Elementary Education Online, 2018; 17(4): pp. 1928-1943
İlköğretim Online, 2018; 17(4): s. 1928-1943. [Online]: http://ilkogretim-online.org.tr
doi 10.17051/ilkonline.2019.506905

An Interdisciplinary Nature Education Program for Gifted Primary School Students and its Effect on their Environmental Literacy [1]

Özel Yetenekli İlkokul Öğrencileri için Disiplinlerarası Bir Doğa Eğitimi Programı ve Onların Çevre Okuryazarlığına Etkisi

Hasret Nuhoğlu, *Maltepe University, hasretnuhoglu@maltepe.edu.tr,* ORCID: 0000-0002-9985-4203
Yeşim İmamoğlu, *Boğaziçi University, yesim.imamoglu@boun.edu.tr,* ORCID: 0000-0002-8790-3127

Abstract. The aim of this study is to introduce an interdisciplinary nature education program (INEP), developed for gifted students in order to create an opportunity for them to discover nature and approach environmental problems in a systematic way. Another aim is to investigate the effect of the program on environmental literacy. Participants of the study were 20 gifted primary school students. INEP took place in a botanical garden preserving the richest endemic species of Turkey. Effectiveness INEP was measured by Elementary School Environmental Literacy Instrument, consisting test of environmental knowledge (TEK), affective disposition towards environment (ADTES) and responsible environmental behavior (CREBS) scales. In addition, participating students' performances and their views about the program were evaluated. Results of data analysis revealed significant differences in students' environmental knowledge and affective disposition towards the environment. Student interviews and observations also support this result. In accordance with the findings, strengths and weaknesses of the program are discussed.

Keywords: Gifted education, interdisciplinary learning and teaching, nature education, environmental education, environmental literacy, out of school learning environments

Öz. Bu çalışmanın temel amacı, özel yetenekli öğrencilerin doğayı keşfetme ve çevre sorunlarına sistematik bir şekilde bakabilme fırsatı sağlamak üzere geliştirilmiş olan disiplinlerarası doğa eğitimi programını tanıtmaktır. İkinci amaç ise geliştirilen programın öğrencilerin çevre okuryazarlığına etkisinin araştırılmasıdır. Çalışma grubu üstün yetenekli 20 ilkokul öğrencisinden oluşmaktadır. Didep, Türkiye'nin en zengin endemik türlerinin korunduğu İstanbul ilindeki bir botanik bahçesi'nde gerçekleştirilmiştir. Programın etkinliği, çevre bilgisi testi (ÇBT), çevreye yönelik duyuşsal eğilimler (ÇYDE) ve çevreye yönelik sorumlu davranış (ÇYSD) ölçeklerini içeren İlköğretim Çevre Okuryazarlığı Anketi ile ölçülmüştür. Bunun yanı sıra öğrencilerin performansı ve program hakkındaki görüşleri değerlendilirmiştir. Veri analizi sonucunda öğrencilerin çevre bilgisinde ve çevreye yönelik duyuşsal eğilimlerinde anlamlı farklılıklar gözlemlenmiştir. Öğrenciler ile yapılan görüşmeler ve gözlemler de bu sonuçları desteklemektedir. Bulgular doğrultusunda programın olumlu ve olumsuz yanları tartışılmıştır.

Anahtar Sözcükler: Özel yeteneklilerin eğitimi, disiplinlerarası öğrenme-öğretme, doğa eğitimi, çevre eğitimi, çevre okuryazarlığı, okul dışı öğrenme ortamları

[1] A part of this study was presented at the congress named "11. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi (11th National Congress of Science and Mathematics Education)" in Adana, Turkey with the title of "Üstün Yetenekli Öğrencilere Yönelik Disiplinlerarası Bir Doğa Eğitimi Programının (DİDEP) Geliştirilmesi (Development of an interdisciplinary nature education program (INEP) for gifted students)". Authors wish to thank the following institutions for their support: Nezahat Gökyiğit Botanical Garden, Üsküdar District Municipality, Üsküdar Çocuk Üniversitesi and Çizgi Çocuk Atölyesi.

Received: 11.02.2017 Accepted: 30.08.2018 Published: 31.10.2018

INTRODUCTION

The world we live in needs lifelong learning individuals since it is in constant change and development. Innovative education approaches aim to help students become individuals who can learn how to learn, identify cause-effect relationships and eagerly come up with alternative solutions when faced with a problem. Children are usually curious and enthusiastic about exploring and discovering in the early ages. But as they get older, these traits seem to diminish. This is a serious concern for educators.

Keeping students' curiosity and enthusiasm alive and developing their observation skills and ability to form relationships is especially important in science education since it aims to teach students how to learn and help them become individuals who are competent in scientific thinking. One of the biggest problems in science education, however, is that educators usually think about science in terms of content; seeing it as a pile of information about scientific developments and discoveries. This point of view is supported when applications of science in classroom settings are examined; revealing that students' minds are crammed with science related information (Lind, 2005).

Every child, specifically gifted and talented ones, have an innate interest in science because science stimulates their curiosity and imagination (Smutny & Von Fremd, 2004). Gifted and talented students have a vast knowledge of facts and deep understanding of concepts related to science (Gould, Weeks & Evans, 2003). They also demonstrate the ability and insight for transferring information they learned from specific examples to more general cases (Kopelman, Galasso, Strom, 1977; Ngoi & Voldracek, 2004). VanTassel-Baska and Stambaugh (2006) state that the subject domain that challenges gifted and talented students' minds and curiosity the most is science. These students enjoy dealing with the unknown and are capable of gathering information by making detailed observations (Karnes & Riley, 2005), conducting experiments and identifying problems that others miss (Meador, 2003).

It has been well documented that development of a gifted child differs from a normal child. Gifted and talented young people are in search of a meaning. These individuals learn to discover and value their own characteristics, and if they succeed in connecting with other people, this search of finding themselves will form the basis for developing personality and self-confidence (Silverman, 1993). There are various methods that have huge importance in educating gifted and talented students. These are acceleration, grouping, differentiation and enrichment. (VanTassel-Baska, 2002). Education programs can be developed using one or a combination of these methods. Acceleration aims to provide students with challenging and deep learning experiences, through alternatives such as content acceleration, double enrollment, honor classes, advanced placement classes, restricted curriculum, and tutoring. Acceleration consists of taking a class or learning a subject one or two years earlier than usual. In grouping, students are placed in different schools or different classes according to their ability levels, or they are taught differently in the same class (VanTassel-Baska & Stambaugh, 2006). Differentiation is used to adapt learning environments to address the needs of students with different readiness levels, styles of learning and interests. Lessons can be differentiated by making use of materials and tasks with different levels of difficulty, enabling individual or group work, providing varying degrees of scaffolding to students. Since gifted and talented students have advanced readiness levels and their areas of interest may be wider than their peers, differentiated instructional programs can be used to adress their needs (Tomlinson, 2000; Meador, 2003).

Enrichment, on the other hand, is concerned with deepening and expanding what is provided to the students, in order to further develop their abilities and make the subject area they are studying more challenging (Shiever & Maker, 2003). Review of the literature reveals that there are four main categories of enrichment for gifted and talented students. These are Content, Process, Environment, and Products. One of the most important techniques in process enrichment is problem-based learning. Problem based learning helps students develop problem-solving strategies and through active involvement in solving real life problems, they acquire knowledge and skills related to the discipline under consideration (Maker, 1982 as cited in Watters, 2004; Stepanek 1999; VanTassel-Basca, 1998). It also enables students to use self-regulation while

learning and to develop their critical thinking and lifelong learning skills. In addition, problem based learning has a positive effect on students' creativity.

Renzulli's *enrichment triad model* (Reis & Renzulli, 1994) focuses on three types of activities: General exploratory activities, group training activities and individual and small group investigation of real problems. General exploratory activities are designed to help students come across new and exciting disciplines that are not included in the curriculum, art forms, occupations, hobbies, people, places and experiences.

One subject domain that involves various disciplines - especially science and mathematics is environmental education. Problems concerned with environmental issues are relevant to our daily lives and solutions of such problems require using information and skills related to multiple subject domains. Even though teachers think students easily understand topics related to environmental problems, many researchers (Boyes, Chuckran & Stanisstreet, 1993; Bozkurt, Cansüngü (Koray), 2002; Grotzer & Basca, 2003; Rye, Ruba & Wiesenmayer, 1997) report that children from different age groups have misconceptions about subject matters related to the environment. Gifted students, on the contrary, can be oversensitive about environmental problems such as endangered species, decreasing energy supplies and pollution (Davis & Rimm, 2004). Clark (1997) states that gifted students are very sensitive towards world problems and they are capable of generating various solutions.

According to Dewey, quality of learning is determined by learning environments involving experiences rather than subject areas. Many studies report that, with the help of observations and discoveries made in natural environments, students can better perceive nature (Aaron, 2009; Erentay & Erdoğan, 2012; Köşker, 2013; Şimşekli, 2010; Yardımcı, 2009), increase their knowledge of ecological concepts and processes (Lisowski & Disigner, 1991; Ratcfille, 2007), become more aware of the environment and act responsibly (Brock, 2010; Burgess & Smith, 2011; Erdoğan, 2011; Howe & Disinger, 1988 as cited in Erentay & Erdoğan, 2012; Özdemir, 2010).

Considering the interest of gifted children in science, nature, and the environment and their educational needs, the aim of this study is to introduce an interdisciplinary nature education program (INEP) developed for gifted students. The rationale for working with these students is that there are the limited amount of studies related to the science and nature education of gifted children, in particular at the primary school level. According to many researchers (Silverman, 1993; Smutny & Von Fremd, 2004; Gould, Weeks, & Evans, 2003; Karnes & Riley, 2005; VanTassel-Baska & Stambaug, 2006) gifted children are usually sensitive about environmental issues and they have creative problem solving skills. Another aim of the study was to examine the effect of the program on students' environmental literacy.

This program has a problem based approach and is enriched by using general exploratory activities and associating various disciplines such as science, mathematics and art with nature. The entire program took place in a botanical garden. Botanical gardens are natural life and learning environments that are designed to reflect relations between groups of plants. With the help of INEP gifted students found the opportunity to discover nature and got involved in interdisciplinary activities led by educators from different fields for five days in a botanical garden containing the biggest collection of plants endemic to Turkey.

In accordance with the aims stated above, the following research questions are posed:

1) Is there a significant difference in gifted primary school students' environmental literacy scores before and after they have parcitipated the interdisciplinary nature education program?
2) What are gifted primary school students' views about the interdisciplinary nature education program and activities?

METHOD

In order to measure the effectiveness of the program and student performances quantitative and qualitative data were collected. The mixed method is applied in the research (Creswell, 2014). Quantitative data were analyzed using a single group pretest-posttest design to see whether the program had an effect on students' environmental literacy. In this experimental

method, *interdisciplinary nature education program-INEP* is the independent variable whose effect was tested on the study group dependent variables of the study are *environmental knowledge*, *affective disposition towards the environment* and *responsible environmental behavior*. In addition, qualitative data obtained from student workbooks, observations, and interviews were analyzed to better understand the strengths and weaknesses of the program.

Participants

The target population of this study consists of students who are officially diagnosed as gifted (by authorized centers in Turkey called the Guidance Research Centers).

Participants were voluntary 20 primary school students (10 girls, 10 boys), aged between 7 and 10. Wisc-R (Wechsler Intelligence Scale for Children) scores of the participants range from 130 to 160. 70% of the participating students were from state schools while remaining 30% came from private schools. Age distribution of students is given in Table 1.

Table 1. *Age distribution of participants*

Age	Female	Male	Total
	f	*f*	
7	1	1	2
8	5	2	7
9	4	5	9
10	0	2	2
Total	**10**	**10**	**20**

Before the program, a meeting was held with the parents of the participating students where the program was introduced and written consents of the parents were collected. They also filled in health information forms. During the program, transportation and food services were offered by the municipality which was one of the sponsors of the project. Data collected form children were available ony to the researchers.

Data Collection

The program took place between 10:00 and 16:00 each day, including two breaks for lunch and snacks. First, two days were spent on games and activities aiming to introduce various plants in the botanical garden. Third day creative problem solving activities and art workshop was carried out. Next day was mathematics day and students participated in activities and played games related to mathematics in nature. Last day of the program consisted of activities that combine music and physics such as the formation of sound and rhythm experiments. Empathy and drama activities also took place that day. There was a small ceremony at the end of the last day, where everything that the students did throughout the program was shared with their parents and students were awarded a certificate of participation. Details of the program are given in the appendix.

Pre-tests were conducted a couple of days before the program. Data were collected throughout the program via student workbooks, observations and interviews. Post tests and program evaluation form were conducted last day of the program before the closing ceremony.

Instruments

Quantitvative data related to the environmental literacy of the participants were collected via Elementary School Environmental Literacy Instrument (ESELI). This instrument was developed for primary school children by Erdoğan (2009). Evidences of validity and reliability for this instrument were established by Erdoğan (2009) and it includes the following parts:

1) *The Test for Environmental Knowledge (TEK):* Consists of 19 four alternativmultiple-choice items and 3 true-false items about knowledge on the ecology and natural history, knowledge on environmental problems and issues, and socio-political-economic knowledge.

2) *Affective Disposition toward Environment Scale (ADTES):* This scale contains 14 four point Likert-type items measuring students' sensitivity, attitudes, the locus of control, responsibility and willingness to participate in environmental problems solving.

3) *Children Responsible Environmental Behavior Scale [CREBS]:* This scale asks students to indicate how many times they demonstrated the given behavior in last one year. The response choices for the items range from never (0 times) to more than five times. Items are related to behaviors such as eco-management action, economic and consumer action, individual and public persuasion, and political action.

Reliability coefficients reported in Erdoğan (2009) and coefficients calculated for pre and post tests in this study are given in Table 2 below:

Table 2. *Reliability coefficients for each part of ESELI*

Part	Reliability reported in the original study	Coefficient alpha (pretest)	Coefficient alpha (posttest)
TEK	.69	.65	.51
ADTES	.78	.85	.68
CREBS	.89	.87	.89

Qualitative data were collected from workbooks, observation forms, program evaluation forms and interviews. A workbook was prepared for each participating student where activities were explained one by one; the purpose and topic of each activity were indicated, the materials needed were listed. The workbook also included readiness questions for each activity, places for students to write their findings and comments, and evaluation questions after each activity. With the help of these books, information on student views, experiences and knowledge related to the activities were collected and evaluated as a part of data analysis.

Workbooks also contain ecological diaries. At the end of each day during the program, students wrote about their feelings, thoughts and experiences related to the activities carried out or other events that have occurred that day. They also used drawings to express themselves. Sometimes they shared their thoughts, and feelings about a plant or animal they had discovered in the garden.

Observation forms were prepared by researchers. Expert opinion for content validity was taken from a faculty member working in the field of gifted education. Throughout the program, five pre-service teachers majoring in gifted education observed the students and filled in these observation forms. Each pre-service teacher was responsible for four students. While obseving the students, they focused on the following points: (i) How students deal with problems they face while working on the activities, (ii) what type of questions they ask, (iii) how they carry out investigations, and (iv) how they interact with others.

Student views about the program were collected via program evaluation form and semi-structured interviews, where students were asked what they think about the activities and the program in general.

Data Analysis

Quantitative data were analyzed to see whether there were any significance differences in students' environmental literacy. Initially, Shapiro-Wilks analysis for normality was conducted for each component of ESELI. Results revealed that normal distribution can be assumed for pre and post tests of TEK (pretest: $W = .95$, $p = .368$ and posttest: $W = .93$, $p = .173$) and of CREBS (pretest: $W = .93$, $p = .129$ and posttest: $W = .91$, $p = .057$). Therefore dependent samples t-test was conducted to compare mean scores of pre and post tests of these components. For ADTES, Shapiro-Wilks test showed that pretest ($W = .89$, $p = .027$) and posttest ($W = .90$, $p = .050$) scores were not normally distributed, therefore parametric tests could not be used. In order to see whether there is a significant difference between mean scores, the Wilcoxon signed rank test was used for this component. Data analysis was carried out using SPSS program and level of significance was chosen as $\alpha = .05$.

Content analysis was carried out on qualitative data. An ID number was assigned to each participant and these ID numbers were used during analysis. Two researchers coded the data independently. Both researchers examined data collected from the workbooks, interviews and the program evaluation form independently and took notes. The second round of evaluations was done to reveal repetitions, similarities, and differences. In the end, categories emerged reflecting student views. Researchers independently formed quantitative charts based on these categories. Then these charts were compared by counting the number of agreements and disagreements. Reliability was established with the Miles and Huberman formula: Reliability = (number of agreements) / (number of agreements + number of disagreements). Formula revealed that researchers were in agreement 85% of the time.

Participants' quotes given in the results section are identified using symbols $n(B/G)_x$ where "n" represents participants' grade, "B" or "G" their gender and "x" their ID number. For example, "$5G_{12}$" means "fifth grade girl with ID number 12".

RESULTS

Environmental Literacy

In order to see whether the program had any effects on students' environmental literacy, pretest and posttest results of ESELI were compared. Table 3 shows mean and standard deviations of pre and posttests and significance values for environmental knowledge (TEK), affective disposition towards environment (ADTES) and responsible environmental behavior (CREBS) scales. As seen in Table 3, mean scores increased for all scales.

Table 3. *Means, Standard Deviations and Significance Levels for Pre and Posttests*

N=20	**PreTest**		**PostTest**		**Significance**
Scales	*M*	*SD*	*M*	*SD*	*p*
TEK	14.80	3.19	17.65	2.19	.000*
ADTES	49.00	6.38	52.90	2.81	.013*
CREBS	78.10	26.04	88.65	29.52	.077

*p < .05

Dependent samples t-test was conducted for TEK and it was concluded that posttest mean score for this scale is significantly higher than mean score of the pretest ($t(19) = 4.69$, $p < .001$); indicating that students' environmental knowledge increased after the program.

In order to see whether there is a significant difference between mean scores of ADTES, the Wilcoxon signed rank test was used and the significant difference was observed as a result ($Z = -2.49$, $p = .013$). It can be concluded that the program had a positive effect on students' affective disposition towards the environment.

To compare mean scores of CREBS, dependent samples t-test was used and it was seen that there were no significant differences between pretest and posttest means ($t(19) = 1.87$, $p = .077$), even though the scores for posttest were higher (see Table 4). In this scale, students responded to the question "how many times did you …. in the recent year" for various behaviors.

Program Activities

Data collected regarding each activitiy were analyzed separately. Due to space restrictions findings for two of activities are given in detail below. Summary of the findings related to the rest of the activities are also reported in this section.

Nature games and discovering the botanical garden

Under the guidance of garden experts, students toured sections of the botanical garden where different species of plants are cultivated. Observation records show that, even though they were really tired, students were very excited about discovering new things. Data collected by

student workbooks and interviews are classified as feelings, observations and new information, as seen in Table 4.

Table 4. *Classification of Student Views Related to Botanical Garden Activities*

Feelings	***f***	**Observations**	***f***	**New Information**	***f***
It was very interesting to me that water lilies and frogs live in the pond benefiting from each other	4	I collected samples of different types of stones, leaves and seeds from the garden	17	I learned about different kinds of trees	15
I felt as if I was in the Black Sea region while we were touring the Black Sea section in the garden	4	I have observed that the cone of turpentine tree is different from other pine cones	12	I learned that different types of plants are cultivated in different sections of the botanical garden	15
It was very interesting to me that cherry laurel (*Prunuslaurocerasus*) plant grows sideways when you keep cutting it from it from the top	3	I examined the leaves of every tree I saw with magnifying glass	7	I learned that each tree has distinct properties	12
		I saw the tallest (type of) tree in the world	5	I learned that plants have similar and different properties	8
				I learned that some trees grow faster than others	7

Students toured the whole garden. Trees that are most remembered are as follows: sequoia, ginko biloba, turpentine, eucalyptus, Japanese cherry (prunusserrulata), linden, cherry laurel and bead tree (melia azedarach). Sections of the garden students remember most include hedge garden, cacti and succulent garden, rock garden, and dry and halophytic garden. Interviews indicate that sequoia, ginko biloba and eucalyptus trees were the most interesting for the students because of their distinct properties and the stories told about these trees during the garden tour made them more memorable. Specifically, a koala bear puppet was used during the introduction of eucalyptus tree. Mentioning the daily products obtained from these trees also increased retention.

Students stated that they had to move fast and work as a team while looking for hidden clues in the garden and they were very happy when they figured out the answer. In the plant identification game, they learned why identifying plants are important. As a part of the game, students worked in teams trying to match the leaves they are given with the trees they belonged to. While some students followed the rules of the game and easily completed the task, others found different methods to determine the tree. It was also observed that students examined other trees and leaves in the garden while searching for their targeted tree.

Creative problem solving workshop

In this workshop, students used six hats thinking the method to discuss an environmental problem about the construction of hydroelectric power plants in Turkey. Students worked in teams and tried to come up with alternative solutions to this problem. Data was collected via student workbooks and interviews conducted with students during and after the workshop session.

At the beginning of the session, students were asked preliminary questions related to their existing knowledge about the power plants and their opinions about their construction. Results indicate that nearly half of the students did not know anything about hydroelectric power plants; they defined hydroelectric power plants as machines that convert electricity, plants that give us electricity, and plants that produce electricity from sun, water, and wind.

After an introduction of these power plants, creative problem solving session was conducted in 6 stages (identifying the general problem area, collecting data, finding the problem, finding ideas, finding solutions and finding validation). Data collected from the students were

divided into three categories: energy sources (that students know), advantages of hydroelectric power plants and disadvantages of hydroelectric power plants, as seen in Table 5.

Table 5. *Data Related to "Identifying the General Problem Solving Area" Stage*

Energy Sources	f	Advantages of Hydroelectric Power Plants	f	Disadvantages of Hydroelectric Power Plants	f
Wind	16	Produce energy	10	Natural beauties are destroyed	12
Sun	15	Produce electricity	10		
Coal	13	Facilitate fishery	8	Animals and other living organisms cannot reproduce and they disappear	8
Water	10	Help irrigation	7		
Petrol	9	Economic value	5		
Hydroelectric p.p	8	Tourism	4	Historical artefacts are destroyed	7
Natural gas	7	Transportation	3		
Waves	6	Prevent floods and overflows	3	Trees are being cut	6
Garbage	6			Some animal species face the danger of extinction	8
Nuclear	5	Help economical use	2		
Animal Waste	4	Longevity	2	Cause fertile soil loss	5
Vegetative Waste	3				
Geothermal	3				
Biomass	3				
Renewable energy	1				

Examination of views presented in Table 5 reveals that students emphasize natural sources such as wind, sun, and water among sources of energy. In addition, while analyzing the advantages and disadvantages of hydroelectric power plants, students consider the gains and losses for humans and nature. Solutions proposed by students for minimizing the damages that hydroelectric power plants cause are as follows:

- Protecting the trees and afforestation (not cutting the trees, forming new forests, planting trees instead of making buildings, relocating the trees in coordination with TEMA -The Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats)
- Protecting natural sources
- Protecting or relocating historical artefacts
- Using filters in hydroelectric power plants to prevent damage to nature
- Supporting local people who are involved in agriculture
- Encouraging public to use electricity economically instead of building hydroelectric power plants

Art workshop

The aim of this workshop is to integrate nature with art. Students first drew pictures of objects they saw and examined in the garden such as plants, trees, seeds, leaves and bird feathers. Then, using these drawings, they made three-dimensional models of the objects with clay. In another activity, students discovered the texture of various objects they saw in nature, by painting them with crayons. Under the guidance of art educators, students observed nature and using their imagination, transformed these observations into art via observational drawing, frottage, sculpturing, interpreting, and synthesis.

According to observation records and student interviews; some students were hesitant to participate at the beginning of the workshop, claiming that they cannot draw pictures. But later they decided to give it a try as they watched their friends work and enjoyed themselves. Another finding was that the workshop enabled students to look at objects in nature from different angles, use light and shade, transform a two-dimensional drawing into a three-dimensional object.

Mathematics Workshop

Before the workshop began students answered open ended questions about their thoughts related to mathematics lessons in their schools and the relationship between nature and mathematics. Responses revealed that all students have positive attitudes towards mathematics. Most students stated they enjoyed doing mathematics. Their responses, related to the relationship between nature and mathematics, indicate that students considered mathematics as a tool to understand nature. Only a few of them stated that there is mathematics in natural events and behaviors of plants and animals. In the first activity, students were asked to find the number of leaves on two different types of tree. Students worked in teams and developed methods for calculating the number of leaves. Method students agreed on was to first find the numbers on a branch and count the number of branches. Branches were divided into groups such main branches and thin branches.

In the cryptography activity, students used simple ciphering methods to cipher keywords about mathematics in nature they had generated. They were also asked how they would develop their own ciphering system. Commonly suggested systems include matching each letter of the alphabet with a shape and assigning numbers to represent letters.

As the third activity, students played the labyrinth game in teams. They were asked to find the shortest way to pass through rectangle grids as they stopped at some points to pick up clues. Clues were words ciphered by the opponent team related to themes of mathematics in nature. Teams designed their own labyrinths by deciding the locations of the clues. It was observed during the game that all teams were successful in locating clues so that the opponents would have to pass through a longer path. They also deciphered the clues and found the underlying theme quickly.

Physics meets music workshop

Students discovered how sound is formed and how it travels with the help of experiments and rhythm exercises. Data collected from students via interviews revealed that prior to attending this workshop; students defined sound as a topic learned in science class. After taking part in the activities integrating physics and music in a natural environment, students were able to explain how sound is formed in detail by giving examples from nature.

Drama workshop

Students carried out empathy exercises using scenarios related to environmental problems and made suggestions for possible solutions. The theme of the play students took part in was about the effects of natural disasters such as forest fires, global warming and sea pollution on humans. Interviews with students suggest that they had a better understanding of environmental problems with the help of empathy exercises. It was observed that, since students were able to experience the effects of natural problems on humans, they were able to relate science topics with daily life more easily.

Student views about the program

Analysis of observations, interviews and program evaluation form revealed that the students participated effectively in all activities, they were more comfortable in a natural environment, asked more questions, formed relationships with each other while playing nature games, and worked in cooperation with their friends. It was observed that they started giving examples from nature during activities and keep talking about preserving trees and endemic species even during breaks.

Students indicated that they were excited to be discovering nature, it was a novel experience for them and they had a lot of fun. Some examples of student views are given below:

> $5B_{12}$: "We've learned a lot of subjects in the botanical garden. I would never be bored at school if the lessons were given outside of the school. We played a spectacular leaf-finding game on the island. I learned that the iridescent plant is an endemic species and I saw it in the garden. Some of the activities were difficult for me, sometimes I thought what we were doing was strange but we had the most fun."

$4B_2$: "I never imagined that we would do such a lessons in a botanical garden, learn while having fun. I have gained so much experience here, I loved it very much."

$4G_{19}$: "I had new friends. The islands of the botanical garden were very nice. We discovered new trees. We worked about hydroelectric power plant (HPP), tried to solve problems. The game of counting the leaves in the trees was very controversial. I have a desire: I wish the classes in our school could be in such a natural environmet. I wish…"

$2B_{15}$: "We enjoyed having fun playing in the nature. Previously I knew the names of the trees, but I did not know life cycle of the trees. I saw their living form in the botanical garden. I saw the eucalyptus tree here for the first time. I was very interested in hydroelectric power plant problems. I can easily ask questions on topics I am curious about. Being in the nature is exactly for me. "

$5G_{18}$: "We were painting our cloth bag with natural vegetables and fruits. We explored a lot of trees. I've been reminded of the trees, traveled the islands. I'm very happy to learn new ideas about electric energies. I was interested in cryptography game and the sound experiment activities. We had a rhythm with our hands, we had a lot of fun in the drama. Every day was full here, we were very happy with my friends."

$4B_1$ "I want to stay here more and more. I do not want to leave. I was worried about bee sting, but I have learned a lot about the bees. I wish we did all our lessons here, I had a lot of fun."

DISCUSSION and CONCLUSION

The aim of this study was to introduce an interdisciplinary nature education program for gifted students in order to help them relate issues about nature with mathematics, science and various forms of art. The program followed enrichment approach by using general exploratory activities. These activities were designed in a way that students could experience things that are not provided by the normal curriculum; such as getting involved with new and exciting disciplines, subjects, events and hobbies, meeting people and entering new environments (Renzulli & Reis, 1985).

Researchers state that observations and discoveries made in natural settings help students develop their awareness and responsible behaviors towards the environment (Brock, 2010; Burgess & Smith, 2011; Erdoğan, 2011; Özdemir, 2010). Findings of this study indicate that students' environmental knowledge and their affective disposition towards the environment improved significantly after the program. Students had the chance to discover various species of plants and trees in the botanical garden and were exposed to new information related with nature in each activity. They also had the opportunity, especially during creative problem solving activity and emphaty excercises carried out in drama workshop, to think about environmental issues and endangered species, and discuss possible solutions to environmental problems.

There was also an increase in students' responsible environmental behavior, however it was not significant. Since the students responded to the question "how many times did you …. in the recent year" for various behaviors in this scale, a period of one week was probably not enough for observing a signigifacnt increase in the frequency of these behaviors. However, it was observed during the acitvities that students followed the rules of the bothanical garden and were very sensitive about not causing any harm to the plants and their surroundings.

It is in children's nature to be active and curious; they learn by making discoveries while they are playing games and having fun. Children, have high interest towards nature (Bonnett & Williams, 2006; Ozaner, 2004), especially gifted children (Watters, James J and Diezmann, Carmel M, 2003). Studies suggest that they usually talk about plants and animals (Burgess & Smith, 2011; Köşker, 2013; Yardımcı, 2009), giving more emphasis on plants (Köşker, 2013; Yardımcı, 2009). INEP provided participants the opportunity to closely examine different species of plants and trees in the botanical garden. Findings related to exploratory games reveal that students examined the trees with deep interest. Furthermore, the in activity of counting leaves, students

developed various methods where they combined their acquired knowledge about the tree with mathematics.

Keeping alive students' curiosity, enthusiasm for discovery and willingness to learn is a tough challenge for many educators. Teacher observations and data collected from students revealed important developments in this regard. The fact that this program was implemented entirely in a botanical garden, a natural environment ready to be explored, rather than a classroom is considered as one of the reasons why it was possible to arouse students curiosity and enthusiasm. Ramey- Gassert (1997) state that out of school learning environments increase willingness to learn and improve motivation for and attitudes towards learning. Such environments have positive effects on meaningful learning, both cognitively and affectively (Anderson, Lucas, & Ginns, 2003; Griffin, 2004; Melber & Abraham, 1999). One of the notable points observed in student views is their gratitiude for taking part in activities in an out of school, natural setting.

The interdisciplinary learning environment provided by the program is thought to be another cause of these improvements observed in the students. Many researchers emphasize that gifted students have the deep interest in science and understanding nature (Gould, Weeks and Evans 2003, 2005; Stepanek, 1999; Halkitis, 1990; Sisk, 2007; VanTassel-Baska, & Stambaugh, 2006). In addition, when it is considered that one of the most distinct characteristics of gifted students is interdisciplinary thinking and the ability to see the cause and affect relationships, it is an expected result that this program, which includes activities appealing to their abilities, was able to stimulate gifted students' curiosity and willingness to learn.

In INEP, nature education was enriched by relating nature with disciplines such as science, mathematics and art. The increase observed in students' environmental literacy and willingness to learn with the help of the enrichment program may cause improvements in their ability to make meaningful connections between events, solve problems and think creatively. Students participated in the program were able to comprehend nature as a whole and important improvements were observed in the way they connect aspects of nature with art, sicence and mathematics. Therefore, it is hoped that this study will contribute to development of other interdisciplinary programs carried out in natural settings.

This program took place in an easily accessible botanical garden in a metropolitan city, which is visited by schools frequently. Therefore it is a convenient and good alternative as an out of school environment. However, if programs such as INEP can be carried out in completely natural settings, they could be even more effective.

Duration of INEP was 30 hours which was packed in 5 days and students participated in many different and intense activities each day. Longer programs can be planned to so that the students can have more time to reflect on what they are doing. In addition, more disciplines such as engineering or architecture can be included in the program. INEP activities can easily be adapted for different age groups.

REFERENCES

Aaron, F. R. (2009). *Planting A Seed: An Examination of Nature Perception, Program Processes, and Outdoor Experience* (Unpublished doctoral thesis). Office of Graduate Studies of Texas A&M University.

Anderson, D., Lucas K. B., & Ginns, I. S. (2003). Theoretical perspectives on learning in an informal setting. *Journal of Research in Science Teaching 40*(2), 177-199. doi:10.1002/tea.10071

Bonnett, M., & Williams, J. (2006). Environmental education and primary children's attitudes towards nature and the environment. *Cambridge Journal of Education, 28*(2), 159-174. doi:10.1080/0305764980280202

Bozkurt, O., & Cansüngü (Koray), Ö. (2002). İlköğretim öğrencilerinin çevre eğitiminde sera etkisi ile ilgili kavram yanılgıları (Elementary school students' misconceptions regarding greenhouse effect in environmental education). *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 23*, 67-73.

Boyes, E., Chuckran, D., & Stanisstreet, M. (1993). How do high school students perceive global climate change: What are its manifestations? What are its origins? What corrective action can be taken?

Journal of Science Education and Technology, 2(4), 541-557. doi: 10.1007/BF00695323

Brock, R. J. (2010). *Exploring the Development of Fourth Grader's Environmental Identity Trough Participation in a Semi – Formal Nature Club* (Unpublished doctoral thesis). The Graduate School University of Nevada.

Burgess, J., & Smith, M. J. (2011). Listening to children: Perceptions of nature. *Journal of Natural History Education and Experience, 5*, 27-43.

Clark, B. (1997). *Growing up gifted: Developing the potential of children at school and at home* (5th edition). Ohio: Pearson.

Creswell, J. W. (2014). *Research design : Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). Sage Publications.

Davis, G. A., & Rimm, S. B. (2004). Enrichment and grouping. In G. A. Davis & S. B. Rimm (Eds.) *Education of the gifted and talented* (5th edition). Boston, MA: Pearson Education.

Erdoğan, M. (2009). *Fifth Grade Students' Environmental Literacy and The Factors Affecting Students' Environmentally Responsible Behaviors* (Unpublished doctoral thesis), Middle East Technical University, Ankara.

Erdoğan, M. (2011). The effects of ecology - based summer nature education program on primary school students' environmental knowledge, environmental affect and responsible environmental behavior. *Educational Sciences: Theory and Practice*, *11*(4), 2233 – 2237.

Erentay, N., & Erdoğan, M. (2012). *22 Adımda Doğa Eğitimi*. Ankara: ODTÜ

Griffin, J. (2004), Research on Students and Museums: Looking more closely at the students in school groups. *Science Education*, 88: S59–S70. doi:10.1002/sce.20018

Gould, J. C., Weeks, V., & Evans, S. (2003). Science starts early. *Gifted Child Today, 26*(3), 38-42. doi:10.4219/gct-2003-102

Gould, J. C., Weeks, V., & Evans, S. (2005). Science starts early: A program for developing talent in science. S. K. Johnsen ve J. Kendrick (Ed.), Science education for gifted students: 3-11. Texas: Prufrock Press.

Grotzer, T.A., & Basca, B. B. (2003). How does grasping the underlying causal structures of ecosystems impact students' understanding? *Journal of Biological Education, 38*(1), 16-29. doi: 10.1080/00219266.2003.9655891

Halkitis, P. N. (1990). A model for elementary school gifted science education. *Gifted Child Today*, 13(4), 12-16.

Karnes, F. A., & Riley, T. L. (2005). Developing an early passion for science through competitions. In S.K. Johnsen & J. Kendrick (Eds.), *Science education for gifted students*. Texas: Prufrock Press.

Kopelman, M., Galasso, V. G., & Strom, P. (1977). A model program for the development of creativity in science. *Gifted Child Quarterly, 21*(1), 80-84. doi:10.1177/001698627702100113

Köşker, N. (2013). İlkokul öğrencileri ve sınıf öğretmeni adaylarının doğaya ilişkin algıları ve sorumluluklarına yönelik düşünceleri (primary school students' and prospective primary school teachers' perceptions of nature and thoughts of their responsibilities towards the nature). *International Periodical for the Languages, Literature and History of Turkish or Turkic, 8*(3), 341-355. doi:10.7827/TurkishStudies.4037

Lisowski, M., & Disinger J. F. (1991). The Effect of Field Based Instruction on Student Understandings of Ecological Concepts. *Journal of Environmental Education, 23*(1), 19-23. doi: 10.1080/00958964.1991.9943065

Lind, K. K., (2005). *Exploring science in early childhood: A developmental approach.* Thomson Delmar Learning, Clifton Park, NY, USA.

Meador, K. S. (2003). Thinking creatively about science: Suggestions for primary teachers. *Gifted Child Today, 26*(1), 25-29. doi:10.4219/gct-2003-93

Melber, L. H., & Abraham, L. M. (1999). Beyond the classroom: Linking with informal education. *Science Activities, 36*, 3-4. doi:10.1080/00368129909601027

Ngoi, M., & Voldracek, M. (2004). Working with gifted science students in a public high school environment:

one school's approach. *Journal of secondary gifted education, 15*(4), 141-147. doi: 10.4219/jsge-2004-459

NGBB (2013). Nezahat Gökyiğit Botanik Bahçesi (Nezahat Gökyiğit Botanical Garden). www.ngbb.org.tr

Nuhoğlu, H. (2012). Fen öğretiminde okul dışı öğrenme ortamları. Laçin Şimşek C. (ed.). *Botanik bahçeleri*. Ankara: Pegem Akademi.

Özdemir O. (2010). Doğa deneyimine dayalı çevre eğitiminin ilköğretim öğrencilerinin çevrelerine yönelik algı ve davranışlarına etkisi (The effects of nature-based environmental education on environmental perception and behavior of primary school students), *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 27,* 125-138.

Ramey- Gassert, L. (1997). Learning science beyond the classroom. *The elementary school journal 97*(4), 433-450. http://www.jstor.org/stable/1002356

Ratcfille, M. M. (2007). *Garden Based Education in School Settings: The Effects of Children's Vegatable Consumption, Vegatable Preferences and Ecoliteracy*, (Unpublished doctoral thesis). Friedman School of Nutrition Science and Policy, Tufts University.

Renzulli, J. S., & Reis, S. M. (1985). *The schoolwide enrichment model: A comprehensive plan for educational excellence.* Mansfield Center, CT: Creative Learning Press.

Reis, S. M., & Renzulli, J. S. (1994). Research related to the schoolwide enrichment triad model. *Gifted Child Quarterly, 38*(1).7-20. doi:10.1177/026142940301800104

Rye J. ,Rubba, R., & Wiesenmayer , R. (1997) . An investigation of middle school students' alternative conceptions of global warming *International Journal of Science Education, 19*(5), 527-551. doi: 10.1080/0950069970190503

Shiever, S. W., & Maker, C. J. (2003). New directions in enrichment and acceleration. In N. Colangelo & G. Davis (Eds.). *Handbook of gifted education* (3rd edition). Boston: Pearson Education.

Silverman, L. K. (Ed.). (1993). *Counseling gifted & talented.* Denver: Love Publishing Company.

Sisk, D. (2007). Differentiation for effective instruction in science. *Gifted Education International*, 23, 32-45.

Smutny, J., &, Von Fremd, S. E. (2004). *Differentiating for the young child*. Thousand Oaks: Corwin Press.

Stepanek, J. (1999). *Meeting the needs of gifted students: Differentiating mathematics and science instruction*. Portland, Oregon: Northwest Regional Educational Laboratory.

Şimşekli, Y. (2010). The original activities for environmental education and their effects on students (a case study in Bursa). *Elementary Education Online, 9*(2), 552-560. [Online]: http://ilkogretim-online.org.tr

Tomlinson, C. A., (2000). Reconcilable differences: Standards-based teaching and differentiation. *Educational leadership*. 58(1), 6-11.

VanTassel-Baska, J. (1998). Characteristics and needs of talented learners. In J. VanTassel-Baska (Ed.), *Excellence in educating gifted and talented learners* (3rd edition). Denver, CO: Love Publishing.

VanTassel-Baska, J. (2002). Theory and research on curriculum development for gifted. In K. A. Heller, F. J. Mönks, R. J. Sternberg, & R. F. Subotnik (Eds.), *International handbook of giftedness a talent*. Oxford, UK: Pergamon Press.

VanTassel-Baska, J., & Stambaugh, T. (2006). *Comprehensive curriculum for gifted learners*. Boston, MA: Pearson Education.

Watters, J. J. (2004). In pursuit of excellence in science. *Australasian Journal of Gifted Education*, *13*(2), 41-53.

Watters, James J and Diezmann, Carmel M (2003) The gifted student in science: Fulfilling potential.

Australian Science Teachers Journal 49(3):46-53.

Yardımcı, E. (2009). *Yaz Bilim Kampında Yapılan Etkinlik Temelli Doğa Eğitiminin İlköğretim 4 ve 5.Sınıftaki Çocukların Doğa Algılarına Etkisi* (Unpublished master's thesis). Abant İzzet Baysal University, Institute of Social Sciences.

APPENDIX: INEP SCHEDULE and ACTIVITIES

INEP took place in Nezahat Gökyiğit Botanical Garden, which was built as a result of a social movement aiming to promote and protect the vitally important biodiversity, specifically plant diversity, initiated by Ali Nihat Gökyiğit Foundation (NGBB, 2013). This botanical garden, located in the middle of a metropolitan city such as Istanbul, is one of the most important out-of-school learning environments with its live plant collection and educational and scientific activities (Nuhoğlu, 2012). Activities are briefly explained below. As an example of how the activities were designed considering the needs of gifted students, one of the workshops is explained in detail. Schedule of the program is given in Table 6.

Table 6. *INEP activity schedule*

Day	Activity Number	Name of Activity
Monday	1	"Gelin Tanış Olalım İşi Kolay Kılalım": First meeting activity
	2	Let's get to know our project
	3	Why is nature education important?
	4	My project Bag: Design Activity
	5	Lunch
	6	NGBB tour: What is in nature?
	7	Snack
	8	What did I do today? My ecological diary
Tuesday	9	Plant identification workshop
	10	Lunch
	11	Discovering NGBB botanical garden
	12	SnackSnack
	13	What did I do today? My ecological diary
Wednesday	14	Creative problem solving using
	15	Lunch
	16	Art Workshop: Transformations
	17	Snack
	18	What did I do today? My ecological diary
Thursday	19	Can you count the number of leaves on a tree?
	20	Mathematics of nature and criptology
	21	Lunch
	22	Game: Build your own maze
	23	Snack
	24	What did I do today? My ecological diary
Friday	25	Physics workshop:Transmission of sound
	26	Physics workshop: High and low pitch sound
	27	Physics workshop: Talking rope
	28	Physics workshop: Does sound travel in water?
	29	Music workshop: Orchestra of sounds of nature
	30	Music workshop: Perception of rhythm with souns of nature
	31	Music workshop: Nature gives me a healty diet-I am making a rhythm salad
	32	Music workshop: Dance of wolves and butterfiles
	33	Lunch
	34	I am a living organism: Emphathy exercise
	35	Parks are for chindren to play
	36	Knowledge competition
	37	What did I do today? My ecological diary
	34	Preperations for the closing ceremony
	35	Student presentations and closing ceremony

Content of the Program

*Exploration of the botanical garden***:** Students toured the huge botanical garden under the guidance of the educators and learned about various species of plants, specifically endemic plants of Turkey.
*Nature games***:** Students played two games, named "discovering the garden" and "what is in nature?" working as teams. In both games, students learned about needs of plants living in different habitats by doing observations. Another game, each team was given a leaf and asked to find which kind of tree it belongs to, using various leads.

Workshops

*Art***:** Students transformed their knowledge and experience of nature into two and three dimensional crafts using the key elements of plastic arts.
*Music meets physics***:** Students made their own compositions with the help of rhythm exercises and using their knowledge and experiences related to nature. Discussions were carried out about the underlying physical events that lead to the formation of rhythms. In addition, students found out how different musical instruments produce different sounds by conducting experiments about the formation and speed of sound, and the factors that affect the speed of sound.
*Drama and empathy***:** In this workshop, students acted as various plants and animals living in a forest, and staged an improvised play based on how they would react in the case of a forest fire. They shared their feelings and thoughts via creative drama activities related to solving an environmental problem.
*Creative problem solving***:** Six hats thinking method was used to solve a problem about the environmental issues related to building hydroelectric power plants in Turkey. Students discussed these issues and tried to come up with alternative solutions for this problem.

Mathematics workshop

The mathematics workshop lasted one whole day and consisted of interrelated activities. As an introduction, whole group discussion was carried out about the relationship between nature and mathematics. Most students gave examples about using mathematics as a tool to understand nature. Only a few of them stated that there is mathematics in natural events and behaviors of plants and animals. With the guidance of the instructor, mathematical structures observed in nature were discussed under four themes: symmetry, patterns, fractals and spirals. For each theme, students found examples from nature. Students were asked to note down the new terms and words they have learned.

In the first activity students were asked to find the number of leaves on two different types of trees that were introduced in the previous activities. Students worked in teams and developed methods for calculating the number of leaves. Their approximations were then checked by an expert in the botanical garden who informed them about various factors effecting the number of leaves of the trees (their age, how tall they grow each year etc.).

In the cryptography activity some basic methods of cryptography were introduced to students. These methods involve matching each letter of the alphabet with another letter. Each group was given one of the previously discussed themes and asked to generate words related to their themes. Then students used the one of the methods they learned to cipher these words. These ciphered words were then used as clues in the labyrinth game. In this activity, students were also asked how they would develop their own ciphering system.

As the third activity, students played the labyrinth game in teams. They were asked to find the shortest way to pass through rectangle grids as they stopped at some points to pick up clues. Clues were words ciphered by the opponent team related to themes of mathematics in nature. Teams designed their own labyrinths by deciding the locations of the clues.

As a closure of the workshop, each group was given the same set of objects and pictures related to the four themes. They chose the materials related to their own themes and prepared posters using these materials.

These activities were enriched in various ways. Problem solving approach was used in all activities and students worked in groups. Branches of mathematics such as cryptography and

fractals that are not included in primary school curriculum were introduced. Methods used in cryptography activity are based on the idea of functions (one to one correspondence) and inverse functions which is included in the high school curriculum. Symmetry and patterns were concepts students were familiar with and they had the chance to connect their existing knowledge with real life. The relationship between mathematics and nature were roughly divided into two categories: Using mathematics as a tool to understand nature and mathematical structures observed in nature. Counting the number of threes was an example of using mathematics as a tool to understand nature and students used their existing procedural knowledge of numerical operations. The other two activities aimed to introduce and mathematical structures observed in nature while at the same time they required students to use their reasoning and decision making skills through complex and multi-layered tasks.