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Duygu Calis & Halil Ibrahim Yildirim

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# The Effect of Prediction, Observation, Explanation Supported Project-Based Environmental Education on the Levels of Attitude and Behavior Toward the Environment*

**Duygu ÇALIŞ** [1]
Ministry of National Education

**Halil İbrahim YILDIRIM** [2]
Gazi University

## Abstract

This study aims to determine the effect of prediction, observation, explanation supported project based environmental education (POESPBEE) on the attitudes and behaviors levels of eighth grade students compared to teacher-centered environmental education. The study used a quasi-experimental research design including pre-test, post-test and control group. The application step of the study was carried out by the researchers in a ten-week period in 2018-2019 academic year. The study group included 62 students, 34 of whom were in the experimental group and 28 of whom were in the control group. The experimental group was applied the POESPBEE and the control group was applied teacher-centered environmental education. Attitude Scale toward Environment and Behavior Scale toward Environment were administrated as pre-test, post-test and follow-up test to evaluate the attitude and behavior levels of the students in the experimental and control groups toward the environment. Data were analyzed using the Independent Samples t-test and Repeated Measures ANOVA. The study found that the POESPBEE provided a significant development on students' attitude and behavior; however, teacher-centered environmental education could not provide a significant development on the students. Based on this result, it can be claimed that the methods like the POESPBEE, which can change individuals' attitudes and behaviors toward the environment in positive way, should be used in environmental education.

**Keywords:** Environmental education, prediction-observation-explanation supported project based environmental education, prediction-observation-explanation, project based learning

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[1] Teacher, Söğütlü Fatih Middle School, Midyat-Mardin, Turkey, ORCID ID: 0000-0003-2351-9334

**Correspondence:** duygu_49@hotmail.com

[2] Assist. Prof. Dr., Faculty of Education, Gazi University, Ankara, Turkey, ORCID: 0000-0002-8836-8349, Email: halily@gazi.edu.tr

## Introduction

Environmental problems caused by human impacts damage human life and life resources. In this sense, the solution of the environmental problems that needs to be addressed as a whole can be achieved not only by repairing the degraded environment, but also by developing awareness for protecting it (Yağlıkara, 2006). Nowadays, one of the most significant functions of education is to teach persons to know the natural environment they live in and to use natural resources efficiently and in a balanced manner. The rapid depletion of natural resources and the destruction of natural habitats and a healthy and livable environment by humans unconsciously are regarded as an important problem by educators (Demir & Yalçın, 2014). The primary way to achieve cognitive, affective and behavioral change in order to eliminate environmental damage caused by human is to provide environmental education (Özdemir, 2007). It is because insensitivity and lack of education are at the center of most environmental problems (Kızılaslan & Kızılaslan, 2005).

### Environmental Education and its Importance

For a sustainable environment, environment education is much prominent for person to be aware of the environment as from their childhood, to exhibit it as a behavior, to understand how their activities can affect environment and to be sensitive about environmental problems (Hsu, 2004; Mahidin & Maulan, 2010). Providing a permanent solution to the environmental problems, educating more environmentally sensitive students, and understanding the importance of protecting nature and leaving it to future generations instead of consuming all the sources offered by nature can only be achieved through environmental education (Baş, 2010; Ramadoss & Poyya Moli, 2011). The aim of environmental education is to provide that persons have information to resolve these issues, help prevent environmental problems and gain positive behavior toward the environment, rather than being unaware of the environmental problems. In other words, environmental education aims to reduce environmental problems by improving environmental awareness among students (Aktaş, 2014; Eryaman et. all, 2010; Gülay & Önder, 2011; Hsu, 2004; Mahidin & Maulan, 2010; Özdemir, 2007). Due to these characteristics, environmental education is different from environmental science or other kinds of education that include ecology. Environmental education offers ecological information on one hand and on the other, it enables the improvement of an attitude toward the environment in individuals and subsequently turns this attitude into a behavior. Environmental education addresses students' cognitive, affective and psychomotor learning domains (Erten, 2004).

By providing environmental education-teaching, it is purposed to train students to love and protect the nature, know and examine the environment they live in, do not remain insensitive to the environmental problems they face, and strive to improve the environment. For this purpose, environment should be perceived as a whole by students, and the importance of taking necessary precautions for every generation to live in a healthy environment should be made to understand. For

the environment to be able to meet the needs of people, preventing excessive consumption of natural resources and allowing environment to renew itself are only achieved by conscious individuals who have received qualified education (Ozdilek, Okur & Eryaman, 2012). Environmental education starts from the preschool; nevertheless, the desired environmental sensitivity cannot actually be achieved (Akçay, 2017; Armağan, 2006; General Directorate of Environmental Impact Assessment Permit and Inspection [GDEIAPI], 2004). However, using natural sources that nature offers correctly and in a planned way in order for the environment to meet the needs of individuals, preventing excessive consumption and environmental pollution, allowing the environment to preserve its ability of self-renewal, arising environmental awareness in humans, and raising persons that are more responsive to environment are the most important aims of environmental education. In this context, inefficiency in environmental education resulting from not using appropriate methods or techniques is the major factor underlying the environmental problems (Gautier, 2014; GDEIAPI, 2004).

Accordingly, it can be argued that individuals should be given environmental education to provide them with a positive attitude and behavior toward the environment, create a sustainable life, and solve the environmental problems. It is thought that student-centered learning approaches such as Prediction, Observation, Explanation (POE) and Project Based Learning (PBL), which can overlap with the environment itself, may procreate resolutions to the issues arising from life, and are based on learning by doing-living should be used in environmental education.

**Predict-Observe-Explain (POE) Technique**

POE technique is used to determine and eliminate students' mistakes regarding the concepts, reveal their knowledge, and achieve more effective teaching (Atasoy, 2004; Boo & Watson, 2001; Liew, 1995). POE technique tackles information with a constructivist approach, enables students to connect and configure their prior knowledge with what they have just learned and helps them absorb knowledge (Güngör & Özkan, 2017). In the prediction stage, the individuals are asked to make predictions regarding the events in the activities that will be created by the teacher and explain their predictions along with their reasons. This can be performed by offering options to the individuals or by asking open-ended questions (White & Gunstone, 1992). In the observation stage, the individuals are allowed to observe the event related to their predictions. The event should be observable by the learner and should be in the quality of causing contradiction in the learner's mind (Tao & Gunstone, 1997; White & Gunstone, 1992). In the explanation stage, the individuals are asked to compare their predictions with their observations, and an investigation is carried out to explain the differences-similarities between the predictions and observations and to eliminate conflicting situations. The results of the observations are made meaningful by the individuals (Liew & Treagust, 1998).

**Project Based Learning (PBL) Method**

PBL is a learning method which puts students in the center of the teaching-learning process, involves real-life issues, includes students' problem-solving skills and other meaningful learning, enables them to work by themselves through individual or group works to construct knowledge, solve problems and produce their own products to build knowledge, and whose focal points are concepts-scientific principles (Korkmaz & Kaptan, 2001; Saracaloğlu, Akamca & Yeşildere, 2006; Simkins, Cole, Tavalin & Means, 2002; Vatansever Bayraktar, 2015). While students play an active role in this process, teachers guide them to develop and finalize their projects. Through project works, students can be enabled to establish relationships between the real world and the concepts of science, and find opportunities to work individually or in collaborative learning environments by observing interdisciplinary relationships (McGrath, 2002; Saracaloğlu et al., 2006). Stages of PBL: 1. Determining the project topics-organizing research groups, 2. Creating project plans, 3. Implementing the project, 4. Planning project presentations, 5. Making presentation (sharing and discussing the project and achieving generalizations) 6. Evaluation (Korkmaz & Kaptan, 2001; Korkmaz, 2002). According to Korkmaz and Kaptan (2001), PBL is the leading method among others that can be used to transfer the knowledge and skills that students gained in science lessons into daily life and associate them with real life. In this approach, while students conduct their projects, they seek solutions to real-life problems by using their creativity and, at the same time, they are involved in activities such as accessing information, making analysis-synthesis and questioning. Children have the opportunity to find themselves in the real world thanks to the research they conduct in line with their interests and abilities (Solomon, 2003). In this context, considering that environment teaching-education is a component of science teaching-education, environmental education should be included in life, and negative environmental behaviors and problems should be learned by doing-living, it can be claimed that PBL method, based on learning by doing-living and problem solving, is important for environmental education.

**Prediction, Observation, Explanation Supported Project Based Environmental Education (POESPBEE)**

POESPBEE may be explained as a learning approach which aims to develop a project for solving a problem about environmental issues using the scientific research method through research-questioning, to reach generalizations through predictions, observations and explanations in the process of sharing and discussing the project. It is a model based on doing-living learning in which individuals are liable for their own learning-comprehension. In the POESPBEE approach, PBL method is supported by POE technique at the beginning, during and after the PBL process. No study on POE supported PBL, except for the one conducted by Güven (2011), was found as a result of the examination of the relevant literature. In the study by Güven (2011), POE technique was used at the beginning of the PBL process only to gain preliminary information; however, how POE supported

PBL method was performed was not explained in detail. In the present study, POE technique was used at the beginning, during and at the end of PBL process, so POE was integrated with PBL. Thus, the POESPBEE approach was designed as a more effective learning method. This makes it an authentic and different study. How PBL method was supported by POE technique in environmental education was expressed in detail in the application part of the study.

**Rationale and Importance of the Study**

Today, attitudes and behaviors toward the environment are very important in solving environmental problems that threaten the whole world and in preventing new environmental problems (Güven, 2014). The fact that students are able to be aware of environmental problems they may encounter in their lives and solve these problems is a necessity for a sustainable environment (Hsu, 2004; Mahidin & Maulan, 2010). At this point, environmental education is an indispensable tool for eliminating the problems that may devastate the world. Raising persons who have environment conscious is aimed through this training (Erten, 2004). The purpose of environment education is not only to provide information about the environment, but also to allow a positive improvement in individuals' attitudes, awareness and behaviors toward the environment, train individuals to ratiocinate, question, try to prevent arising of new problems, and produce solutions when they occur. To attain environmental goals, it is necessary for individuals to gain awareness for environmental problems and display attitudes and behaviors that will prevent these problems. These goals may be reached through environment education given by methods-techniques that put the student at the center (Erten, 2004; Güven, 2011; Karataş, 2013). Traditional teaching methods teach many subjects, but they lack in making children transfer what they have learned to real life. It is clear that children who have received traditional education, which includes environmental issues, lack in environmental awareness. Therefore, it is necessary to get students to adopt lifelong environmental literacy habits on environmental issues through collaborative groups and student-centered learning-teaching approaches inside or outside classroom environments (Akgün, 2001; Güven, 2011; Yılmaz, 2006). Environmental education that the time requires should focus on providing a perspective that will enable the establishment of a sustainable life culture on earth and developing cognition, awareness, skills and talents in parallel with it, rather than setting objectives limited to protection of environment (Özdemir, 2007). In this context, in the process of education about the environment, which is the real life itself, it is clear that it is impossible to achieve environmental goals through traditional education which cannot be connected with real life. This shows the necessity of using student-centered teaching methods such as PBL and POE, based on learning by doing-living, can build up relationship with life, allow individuals to actively participate in the learning-teaching process and enable the application of what has been learned. Using the POESPBEE in this study to achieve the objectives of environmental education makes this study significant.

The rationales for using POE technique supported by PBL in environmental education have been given below. There is no environment education class in the curriculum of the Ministry of National Education (MoNE) and environmental education is provided in a limited scope within the science course (MoNE, 2018). This may result in a lack of prior knowledge about the environmental issues in students. The pilot study of this research conducted in 2017 revealed that when only PBL was used in environmental education, the lack of prior knowledge about the environment in students resulted in failure to produce qualified projects, thus not being able to realize PBL process that could further develop the cognitive and affective skills toward the environment among students. It is essential in the PBL process that the subjects be learned during the process in that individuals design a project for the solution of a problem through research-inquiry using a scientific research method and then share it. In this context, PBL method was supported with POE technique at the beginning of the PBL process to make the learning process more effective with qualified projects that can solve problems, to question prior information about the environmental issues, to give preliminary information and to draw notice to the significance of the environment and the environmental problems. In addition, PBL method was supported by POE technique to facilitate the learning by reaching generalizations through predictions, observations and explanations during the sharing stage of projects in the PBL process and to actively involve the students who follow the projects in the learning process.

Studies in the literature suggest that instead of giving environmental education under different courses and with a limited scope, it should be given with its own learning approach and a curriculum with sufficient time in which environmental education subjects-gains can be applied. A specific environmental education is needed for students to train them to have environmental awareness and environmental literacy to solve the environmental problems during their education (Erdoğan, Kostova & Marcinkowski, 2009; Mosothwane, 2002; Özsevgeç & Artun, 2012). Designing an authentic POESPBEE approach that includes environmental education issues to meet this necessity makes the present study important.

A review of the secondary school science curriculum indicates that it includes the goals and subjects of environmental education, but students receive narrow-scale education related to these subjects at different grades (MoNE, 2018). In addition, the related curriculum does not provide a learning environment in that individuals may conduct study in the field of environment education, resolve issues regarding the environmental problems, and discuss their solutions (Taycı & Uysal, 2009). This may negatively affect students' attitudes toward the environment (Cutter, 2009; Seçkin, Yalvaş & Çetin, 2010) and, accordingly, their knowledge and behavior. Positive development of attitudes and behaviors can be achieved by active attendance of individuals in the learning-teaching environment through learning by doing-living and being involved in the learning experiences. In both the POE approach and PBL method, which were included in the present study, individuals are given

the occasion to structure what they learn through learning by living and they are made liable for their own learning. In this context, the originally designed POESPBEE model, in which PBL method was supported by POE technique, was determined as the subject of this study to gain positive attitudes and behaviors toward the environment which is real life itself.

### The Aim of the Study

This study aims to show the effect of the POESPBEE approach on the attitudes and behaviors of eighth grade students compared to teacher centered environmental education.

## Method

### Research Model

The study used a quasi-experimental design because the students in the experimental and control groups were not assigned based on drawing a lot or randomization, in other words, students who had already been grouped were included. Since the environmental issues and problems were covered using the POESPBEE approach and teacher-centered teaching method, and the changes in the environmental attitudes and behaviors of students were compared, the pre-test and post-test and control group design were used in the study (Büyüköztürk, Akgün, Kılıç Çakmak, Karadeniz & Demirel, 2016).

### The Study Group

The study was conducted with eighth grade students studying in the 2018-2019 academic year. It included a total of 62 students; 34 students in the experimental group and 28 students in the control group.

### Characteristics of the Participants

All the students in the study group received education in the same state secondary school in the district center of a medium-sized city in Turkey in the 2018-2019 academic year. The participants resided in the center of the district. The control group consisted of 15 female and 13 male students, and the experimental group consisted of 17 female and 17 male students.

### Sampling Procedures

For the study, eighth grade students whom the researcher could easily reach, apply the experimental process, and make guidance, and who were enrolled in the school where the researchers worked were included in the study group. Therefore, it can be claimed that the appropriate sampling method was used (Büyüköztürk et al., 2016).

**Data Collection Tools**

**Behavior Scale toward Environment (BSTE)**

The students' environmental behavior scores were evaluated using the Behavior Scale toward Environmental Problems (BSTE) that is composed of 20 items. In the scale, developed by Yavetz and Pe'er (2006) and adopted into Turkish by Timur and Yılmaz (2013), one item is negative and the other 19 are positive. In this likert scale, the items are scored according to the following responses: "Always=5," "Usually=4," "Sometimes=3," "Rarely=2," and "Never=1." The Cronbach's alpha value of the scale was found to be 0.85. The item that includes a negative expression is reverse scored. The highest score is 100 and the lowest is 20. Before passing the application stage of the study, the BSTE was applied to 127 students who were excluded from the sample of the study. The Cronbach's alpha reliability coefficient of the BSTE was calculated to be 0.84.

**Attitude Scale toward Environment (ASTE)**

Students' attitude scores toward the environment were evaluated using the Attitude Scale toward Environment (ASTE) that consists of 25 items. In the ASTE, developed by Atasoy and Ertürk (2008), four items have positive and 21 have negative expressions. The Cronbach's alpha value of this 5-point Likert type scale is 0.85. The items are scored according to the following responses: "Completely agree=5," "Agree=4," "Partly agree=3," "Disagree=2," and "Completely disagree=1" The items including negative expressions are reverse scored. The lowest score in the scale is 25 and the highest is 125. Prior to conducting the study, the ASTE was applied to 127 students who were not included in the study sample and the Cronbach's alpha reliability coefficient was calculated to be 0.89. The reliability coefficients of the BSTE and ASTE were greater than 0.70, which indicated that they were reliable (Büyüköztürk, 2016).

**Data Analysis**

The data were analyzed using the SPSS 22. Kolmogorov Smirnov and Shapiro Wilk analyzes were used to check whether the data were distributed normally, and the results were given in Table 1 below.

**Table 1.** Normal Distribution of Data Analysis Results

| Group | Variable | Test | Skewness | Kurtosis | Shapiro-Wilk (p) | Kolmogorov Smirnov (p) |
|---|---|---|---|---|---|---|
| Control | Attitude | Pre | -0.67 | -0.60 | 0.142 | 0.053 |
| | | Post | -0.56 | -0.75 | 0.200 | 0.076 |
| | | Follow-up | -0.23 | -0.83 | 0.200 | 0.590 |
| | Behavior | Pre | 0.22 | -0.20 | 0.200 | 0.973 |
| | | Post | -0.16 | -0.17 | 0.200 | 0.968 |
| | | Follow-up | 0.27 | -0.88 | 0.200 | 0.519 |
| Experiment | Attitude | Pre | 0.05 | -0.03 | 0.200 | 0.618 |
| | | Post | -0.35 | -0.34 | 0.200 | 0.325 |
| | | Follow-up | -0.15 | -0.78 | 0.200 | 0.668 |
| | Behavior | Pre | 0.55 | 0.12 | 0.200 | 0.261 |

| | | | | | |
|---|---|---|---|---|---|
| | Post | -0.20 | -0.54 | 0.200 | 0.799 |
| | Follow-up | -0.29 | -0.55 | 0.200 | 0.650 |

The experimental and control groups' Kolmogorov Smirnov and Shapiro Wilk results regarding attitude and behavior pre-test, post-test and follow-up tests were greater than 0.05, and the skewness-kurtosis coefficients were between -1.5 and +1.5. Accordingly, the pre-test, post-test and follow-up test data of the control and experimental groups about the attitude and behavior toward the environment were normally distributed. In addition, analyses of the equality of the variances conducted using the Levene's test showed that the variances were equal. Based on these results, parametric tests were used for the analysis of the data that showed a normal distribution. The Independent Samples t-Test was used to determine whether there was a significant difference between the pre-test, post-test and follow-up test scores of the control and experimental groups, which were measured using the Repeated Measures ANOVA. All analyzes were evaluated at 0.05 significance level. Eta Squared ($\eta 2$) value was used to calculate the effect size in the analyses in which the difference was significant. The effect size was evaluated according to $\eta 2$ as $0.01<\eta 2<0{,}06$= small, $0.06\leq \eta 2<0.14$= medium, and $0.14\leq \eta 2$=large (Cohen, 1988).

**Application Step of the Study**

The study was conducted with eight grade students in a public school during 2018-2019 academic year, and it was completed in 40 lesson hours in 10 weeks. The pre-test, post-test and follow-up tests were not included in this period. The applications were carried out by the researchers for both groups to prevent the errors that could have resulted if different teachers were assigned. Thus, an error that might arise from the researcher was aimed to be controlled (Çepni, 2014). Before the experimental procedure, the BSTE and ASTE were implemented for the experimental and control groups.

**Application in the Control Group**

Teacher-centered teaching methods were used for the control group in environmental education. These methods included narration, demonstration, question and answer. The subjects of environmental education given in Table 2 were taught in the control group.

**Application in the Experiment Group**

The topics regarding the environment were taught to the experimental group using the POESPBEE, and the application process was given in Table 2.

**Table 2.** Application Process of the POESPBEE Approach in the Experimental Group

| | Lessons Provided in Two Parts | |
|---|---|---|
| Week | The First Part of the Lesson (2 lessons per week): Drawing attention, interest to the environmental issues and providing preliminary knowledge through POE | The Second Part of the Lesson (2 lessons per week): Implementation of stages of PBL Method |
| 1 | Environmental concepts<br>Environmental pollution and the Change in the environment from past to present<br>Air pollution | Giving information about the project and PBL method<br>Giving information about the stages of the project, determining the groups |
| 2 | Water pollution<br>Soil pollution | Determination of project topics<br>Determination of problem sentence<br>Planning the study process |
| 3 | Nuclear pollution<br>Electromagnetic pollution | Conducting research, preparing projects |
| 4 | Noise pollution<br>Light pollution | Conducting research, preparing projects |
| 5 | Renewable energy sources<br>Recycling<br>The environment for a sustainable life<br>Greenhouse effect and global warming | Conducting research, preparing projects |
| | Lessons Given in One Part (four lessons per week) | |
| 6, 7, 8, 9, 10 | Sharing and discussing the projects in the classroom, making generalizations and evaluation with the support of POE technique | |

**Application in the Experimental Group in the First Five Weeks**

Lessons in the first five weeks were designed as two parts and lasted 20 lessons (four lessons per week). In the first part of the lesson, POE technique regarding the environmental concepts, topics and problems was used to prepare higher quality projects on the environmental issues and to apply PBL method more effectively. Thus, students' attention and interest were drawn to the importance of the environment and the environmental problems for a sustainable life and they were provided with preliminary knowledge about these topics. For example, while POE technique was used for water pollution, visuals about water pollution excerpted from interesting video-animations were shown to the students. Subsequently, they were asked to make predictions about how the event in the visuals had an impact on the environment, whether this event was an environmental problem, about its causes, consequences and how this event would affect human life. During the observation stage, they were asked to watch the video including visuals about how water pollution occurs, its causes, results and effects on the environment and life. At the explanation stage, the students were asked to explain whether the predictions were consistent with the observations. During the application of POE, a POE activity document was prepared for each environmental issue and the students were asked to fill it out. Therefore, the students' attention and interest were drawn to the environmental issues and preliminary information was provided using POE technique.

In the second part of the lesson, stages of PBL method were addressed. In the first week, project, scientific research, and stages of preparation of scientific research-project were explained to

the students with examples, and project groups were formed. The students in the groups were asked to find a name and slogan for their groups to warm them to one another. They were also asked to conduct research to determine the topic of the project related to the environmental issues and problems.

In the second week, the project topics were identified, a problem sentence was determined for the environmental problems, and the research process for the solution of the problem was planned. In the POE technique used in the abovementioned process, predictions were taken for the solution of the problem. In addition, necessary research and investigations were made to solve the problem, and relevant information was collected.

In the third week, project proposals for the solution of the problem were developed and projects were started to be prepared based on the collected information.

Preparation of projects continued in the fourth and fifth weeks. In this process, the students were given a "PBL Method Form." Furthermore, some out-of-school time was allocated for the project preparation process and project groups were interviewed and guided.

The POE technique was also used during the PBL process. The group that prepared the project made predictions for the solution of the environmental problem during the prediction stage. In the observation stage, the students in this group observed the results of the project and recorded their observations. In the explanation stage, they explained whether their predictions and observations were consistent.

**Applications for the Experimental Group in the Sixth, Seventh, Eighth, Ninth and Tenth Weeks**

The lessons in the sixth, seventh, eighth, ninth and tenth weeks were designed as one part and lasted 20 lessons (four lessons per week). In the lessons designed as one part, the missed projects were completed outside the lessons and the completed projects were shared, discussed and generalized in the classroom by being supported by POE technique. A "Project Presentations POE Activity Paper," completed by the students, who followed the project presentations as participants, was used for each project. Before the projects were presented -at the prediction stage of POE technique- the students' predictions about which the environmental problem that the project shown was intended to solve, how this solution could prevent the environmental problem, and how it could be beneficial to the environment and sustainable life were obtained. During the observation stage, the project was presented, projects were examined and observations were recorded through touching and seeing by the students who observed them. At the explanation stage, the students were asked to explain whether the predictions and the observations were consistent. Afterwards, the students completed "Project Presentations POE Activity Paper" for each project. After the project was shared in the classroom, the students discussed the environmental issue-problem in the project and made generalizations about them. Thus, the stages of the POESPBEE approach were completed. In this process, the teacher guides

the students, monitors the process, designs the learning environment, manages the sharing and discussing stages of the project and applies the stages of the POESPBEE approach. On the other hand, the students investigate, question, perform the stages of a scientific study, produce projects and take responsibility for their own learning.

At the end of the experimental process, the ASTE and BSTE were administered as post-test. 12 weeks after this procedure, the ASTE and BSTE were administered to the control and experimental group as a follow-up test.

## Findings

### The Findings of the Attitude Scale toward Environment (ASTE)

**Table 3.** Independent samples t-test results for the ASTE

| Test | Group | N | $\overline{X}$ | S | Df | t | p |
|---|---|---|---|---|---|---|---|
| Pre | Control | 28 | 85.61 | 15.95 | 60 | 0.46 | 0.647 |
| | Experiment | 34 | 83.85 | 14.05 | | | |
| Post | Control | 28 | 87.29 | 16.68 | 60 | -4.05 | 0.001 |
| | Experiment | 34 | 102.59 | 13.05 | | | |
| Follow-up | Control | 28 | 86.36 | 17.41 | 60 | -5.25 | 0.001 |
| | Experiment | 34 | 101.03 | 12.25 | | | |

According to Table 3, there was no significant difference between the control and experimental group students' ASTE scores at the beginning of the study ($t_{(60)}$=0.46; p>.05). However, there was a significant difference between the groups' post-test scores ($t_{(60)}$= -4.05; p<.05) and follow-up test scores ($t_{(60)}$= -5.25; p<.05) in favor of the experimental group. The η2=0.22 value, determined for the significant difference between the experimental and control groups' post-test scores on the ASTE and the η2=0.31 value, determined for the difference between their follow-up test scores, were higher than 0.14, which indicated that the effect size was large (Cohen, 1988).

**Table 4.** The descriptive analysis of the control group's ASTE scores

| Test No | Test | N | $\overline{X}$ | S |
|---|---|---|---|---|
| 1 | Pre | 28 | 85.61 | 15.95 |
| 2 | Post | 28 | 87.29 | 16.68 |
| 3 | Follow-up | 28 | 86.36 | 17.41 |

**Table 5.** The control group's repeated measures ANOVA results for the ASTE scores

| Source of Variance | Sum of Square | df | Mean Square | F | p |
|---|---|---|---|---|---|
| Between Subjects | 20310.417 | 27 | 752.238 | | |
| Measurement | 39.595 | 2 | 19.798 | 0.474 | 0.625 |
| Error | 2254.405 | 54 | 41.748 | | |
| Total | 22604.42 | 83 | | | |

Table 5 showed that there was no significant difference between the control group students' ASTE pre-test, post-test and follow-up test scores ($F_{(2-54)}$=0.474; p>.05).

**Table 6.** The descriptive analysis of the experimental group's ASTE scores

| Test No | Test | N | $\overline{X}$ | S |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 1 | Pre | 34 | 83.85 | 14.05 |
| 2 | Post | 34 | 102.59 | 13.05 |
| 3 | Follow-up | 34 | 101.03 | 12.25 |

**Table 7.** The experimental group's repeated measures ANOVA results for the ASTE scores

| Source of Variance | Sum of Square | df | Mean Square | F | p | Significant Difference |
|---|---|---|---|---|---|---|
| Between Subjects | 12377.490 | 33 | 375.075 | | | |
| Measurement | 7349.353 | 2 | 3674.676 | 51.427 | 0.001 | 1-2, 1-3 |
| Error | 4715.980 | 66 | 71.454 | | | |
| Total | 24442.823 | 101 | | | | |

Table 7 showed that there was a significant difference between the experimental group's ASTE pre-test, post-test and follow-up test scores ($F_{(2-66)}$=51.427; p<.05). The difference between the post-test and pre-test was in favor of post-test, and the difference between the follow-up test and pre-test was in favor of follow-up test. The POESPBEE approach can be claimed to have a significant effect on development of attitude toward environment as the value of η2=0.61 was greater than 0.14 (Cohen, 1988).

**The Findings of the Behavior Scale toward Environment (BSTE)**

**Table 8.** Independent samples t-test results for the BSTE

| Test | Group | N | $\overline{X}$ | S | Df | t | p |
|---|---|---|---|---|---|---|---|
| Pre | Control | 28 | 60.21 | 15.45 | 60 | 0.76 | 0.450 |
| | Experiment | 34 | 57.47 | 12.97 | | | |
| Post | Control | 28 | 62.75 | 14.67 | 60 | -5.62 | .001 |
| | Experiment | 34 | 81.06 | 10.93 | | | |
| Follow-up | Control | 28 | 62.18 | 16.10 | 60 | -5.25 | 0.001 |
| | Experiment | 34 | 80.65 | 11.53 | | | |

Table 8 showed that there was no significant difference between the BSTE pre-test scores of the students in the experimental and control groups ($t_{(60)}$=0.76; p>.05). However, there was a significant difference between the post-test scores ($t_{(60)}$=-5.62; p<.05) and follow-up test scores ($t_{(60)}$=-5.25; p<.05) in favor of the experimental group. The η2=0.35 value, determined for the significant difference between the experimental and control groups' post-test scores for their behavior toward environment, and the η2=0.32 value, determined for the difference between the follow-up test scores, were higher than 0.14, which indicated that the effect size was large (Cohen, 1988).

**Table 9.** The descriptive analysis of the control group's BSTE scores

| Test No | Test | N | $\overline{X}$ | S |
|---|---|---|---|---|
| 1 | Pre | 28 | 60.21 | 15.45 |
| 2 | Post | 28 | 62.75 | 14.67 |
| 3 | Follow-up | 28 | 62.18 | 16.10 |

**Table 10.** The control group's repeated measures ANOVA results for the BSTE scores

| Source of Variance | Sum of Square | df | Mean Square | F | p |
|---|---|---|---|---|---|
| Between Subjects | 16824.476 | 27 | 623.129 | | |
| Measurement | 99.071 | 2 | 49.536 | 1.099 | 0.340 |
| Error | 2433.595 | 54 | 45.067 | | |
| Total | 19357.142 | 83 | | | |

Table 10 showed that there was no significant difference between the control group's BSTE pre-test, post-test and follow-up test scores ($F_{(2-54)}$= 1.099; p>.05).

**Table 11.** The experimental group's measures of central tendency and expansion for the BSTE

| Test No | Test | N | $\overline{X}$ | S |
|---|---|---|---|---|
| 1 | Pre | 34 | 57.47 | 12.97 |
| 2 | Post | 34 | 81.06 | 10.93 |
| 3 | Follow-up | 34 | 80.65 | 11.53 |

**Table 12.** The experimental group's repeated measures ANOVA results for the BSTE scores

| Source of Variance | Sum of Square | df | Mean Square | F | p | Significant Difference |
|---|---|---|---|---|---|---|
| Between Subjects | 9039.647 | 33 | 273.929 | | | |
| Measurement | 12395.529 | 2 | 6197.765 | 84.402 | 0.001 | 1-2, 1-3 |
| Error | 4846.471 | 66 | 73.431 | | | |
| Total | 26281.647 | 101 | | | | |

Table 12 showed that there was a significant difference between the experimental group's BSTE pre-test, post-test and follow-up test scores ($F_{(2-66)}$=84.402; p<.05). The difference between pre-test and post-test was in favor of post-test, and the difference between the pre-test and post-test was in favor of the follow-up test. The η2=0.71 value was higher than 0.14, which indicated that the POESPBEE approach had a significant effect on the improvement of behavior toward environment (Cohen, 1988).

## Discussion

The experimental and control groups' levels of attitude toward environment were similar at the beginning of the study; however, the experimental group's level of attitude toward environment was significantly higher than that of the control group at the end and three months after the study. In addition, the effect size value was large in both the post-test and the follow-up test. These results showed that the POESPBEE approach was more effective than teacher-centered environmental education in improving the attitudes toward environment. The differences between the attitude toward environment pre-test, post-test, and follow-up test scores were insignificant in the control group. This can be interpreted that teacher-centered environmental education has no significant contribution to the improvement of the attitudes toward the environment. This result can be explained by the fact that students are inactive in teacher-centered teaching and this teaching model is not interesting and attractive.

The ASTE scores of the students in the experimental group significantly increased at the end of the study process, and this increase was maintained three months after the study. The POESPBEE approach also has a large effect on the improvement of the attitudes toward the environment. These results can be interpreted as a positive contribution of the POESPBEE approach to the improvement of the attitude toward the environment. In the POESPBEE approach, students' interest and attention were drawn to the environmental issues through the prediction, observation and explanation stages, they

conducted a scientific project, they realized that the environmental problems threatened a sustainable life and that they became aware of the results of the environmental problems, all of which can be argued to pave the way to an improvement in their attitudes toward the environment. In addition, projects on socio-scientific subjects, such as environmental pollution, recycling, greenhouse effect and global warming, were carried out in the POESPBEE approach, and the results were discussed and shared in the classroom. It is possible to claim that the fact that students came up with new ideas for the solution of environmental problems, designed projects, made predictions, observations and explanations, and shared their ideas in this process contributed to a positive change in their attitudes toward the environment. In short, the project was carried out by performing the applications in line with the objectives, which might have resulted in the fact that the students were ensured to like the subjects of environmental education and as a result, their attitudes toward the environment were improved (Benli, Ay & Kahramanoğlu, 2011; Farmer, Knapp & Benton, 2007; Güven, 2011; Güven, 2014; Knapp & Barrie, 2001). No study, except for the one which Güven (2011) conducted and in which POE and PBL were used together, was found as a result of the literature review, and neither was a study on the effect of POE technique on attitude and behavior toward the environment. Therefore, the results of the study examining the effect of PBL on the attitudes and behaviors toward the environment were also included in the discussion section of this study. Güven (2011) concluded that the PBL method supported by POE technique improved prospective science teachers' attitudes toward the environment. POE technique was used only at the beginning of the PBL process in the study carried out by Güven (2011); however, in the present study, the entire PBL process was integrated with POE technique, using it at the beginning, during and at the end of the process. Moreover, being sensitive to the environment for the prospective science teachers, who were included in the sample in Güven's (2011) study, is the teachers' competence specified by the MoNE (MoNE, 2017). Therefore, the improvement in the attitudes of prospective teachers toward the environment at the end of environmental education is a situation that is expected to emerge naturally. However, in the present study, eighth grade students, whose environmental sensitivity was not determined as a professional competence, were included in the sample. These two factors make the present study original and different. Also, the studies conducted by Awad (2017), Bayram and Seloni (2014), Benli, Ay and Kahramanoğlu (2011), Benzer (2010), Benzer and Şahin (2012), Borhan and İsmail (2011), Erol (2016), Kaşarcı (2013), Yucasu (2015) found that PBL method made a significant contribution to the improvement of the attitude toward the environment, which supports the result of the present study. Evans, Koul and Rennie (2007); Matlack and McEwan (2008) emphasized that projects played an important role in raising environmental awareness. In the abovementioned studies, how PBL improves the environmental attitudes is explained by the fact that students conduct a study on the subjects that attract their interest and attention and create a product, called a project. In these studies, explanations about the effect of PBL on attitude overlap with the learning activities involved in the POESPBEE process. The positive change in the attitudes of the individuals will also change the environmental

behaviors positively. In this context, to prevent environmental problems and eliminate the behaviors that cause these problems, the attitudes toward the environment should positively improve and these positive attitudes should turn into behaviors. For this purpose, it can be claimed that the methods like the POESPBEE, which can change individuals' attitudes toward the environment in positive way, should be used in environmental education.

There was no significant difference between the experimental and control groups' BSTE scores at the beginning of the application; however, the experimental group's scores were significantly higher than those of the control group at the end and three months after the application. In addition, the effect size value was high in both the post-test and the follow-up test. According to this finding, the POESPBEE approach is more effective than the teacher-centered environmental education in the increase of environmental behavior scores. There was no significant improvement in the behavior of the control groups, whom teacher-centered environmental education was applied, toward the environment. This could have resulted from the fact that the negative effects of the negative behaviors toward the environment could not be seen as the students were inactive during the learning process and learning by doing-living was not realized. There was a significant increase in the experimental group's BSTE scores at the end of the study, and this increase was maintained three months after the study. In addition, the POESPBEE approach has a large effect on behavior. These findings show that the POESPBEE approach has a positive effect on the improvement of the environmental behavior. This result can be explained by the fact that through the learning by doing-living in the POESPBEE process, individuals were enabled to see that negative behaviors toward the environment caused environmental problems, that the environmental problems posed a threat to human health and the future of the world, and that behaviors were the most important factors on a sustainable life. The literature includes studies which have found similar results suggesting that PBL method positively affects students' behaviors. For example, studies conducted by Bayram and Seloni (2014), Benzer (2010), Benzer and Şahin (2012), Borhan and İsmail (2011), Erol (2016), Kırbağ Zengin and Yucasu (2017), Yucasu, (2015) found that PBL method significantly contributed to the improvement of the environmental behavior. Rooij (2009) found that students' communication and intra-group collaborative behaviors improved positively through a well-planned and disciplined project method. Güven (2011) concluded that the PBL method supported by the POE technique improved prospective science teachers' behaviors toward the environment. The improvement of the behaviors was explained by learning by doing-living through carrying out projects in the abovementioned studies. In these studies, explanations about the effect of PBL on behavior overlap with the learning activities involved in the POESPBEE process. The positive behaviors that individuals display toward the environment are very important in terms of solving the environmental problems that threaten a sustainable life and preventing new problems from arising. Therefore, individuals' negative behaviors toward the environment should be changed (Güven, 2011; 2014). In this context, instead of traditional teaching in

environmental education, the learning-teaching approaches, in which individuals will be able to experience the effects of environmental behaviors on the environment by doing-living, should be used for them to show positive behaviors toward the environment.

## Conclusion and Suggestions

In brief, the POESPBEE approach was effective in the development of attitude and behavior toward the environment while teacher-centered environmental education was not effective. Considering the results and the activities carried out in the POESPBEE approach, the methods in which students can make predictions, observations and explanations for the purpose of drawing interest and attention to environmental issues, questioning and providing preliminary information, as in POE technique, can be used in environmental education. In addition, as in PBL method, it can also be suggested that the methods, in which ideas for the solution of the environmental problems can be proposed, studies can be done, projects can be designed, shared and discussed during the research process, and which indicate that environmental problems threaten a sustainable life and enable to be aware of the results of the environmental problems, be applied.

Based on the results of this study, it is clear that improving the attitudes toward the environment and turning them into environmentally friendly behaviors is not possible through traditional education to which environment, the real life itself, cannot be connected during education process. Therefore, instead of teacher-centered methods in environmental education, student-centered learning-teaching approaches, which are based on learning by questioning-doing-living, enable an active attendance in the learning environment, and can establish a relationship with life, should be preferred.

In this study, there were two eighth grade classes in the school where the application was carried out; therefore, while the effect of the teacher-centered teaching and the POESPBEE approach on the attitude and behavior toward the environment was being investigated, the effects of the POE technique and the PBL method could not be examined individually. This is the limitation of the research. For this reason, it may be suggested that studies which compare the effects of the teacher-centered teaching, the POESPBEE approach, POE technique and PBL method be carried out.

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