overwiev For Developing Environmentally Literate Citizens", http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/32/38/8c.pdf , accessed at June 2012.

Roth, C.E., 1992, "Environmental Literacy: Its Roots, Evolution and Directions in the 1990s", http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/24/44/47.pdf, accessed at June 2012.

Salmon, J., 2000, "Are we building environmental literacy? ", *Journal of Environmental Education, Vol.* 31, pp. 4-10.

Saylan, C., and D. Blumstein, 2011, *The Failure of Environmental Education (and How We Can Fix It),* University of California Press.

Selvi, M., 2007, *Biyoloji Öğretmeni Adaylarının Çevre Kavramları ile İlgili Algılamalarının Değerlendirilmesi,* Ph. D. Thesis, Gazi Üniversitesi.

Serin, G., 2009, *The Effect of Problem Based Learning Instruction on 7th Grade Students' Science Achievement, Attitude Toward Science and Scientific Process Skills*, Ph. D. Thesis, Graduate School of Natural and Applied Sciences, Middle East Technical University.

Stanisic, J. and S. Maksic, 2014, ''Environmental Education in Serbian Primary Schools: Challenges and Changes in Curriculum, Pedagogy, and Teacher Training'', *The Journal of Environmental Education,* Vol. 45, No. 2, pp. 118-131.

Stapp, W. B., 1969, ''The Concept of Environmental Education'', *The Journal of Environmental Education,* Vol. 1, No. 3, pp. 31-36.

Şenyüz, G., U. Kanlı and O. Aslan, 2006, ''Yeni Fen ve Teknoloji Programının Öğrencilerin Bilimsel Süreç Becerilerini Geliştirmedeki Yeterliliğinin Tespiti Üzerine Bir Araştırma'', *7. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi (UFBMEK-7),* 7-9 Eylül 2006, Gazi Üniversitesi, Gazi Eğitim Fakültesi, Ankara.

Temiz, K. B., 2001, *Lise 1. Sınıf Fizik Dersi Programının Öğrencilerin Bilimsel Süreç Becerilerini Geliştirmeye Uygunluğunun İncelenmesi*, Master Thesis, Gazi Üniversitesi.

The Challenge 2000 Multimedia Project, 1999, *Why do project-based learning?*, San Mateo, CA: San Mateo County Office of Education, http://pblmm.k12.ca.us/PBLGuide/WhyPBL.html, accessed at June 2013.

Toolin, R. E., (2004), Striking A Balance Between Innovation and Standards: A Study of Teachers Implementing Project-Based Approaches to Teaching Science, *Journal of Science Education and Technology*, Vol. 13, No. 2, pp. 179-187.

Tuncer, G., C. Tekkaya and S. Sungur, J. Çakıroğlu, H. Ertepınar and M. Kaplowitz, 2009, ‘‘Assessing Pre-service Teachers’ Environmental Literacy in Turkey as a Mean to Develop Teacher Education Programs’’, *International Journal of Educational Development*, Vol. 29, 426-436.

UNESCO, 1975, *The Belgrade Charter* (Belgrade, United Nations, Educational, Scientific and Cultural Organization with UNEP), https://unesdoc.unesco.org/ark:/48223-pdf0000017772, accessed at June 2013.

UNESCO, 1978, ‘‘The Tbilisi Decleration: Final Report’’, *Intergovernmental Conference on Environmental Education*, Organized by UNESCO in corporation with UNEP, Tbilisi (USSR), 24-26 October 1977, Paris, http://www.gdrc.org/uem/ee/EE-Tbilisi_1977.pdf, accessed at June 2013.

UNESCO, 1987, ‘‘International strategy for action in the field of environmental education and training for the 1990s ’’, UNESCO/UNEP International Congress on Environmental Education and Training, August 17-21, ERIC Number: ED291556, accessed at June 2013.

UNESCO, 1997, ‘‘Declaration of Thessaloniki’’, *International Conference on Environment and Society: Education and Public Awareness for Sustainability, Education*, 8-12 December 1997, Thessaloniki, document code: EPD.97/CONF.401/CLD.2, accessed at June 2013

Uzun, N. and Sağlam, N., 2005, ‘‘Sosyo-ekonomik Durumun Çevre Bilinci ve Çevre Akademik Başarısı Üzerindeki Etkisi’’, *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, Vol. 29, pp. 194-202.

Üredi, I, and L. Üredi, 2005, ‘‘İlköğretim 8. Sınıf Öğrencilerinin Öz-düzenleme Stratejileri ve Motivasyonel İnançlarının Matematik Başarısını Yordama Gücü’’, *Mersin Üniversitesi Eğitim Fakültesi Dergisi*, Vol. 1, No. 2, pp. 250-260.

Varışlı, T., 2009, *Evaluating Eigth Grade Students' Environmental Literacy: The Role of Socio-demographic Variables*, Master Thesis, Middle East Technical University, Ankara.

Willis, A.L., 1999, *A survey of the Environmental Literacy of High School Junior and Senior Science Students from a Southeast Texas School District*, Ph. D. Thesis, Faculty of The College of Education University of Houston.

Wright, J.M., 2006, *The Comparative Effect of Constructivist Versus Traditional Teaching Methods on Environmental Literacy of Post-Secondary Non-Science Majors*, Ph. D. Thesis, Graduate School of University of Nevada.

Yavuz, S., 2006, *Proje Tabanlı Öğrenme Modelinin Kimya Eğitimi Öğrencilerinin Çevre Bilgisi ile Çevreye Karsı Tutumlarına Olan Etkisinin Değerlendirilmesi*, Ph. D. Thesis, Hacettepe Üniversitesi, Ankara.

Yıldırım, H., 2011, *Probleme dayalı öğrenme ve proje tabanlı öğrenme yöntemlerinin ilköğretim öğrencilerinin başarılarına ve tutumlarına etkisi*, Master Thesis, Selçuk Üniversitesi.

Yıldırım, S., 2007, *İlköğretim 4. Sınıf Sosyal Bilgiler Dersinde Proje Tabanlı Öğrenme Modelinin Araştırma Becerilerinin Gerçekleşme Düzeyine Etkisi,* Master Thesis, Marmara Üniversitesi.

Yıldız, N. M., 2004, ‘‘Proje Tabanlı Öğrenme Modeli’’, http://www.erg.sabanciuniv.edu/iok2004/bildiriler/nadir%20Namik%20Yildiz.doc, accessed at August 2013.

Yıldız, K., Ş. Sipahioğlu and M. Yılmaz, 2000, *Çevre Bilimi*, Gündüz Eğitim ve Yayıncılık, 205p.

Yılmaz, O., W.J. Boone and H.O. Andersen, 2004, ‘‘Views of Elementary and Middle School Turkish Students Toward Environmental Issues’’, *International Journal of Science Education,* Vol. 27, No. 12, pp. 1527-1546.

Yucasu, Ş., 2015, *Proje Tabanlı Öğrenme Yönteminin Fen Bilgisi Öğretmen Adaylarının Çevre Okuryazarlığına Etkisi,* Master Thesis, Fırat Üniversitesi.

APPENDIX A: ENVIRONMENTAL LITERACY TEST

ÇEVRE OKURYAZARLIĞI TESTİ

Sevgili Öğrenciler, Bu anket 3 kısımdan oluşmaktadır. İlk bölüm çevre ile ilgili bilginizi, ikinci kısım tutumunuzu ve son kısımda davranışlarınızı belirlemeyi amaçlamaktadır. Anketin tamamlanması yaklaşık 15–20 dakikanızı alacaktır. Aşağıdaki soruları dikkatle okuyarak her bir soru için tek bir seçenek işaretleyiniz.

Yardımlarınız ve katkılarınız için teşekkür ederim.

Sevgi Aslıhan KARAYOL

1. Bölüm: Çevre Bilgisi

1. Canlıların birbirleri ve fiziksel çevreleri ile arasındaki ilişkileri inceleyen bilim dalı aşağıdakilerden hangisidir?

a. Zooloji

b. Biyoloji

c. Ekoloji

d. Botanik

e. Bilmiyorum

2. Karbon monoksit Türkiye'de hava kirliliği yaratan önemli bir kirleticidir. Aşağıdakilerden hangisi en önemli karbon monoksit kaynağıdır?

a. Fabrikalar ve işyerleri

b. İnsanların nefes alıp vermesi

c. Motorlu araçlar

d. Ağaçlar

e. Bilmiyorum

3. Enerji elde etmek için kömür yakılması neden bir çevre sorunudur?

a. Hava kirliliğine neden olan maddeleri yayar

b. Asit yağmurlarını azaltır

c. Stratosferdeki ozon miktarını düşürür

d. Su yataklarının kirlenmesine neden olur

e. Bilmiyorum

4. Aşağıdakilerden hangisi küresel ısınma nedeniyle deniz seviyesinin yükselmesini en iyi açıklar?

a. Yağış miktarının artması

b. Suyun ısındığı için genişlemesi

c. Buzulların erimesi

d. Nehirlerde taşkınların artması

e. Bilmiyorum

5. Aşağıdakilerden hangisi asit yağmurlarının başlıca nedenlerindendir?

a. Kükürt dioksit

b. Karbondioksit

c. Ozon

d. Azot

e. Bilmiyorum

6. Nehirlerin üzerine baraj yapılmasının en zararlı etkisi aşağıdakilerden hangisi olabilir?

a. Barajlar nehirdeki çamuru arttırır

b. Barajlar su kirliliğini arttırır

c. Barajlar nehrin taşmasına neden olur

d. Barajlar nehrin doğal ekosistemine zarar verir

e. Bilmiyorum

7. Sulara karışan fosfatlı kimyasal maddeler aşağıdakilerden hangisine neden olur?

a. Balıklarda kansere neden olur

b. Balıklarda üremeyi durdurur

c. Suyu bulanıklaştırır

d. Alglerin sayısını arttırarak balıkların ölmesine neden olur

e. Bilmiyorum

8. Atmosferde karbondioksit, metan gibi gazların ve su buharı miktarının artması aşağıdaki olayların hangisi ya da hangilerine sebep olur?

I. Ozon tabakasının delinmesi

II. Sera etkisi

III. Sıcaklığın artması

a. Yalnız I b. II ve III c. I ve II d. I ve III

e. Bilmiyorum

9. Geri dönüşümün başlıca nedeni aşağıdakilerden hangisidir?

a. Daha dayanıklı plastik maddeler üretebilmek.

b. Ormanları korumak.

c. Atık miktarını azaltmak.

d. Hava kirliliğini azaltmak.

e. Bilmiyorum

10. Geri dönüşümü sağlanamayan ve tekrar kullanılamayan madde aşağıdakilerden hangisidir?

a. Çocuk bezleri

b. Gazeteler

c. Alüminyum kaplar

d. Plastik şişeler

e. Bilmiyorum

11. Aşağıdakilerden hangisi doğada en zor kaybolur?

a. Teneke

b. Pamuk

c. Odun

d. Alüminyum

e. Bilmiyorum

12. Türkiye'de elektrik üretimi büyük ölçüde nasıl gerçekleştirilmektedir?

a. Petrol, kömür ve odun yakılarak

b. Nükleer santraller ile

c. Güneş enerjisi ile

d. Hidroelektrik santraller ile

e. Bilmiyorum

13. Aşağıdakilerden hangisi yenilenebilir bir kaynaktır?

a. Petrol

b. Demir Madeni

c. Ağaçlar

d. Kömür

e. Bilmiyorum

14. Ozon, atmosferin üst katmanlarında koruyucu bir tabaka oluşturur. Ozon bizi aşağıdakilerden hangisinden korur?

a. Asit yağmurlarından

b. Küresel ısınmadan

c. Sıcaklıktaki ani değişimlerden

d. Zararlı, kansere neden olan güneş ışığından

e. Bilmiyorum

15. Aşağıdakilerden hangisi zararlı atık olarak adlandırılabilir?

a. Plastik ambalajlar

b. Cam şişeler

c. Piller

d. Bozulmuş yiyecekler

e. Bilmiyorum

16. Hayvan türlerinin nesillerinin tükenmesinin en yaygın sebebi nedir?

a. Pestisitlerin (tarım ilaçlarının) kullanılması.

b. Yasam alanlarının insanlar tarafından yok edilmesi.

c. Avcılığın artması.

d. İklim değişiklikleri

e. Bilmiyorum

17. Aşağıdakilerden hangisi çevre için uzun zaman diliminde en zararlı etkendir?

a. Nüfus fazlalığı.

b. Doğal afetler.

c. Vahşi hayvanlar.

d. Erozyon

e. Bilmiyorum.

18. Aşağıdakilerden hangisi civa gibi ağır bir metalin bitkiler tarafından alınarak besin zincirine girmesi sonucu olacakları açıklar?

a. Metal bitkiyi hemen öldürür ve toprağa geri döner bu nedenle otçul ve etçillere geçemez.

b. Metal konsantrasyonu bitkilerde, otçullarda ve etçillerde hemen hemen eşit olur.

c. Metal konsantrasyonu bitkilerde az, otçullarda fazla, etçillerde ise en fazla olur.

d. Metal konsantrasyonu bitkilerde en fazla, otçullarda az, etçillerde ise en az olur.

e. Bilmiyorum.

19. Bilim adamları nükleer atıkların depolanması ile ilgili çalışmalarında henüz sonuca ulaşamamışlardır. Şu anda dünyada yaygın olan nükleer atıklar nasıl depolanmaktadır?

a. Nükleer yakıt olarak kullanılmaktadır.

b. Başka ülkelere satılmaktadır.

c. Çöp depolama alanlarında depo edilmektedir.

d. Depolanmakta ve kontrol altında tutulmaktadır.

e. Bilmiyorum

20. Türkiye'de çevreyi korumaya yönelik kararlar alan resmi kurumun adı nedir?

a. Çevre ve Orman Bakanlığı.

b. TEMA.

c. Tabiatı Koruma Vakfı

d. Türkiye Çevre Eğitim Vakfı

e. Bilmiyorum

2. Bölüm: Çevre Tutumu

Aşağıdaki ifadelerden sizin düşüncenize en yakın olduğunu düşündüğünüz seçeneği işaretleyiniz.

5= Kesinlikle Katılıyorum

4= Katılıyorum

3= Kararsızım

2= Katılmıyorum

1= Kesinlikle Katılmıyorum

1. Çevreyle ilgili televizyon programları izlemekten hoşlanırım	**1**	**2**	**3**	**4**	**5**
2. Dışarıdayken böcek, kuş gibi hayvanların sesini duymak çok hoşuma gider.	**1**	**2**	**3**	**4**	**5**
3. Çevre problemleri hakkında bilgi sahibi olmak benim için önemlidir.	**1**	**2**	**3**	**4**	**5**
4. Ormanların hızla yok olması beni endişelendiriyor.	**1**	**2**	**3**	**4**	**5**
5. Ozon tabakası sorunu ile ilgili olarak herkesin kaygılanması gerektiğini düşünüyorum.	**1**	**2**	**3**	**4**	**5**
6. Kullandığım ürünlerin fiyatının artması pahasına bile olsa çevre kalitesinin korunması için endüstri ve tarım alanları üzerindeki denetimin daha da artırılmasını isterim.	**1**	**2**	**3**	**4**	**5**
7. Bütün bitki ve hayvan türlerinin insanların kullanımı için var olduğuna inanıyorum.	**1**	**2**	**3**	**4**	**5**
8. Fosil yakıt kullanımının önündeki yasal engellerin kaldırılması gerektiğini düşünüyorum.	**1**	**2**	**3**	**4**	**5**
9. Daha fazla vergi ödenmesi pahasına bile olsa devlet yenilenebilir enerji kaynakları ile ilgili çalışmalara finansal destek vermelidir.	**1**	**2**	**3**	**4**	**5**
10. Bireyin özgürlüklerinin kısıtlanması pahasına bile olsa çevre koruma ile ilgili yasalar çıkartılmalıdır.	**1**	**2**	**3**	**4**	**5**
11. Çevresel problemlerin önlenmesine yardımcı olmak istiyorum.	**1**	**2**	**3**	**4**	**5**
12. Davranışlarımla çevresel problemlerin önlenmesine katkıda bulunacağıma inanıyorum.	**1**	**2**	**3**	**4**	**5**
13. Kendimi çevresel problemlerin önlenmesi noktasında sorumlu hissediyorum.	**1**	**2**	**3**	**4**	**5**

14. Türkiye'de desteklenmesi gereken daha önemli projeler olduğu halde, Dünya Bankasının hava kirliliğini ölçme projelerini desteklemesi gereksizdir.	**1**	**2**	**3**	**4**	**5**
15. Çevre koruma fikri gelişmekte olan ülkelerin kalkınmasını önlemek amacıyla batılılar tarafından uydurulmuştur.	**1**	**2**	**3**	**4**	**5**
16. İnsanoğlu yaşamını devam sürdürmek için çevreye uyumlu yaşamak zorundadır.	**1**	**2**	**3**	**4**	**5**
17. İnsanoğlu ihtiyaçlarını karşılamak için çevrede değişiklikler yapma hakkına sahiptir.	**1**	**2**	**3**	**4**	**5**
18. Sadece çevre sorunları ile ilgilenen bir kulübe üye olmam.	**1**	**2**	**3**	**4**	**5**

3. Bölüm: Çevresel davranış

Aşağıdaki davranış ifadelerini ne kadar sıklıkta yaptığınızı işaretleyiniz.

3= Her zaman

2= Ara sıra

1= Hiçbir zaman

1. Elektrik tasarrufu için kullanmadığım lambaları ve elektrikli aletleri kapalı tutarım.	**1**	**2**	**3**
2. Çevreye zararlı davranışlarını gördüğüm insanlarla, bu davranışlarını yapmamaları için konuşurum.	**1**	**2**	**3**
3. Daha az tüketici olmak için çaba sarf ederim.	**1**	**2**	**3**
4. Çevreye duyarlı davranışlar konusunda arkadaşlarıma olumlu örnek olmaya çalışırım.	**1**	**2**	**3**
5. Yerde boş bir alüminyum kutu gördüğümde onu oradan kaldırıp atıncaya dek yanımda taşırım.	**1**	**2**	**3**
6. Gazete, cam veya metal kutu gibi atıkları geri dönüşüm kutularına atarım.	**1**	**2**	**3**
7. Çevreye olumsuz etkisi olan ürünleri satın almam.	**1**	**2**	**3**
8. Arkadaşlarımla ve ailemle çevresel sorunların önlenmesi için neler yapabileceğimizi konuşurum.	**1**	**2**	**3**
9. Çevresel sorunlarla ilgili görüşlerimi ifade etmek için yetkililere	**1**	**2**	**3**

mektup yazar veya telefon ederim.			
10. Gazete ve dergilerdeki çevreyle ilgili yazıları okurum.	**1**	**2**	**3**
11. Ucuz ürün almak yerine geri dönüşümlü ürünleri satın alırım.	**1**	**2**	**3**
12. Duyduğum ve gördüğüm çevresel ihlalleri hemen yetkililere bildiririm.	**1**	**2**	**3**
13. Çevreyle ilgili panel, konferans gibi etkinliklere katılırım.	**1**	**2**	**3**
14. Ellerimi sabunlarken ve dişlerimi fırçalarken musluğu kapalı tutarım.	**1**	**2**	**3**
15. Her doğum günümde bir fidan diker veya hediye ederim.	**1**	**2**	**3**

APPENDIX B: SCIENCE PROCESS SKILLS TEST

BİLİMSEL ARAŞTIRMA VE BİLİMSEL SÜREÇ BECERİLERİ TESTİ

Sevgili Öğrenciler,

Bu anket bilimsel araştırma ve bilimsel süreç becerilerinizi belirlemeyi amaçlamaktadır. Toplam 10 sorudan oluşmaktadır ve testin tamamlanması yaklaşık 15–20 dakikanızı alacaktır. Aşağıdaki soruları dikkatle okuyarak her bir soru için tek bir seçenek işaretleyiniz.

Yardımlarınız ve katkılarınız için teşekkür ederim.

Sevgi Aslıhan KARAYOL

1. Bir öğrenci karınca yuvalarının düz olmak yerine batıya doğru yönelmesiyle, o yöredeki rüzgarların da batı yönünde esmesinin ilişkisini merak ediyor. Bu öğrencinin bilimsel araştırmasını başlatan ilk adım nedir?

a) Açıklama yapmak

b) Araştırma metodunu seçmek

c) Tahmin etmek

d) Gözlem yapmak

2. Bir okul bahçıvanı, 7 farklı futbol sahasının çimlerini kesiyor. Her hafta farklı bir sahayı kesiyor. Çim genellikle bazı sahalarda diğerlerinden daha uzun oluyor. Aşağıdakilerden hangisi çimlerin uzunlukları arasındaki fark ile ilgili ölçülebilir bir açıklamadır?

a) Daha çok sulanan sahalar daha uzun çimlere sahiptir.

b) Çimleri daha kısa olan sahalar futbol oynamak için daha uygundur.

c) Daha çok taş bulunduran sahalardaki çimleri kesmek daha zordur.

d) Daha çok karbondioksit olan sahalar daha uzun çimlere sahiptir.

3. Bir araba sürücüsü, arabanın yüksek hızda sürüldüğünde daha fazla yakıt kullanıp kullanmadığını öğrenmek istemektedir. Bu araştırmayı yapmanın en iyi yolu hangisidir?

a) Farklı sürücülere, hızlı araba kullandıkları bir saatlik sürede ne kadar benzin harcadıklarını sorup ortalamalarını alarak.

b) Kendi arabasını farklı zamanlarda farklı hızlarda kullanarak, her zaman dilimi için ayrı ayrı harcadığı benzinin kaydını tutarak.

c) Arabasını bir hafta düşük, diğer hafta yüksek hızda kullanarak harcanan benzin miktarının kaydını tutarak.

d) Farklı sürücülerden farklı arabaları aynı mesafede birçok kez farklı hızlarda kullanmasını isteyerek her seyahat için kullanılan benzin miktarını kaydederek.

4. Doktorlar belirli bir bakteri türünün fareye enjekte edildiğinde, farenin çeşitli semptomlar (hastalık belirtileri) gösterip öldüğünü fark ediyorlar. Farenin hücreleri mikroskopta incelendiğinde, bakterinin vücuda dağılmadığı sadece hastalıklı bölgede kaldığı görülüyor. Bu durum, ölüme bakterilerin değil, onlardan salgılanan zehirli kimyasalların neden olduğunun düşünülmesini sağlıyor. Aşağıdakilerden hangisi farenin ölümü için uygun bir açıklamadır?

a) Fare, mikroskopta incelenmek için alınmış hücreler tarafından öldürüldü.

b) Bakteriler vücuda dağılmadı fakat hastalıklı bölgede kaldılar.

c) Bakteriden salgılanan zehirli kimyasallar fareyi öldürdü.

d) Fare semptomlar gösterdiği için öldü.

5. Ayşe çaydanlığı temizlemek için kullandığı çelik tel yumağının havayla temas ettiğinde çabuk paslandığını fark ediyor. Ayrıca kullandıktan sonra suya koyduğunda daha geç paslandığını da gözlemliyor. Ayşe çaydanlığın paslanmasına neden olanın hava mı yoksa su mu olduğunu merak ediyor. Aşağıdakilerden hangisi Ayşe'nin merakını gidermek için test edilebilir?

a) Çelik tel yumağı hava ile temas ederse çaydanlığı daha iyi temizler.

b) Çelik tel yumağı suya bırakılırsa daha geç paslanır.

c) Çelik tel yumağının paslanması için su gereklidir.

d) Oksijen çelik tel yumağıyla reaksiyona girebilir.

6. Bir biyoloji öğretmeni sınıfta ışık yoğunluğu ile bitki büyüme oranı arasındaki ilişkiyi göstermek istiyor. Bir araştırma yürütüyor ve şu sonuçlara ulaşıyor.

Işık yoğunluğu	Bitki büyüme oranı (cm)
250	2
800	5
1000	9
1200	11
1800	12
2000	15
2400	13
2800	10
3100	5

Aşağıdaki yargılardan hangisi bu sonuçların ne anlama geldiğini doğru bir şekilde açıklar?

a) Işık yoğunluğu arttıkça, bitki büyümesi de artar.

b) Bitki büyümesi arttıkça, ışık yoğunluğu azalır.

c) Bitki büyümesi arttıkça ışık yoğunluğu artar sonra azalır.

d) Işık yoğunluğu azaldıkça, bitki büyümesi artar sonra azalır.

7.8 ve 9. Sorular aşağıdaki metine göre cevaplandırılacaktır.

Ahmet, soğuk kış mevsiminin domateslerin büyümesini nasıl etkileyeceği konusunda meraklanmaktadır. Sıcaklığın domates bitkisinin büyümesi üzerindeki etkisini araştırmaya karar verir. Domates tohumlarını aynı toprak tipi ve aynı su miktarıyla dört farklı kaba ekmiştir. Bu kaplar farklı cam kutulara farklı sıcaklıklarda yerleştirilmiştir. Biri 0 derece, diğeri 10 derece, diğeri oda sıcaklığında, dördüncü ise 50 derecededir. Domates bitkisinin büyüme oranları 14 günün sonunda kaydediliyor.

7. Bu araştırmadaki sıcaklık değişimlerinin nasıl bir etkisi vardır?

a) Mevsimlerde değişiklik

b) Kullanılan su miktarındaki değişiklik

c) Domates bitkisinin büyüme oranındaki değişiklik

d) Farklı kaplarda kullanılan toprak çeşidindeki değişiklik.

8. Deneyde incelenen faktör(ler) şunlardır.

a) Sıcaklıktaki değişim ve kullanılan toprak çeşidi

b) Sıcaklıktaki değişim ve domates bitkisinin büyüme oranı

c) Domates bitkisinin büyüme oranı ve kullanılan su miktarı

d) Kullanılan toprak miktarı ve domates bitkisinin büyüme oranı

9. Bu araştırmada hangi faktörler sabit tutulmuştur?

a) Zaman ve domates bitkisinin büyüme oranı

b) Domates bitkisinin büyüme oranı ve kullanılan su miktarı

c) Toprak tipi ve kullanılan su miktarı

d) Sıcaklık ve kullanılan toprak miktarı

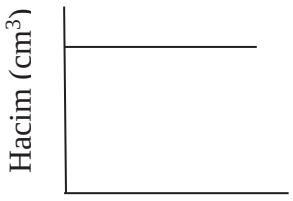
10) Ceren, magnezyum ile sulandırılmış hidroklorik asidin tepkimeye girdiği bir araştırma yapıyor. Her saniye için, tepkimeden üretilen hidrojen hacmini kaydediyor. Sonuçlar aşağıdaki gibidir.

Zaman(saniye)	0	1	2	3	4	5	6	7
Hacim (cm^3)	0	14	23	31	38	40	40	40

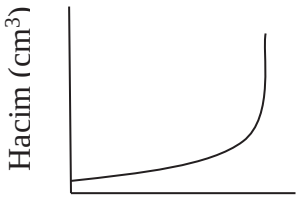
Tablo 1. Saniyede üretilen hidrojen hacmini gösterir

Aşağıdaki grafiklerden hangisi sonucu doğru bir şekilde gösterir?

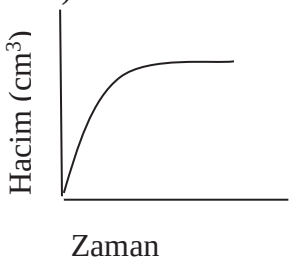
A)



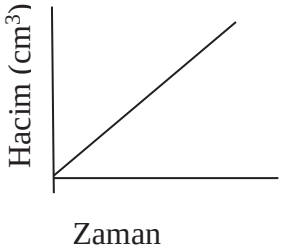
B)



C)



D)



APPENDIX C: INTERVIEW QUESTIONAIRES

GÖRÜŞME SORULARI

1. ‘Çevre’ kelimesini duyduğunda aklına neler geliyor?

2. Yaşadığın bölge yani Esenler’i düşündüğünde, çevreden memnun musun?

3. Esenlerde çevre için neleri değiştirmek istersin?

4.
   a. Çevre üzerinde olumlu etkin olduğunu düşünüyor musun? Evet/Hayır.

   b. Çevre üzerinde olumsuz etkin olduğunu düşünüyor musun? Evet/Hayır.

5.
   a. Gelecekteki dünyayı düşündüğünde, genel olarak çevre için endişelerin var mı? Evet/Hayır.
      Eğer cevap evet ise 5.b sorusuna yönelt.

   b. Çevreyle ilgili endişelerin nelerdir?

6.
   a. Çevre konularıyla ilgili misin? Evet/Hayır.
      Eğer cevap evet ise 6.b sorusuna yönelt.

   b. Çevreyle ilgili bir birey olarak neler yapıyorsun?

7. Bir problem düşün. Bu çevresel veya bilimsel bir problem olabilir. Bu problemin başlangıçtaki sebebini bulmak için nasıl bilgi edinirsin?

8. Sebebini bulduktan sonra problemi çözmek için hangi basamakları izlersin?

9. Sana göre bu proje sana hangi değerleri kattı?

Sadece uygulama sonrasında Group PB öğrencilerine yöneltilecektir.

APPENDIX D: AN EXAMPLE TRANSCRIPTION OF INTERVIEWS

Son görüşme S7
A: Evet Gönül hoş geldin öncelikle teşekkür ediyorum tekrar benimle röportaj yapmayı kabul ettiğin için.
G:Rica ederim hocam.
A: Biliyorsun çevre ünitesini işledik, hatta çevre sorunları için projeler geliştirdik. Şimdi sana sormak istiyorum, çevre denince aklına neler geliyor.
G: Mesela sabah uyandığımda şöyle bir camdan baktığımda etrafımda gördüğüm bütün alan doğal ortam her şey
A: Her şey dediğin neler girebilir bunun içine örnek vermen gerekirse
G: Ağaçlar girebilir, insanlar, okulum girebilir (sessizlik) ondan sonra hayvanlar falan girebilir
A: Pekiiii, kendi yaşadığın çevreyi yani Esenleri düşünürsen, memnun musun yaşadığın çevreden?
G: Esenlerden…. Esenlerden ve Esenlerdeki insanlardan memnun değilim.
A: Peki elinde bir güç olsaydı Esenlerde çevre için neleri değiştirmek isterdin?
G: Esenlerde yeşil alan azlığı var eeeee okulumzda da proje yaptık bununla ilgili eee etrafımızdaki boş arazilere ııı ağaç dikebiliriz
A: Hıhıı
G: Görüntü kirliliğini düzeltmek için falan yasalar düzenlenebilir
A: Yasalar düzenlenebilir diyorsun,
G: Elimizden geldiği kadar
A: Evet

G: Bu kadar
A: Bu kadar. Peki sence senin çevre üzerinde olumlu etkin var mıdır?
G: İnsanlar doğayı etkiliyor. Olumlu yönde de etkiliyor, olumsuz yönde de etkiliyor. Bazı insanlar vardır çevresine çok zarar verir, bazı insanlar vardır çevresini kendi gibi korur. Olumsuz mesela insanlar ııı hiç ı yere tükürerek yürüyorlar mesela.
A: Hıhıı evet
G: Yani pislik yapıyorlar. Olumlu olarak da mesela bazı insanlar da uyarıyor.
A: Peki şimdi sadece Esenleri düşünmeyelim Türkiye hatta dünyayı düşünelim genel olarak ıı senin dünyayla yani dünyanın, doğanın geleceğiyle ilgili endişelerin var mı?
G: Gittikçe ozon tabakası deliniyor.
A: Evet
G: İnsanlar ürün alırken şeyine bakmıyor eee kullanım şeyine hani zararlarını falan bakmadan alıyor. Yani böyle
A: Peki başka senin aklına gelen…
G: Su kirliliği
A: Başka dünyayı tehdit eden önemli sorunlar neler olabilir?
G: Susuzluk
A: Susuzluk dünya için büyük bir tehdit oluşturuyor diyorsun
G: Evet
A: Peki sence sen çevre sorunlarıyla ilgili misin?
G: Evet

A: Neler yapıyorsun çevreyle ilgili bir insan olarak?
G: Televizyonda bir program görsem izlerim veya ıı bir yazı görsem çevreyle ilgili okurum
A: Iıı evet, şimdi başka bir konuya geçersek. Eeee diyelim ki bir problemle karşılaştın. Bu bir çevre problem de olabilir herhangi başka bir sorun da. Bu problemin kaynağını nasıl tespit edersin?
G: ilk önce gözlem yapmak lazım yani eee şey verilerle şeylerle gözlem yapmak lazım ilk önce neden kaynaklandı diye
A: Evet neden kaynaklandığını bulmak için gözlem yapıyorsun. Peki daha sonar sorunu çözmek için hangi basamaklardan geçiyorsun, ııı hangi adımları takip ediyorsun?
G: Eeee bu şimdi gözlem yapıldı ee sonar bu sorun için hipotez geliştirilir
A: Varsayımda bulunuyorsun şöyle olursa şöyle olur diye, sonra
G: Uygulamaya geçmeden önce bir araştırma yaparın konuyla ilgili. İnternetten ıı sonraaa bilen yetkililerden
A: Başka nerelerden yararlanırsın?
G: Dergilere bakarız ıı kütüphanelere gideriz sonraaa öğretmenlere sorarız.
A: Pekiii bu bilgileri topladıktan sonra ne yaparsın?
G: Iı sonra uygulamaya geçersin, yani geçer kim yapıyorsa.
A: Sonra?
G: Sonraa ne yaparız (sessizlik) sayısal veri toplarız. Onları analiz ederiz. Sonuçlarına bakar yorumlarız, ıı en sonunda da uygulama yapar sunarız iste.
A: Uygulamamız gerekiyor diyorsun. Pekii Gönül teşekkür ediyorum katıldığın için.
G: Ben teşekkür ederim hocam.

APPENDIX E: PROJECT GROUP EVALUATION FORM

PROJE GRUBU DEĞERLENDİRME FORMU

Proje gruplarını verilen özelliklere göre değerlendiriniz ve toplam puanı aşağıya yazınız Çok kötü:1 Kötü:2 Orta:3 İyi:4 Çok iyi:5 puana eşdeğerdir. Bir grubun en düşük alabileceği puan 14, en fazla alabileceği puan 90'dır.

Proje Grubu Adı:

Proje değerlendirmede dikkat edilecek özellikler	**Çok kötü (1)**	**Kötü (2)**	**Orta (3)**	**İyi (4)**	**Çok iyi (5)**
Kullanışlılık					
Görsellik					
Harcanan emek					
Amaca uygunluk					
Öğrenci düzeyine uygunluk					
Yaratıcılık					
Bilimsel süreç becerilerini kullanma					
Bilimsel yöntem basamaklarını kullanma					
Çeşitli bilgi kaynaklarından yararlanma					
Sunum					
Detaylara verilen önem					
Takım çalışması					
Materyal kullanımı					
Projenin tasarımı					

Toplam Puan:

APPENDIX F: 9-12th GRADES SCIENTIFIC RESEARCH AND SCIENCE PROCESS SKILLS OBJECTIVES

BAS 1. Varlıkları duyu organlarını ve/veya uygun araç ve gereçleri kullanarak gözlemler.

BAS 2. Çeşitli sınıflandırma ölçütlerini kullanır, açıklar ve/veya oluşturur.

BAS 3. Biyolojik olaylarla ilgili çeşitli öngörülerde bulunur.

BAS 4. Güvenilir ve kesin verilere dayalı tahminlerde bulunur.

BAS 5. Kavramları yapılandırmak ve fikirleri geliştirmek için benzeşimler (analojiler) üretir.

BAS 6. Bir araştırmayı yapmak için uygun olan metodu seçer.

BAS 7. Bilgi toplamak amacıyla çeşitli kaynaklara başvurur.

BAS 8. Yanlılık gösteren bilgi ve görüşleri ayırt eder.

BAS 9. Araştırmayı veya etkinliği yapmak için gerekli, uygun alet ve materyalleri seçer.

BAS 10. Kullanma kılavuzu veya sözlü beyanlardan bir alet veya materyalin nasıl kullanılacağını öğrenir ve uygular.

BAS 11. Araştırma tekniklerini uygulamak amacıyla çeşitli araç gereçleri etkin olarak kullanır.

BAS 12. Bir problemi kesin ve açık olarak belirtir.

BAS 13. Verilen probleme bir veya daha fazla çözüm önerisi getirir.

BAS 14. Verilen bir olayda değişkenleri (bağımlı, bağımsız ve kontrol edilen değişkenler) belirler.

BAS 15. Öne sürdüğü hipotezi test etmek amacıyla bir etkinlik tasarlar ve yapar.

BAS 16. Uygun araç gereçleri kullanarak doğru ölçümler yapar.

BAS 17. Bir hipotezi desteklemek ya da reddetmek amacıyla bulduğu sonuçları açık olarak ifade eder.

BAS 18. Deneysel sonuçların doğruluğunu sınırlayan hataların kaynaklarını belirler.

BAS 19. Tablo, grafik gibi uygun teknikleri kullanarak verileri sınıflandırır ve düzenler.

BAS 20. Verilerde ortaya çıkan eğilimleri yorumlar.

BAS 21. Çeşitli araştırmacıların deneysel verilerini sonuçlarını doğrulamak amacıyla kullanır.

BAS 22. Sonuçlar ilk öne sürülen hipotezi doğrulamıyorsa ikinci bir hipotez kurar.

BAS 23. Hipotez doğrulandığında uygun sonuçlar çıkarır.

BAS 24. Doğrulanabilir verilerin gerekliliğini savunur.

BAS 25. Bilimsel kavramların anlaşılmasını kolaylaştıracak modelleri ve bilgisayar simülasyonlarını etkili olarak kullanır.

BAS 26. Bilimsel kavram, süreç ve araştırma sonuçlarını çizim, grafik, tablo, histogram vb. yazma ve/veya sözel iletişim yoluyla özetler.

BAS 27. Araştırma sonucu keşfedilen ilişkileri günlük yaşamda meydana gelen olayları açıklamak için kullanır.