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Cansu Keskin[1], Hakan Akcay[2], Hasan Ozgur Kapici[2]
[1]Ministry of National Education
[2]Yildiz Technical University

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The Effects of Environmental Science e-Projects on Middle School Students' Behaviors and Attitudes

Cansu Keskin, Hakan Akcay, Hasan Ozgur Kapici

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Abstract

Providing individuals with environmental awareness from a young age is very important for a livable and sustainable world. In this context, this study aims to investigate the impacts of the environmental science project, the Water Explorer Program, on middle school students' water usage behaviors, and attitudes. A quasi-experimental research design was used. The participants were 87 (36 girls and 51 boys) eighth-grade students from four different classes in a public school. Whereas the textbook-based instructional approach was used in the control group, the Water Explorer Program was used in the experimental group. Water usage attitudes and water usage behavior scales were administered to the groups at the beginning and end of the study. In addition to pre-post tests, reflection papers were gathered from students in the experimental group. The findings of the study revealed that students in the experimental group developed significantly better water usage behaviors, and attitudes than their counterparts in the control group. Therefore, environmental projects should be involved in science curricula.

Introduction

The advancement and rapid dissemination of science and technology rapidly change the concept of dominating nature. This change leaves the environmental consciousness in the second place and creates a society that produces and consumes as much as possible (Basuhail, 2019; Marpa, 2020; Wallace-Spurgin, 2018; Yılmaz, Morgil, Aktuğ, & Göbekli, 2002). Therefore, there is a need for individuals who are respectful and sensitive to nature. To meet this need, individuals, who are aware of environmental awareness, protection, and sensitivity, should be trained. According to Ilgar (2007), an environmentally sensitive individual can be defined as a human who avoids harming the environment, consciously produces and consciously consumes, is aware of its being a part of this environment and sensitive to environmental problems. Such a human model emerges in cultures that are aware that the environmental problem occurring anywhere in the world affects the whole world equally. Environmental education is very important for the formation of this culture.

Environmental education has a very important place in science education. It is also a must for a sustainable environment. In the 1970s, environmental education was first discussed at a higher education level (Ünal & Dımışkı, 1999). Environmental education aims to make students aware of environmental problems and to act the problems (Alagoz & Akman, 2016; Jensen & Schnack, 2006; Lai, 2018). Tilbury (1995) said that there are three different approaches to environmental education. These are in the environment, about the environment, and for the environment. About the environment is giving environmental knowledge to students. Currently, science education in schools includes the environment group. Education in the environment includes activity-centered training. It is aimed to improve the environmental awareness of the individual through the studies conducted outside the classroom. Applications combined with non-formal education can be given as examples. Lastly, environmental education is a much more comprehensive education. In addition to the other two approaches, education for environment includes individual participation and environmental problem-solving. It is a holistic perspective.

In the current study, the Water Explorer Program that provides knowledge about the environment is used. It enables students to use this information with student-centered applications. It has a part of informal education. It improves empathy ability and gives the message of protecting the resources of the whole world and if it is trouble somewhere in the world this affects all countries (for more information, please visit www.waterexplorer.org). In this respect, the program addresses the "for the environment" which is exactly the desired environmental education.

Theoretical Framework

Many countries in the world want knowledgeable citizens who can make their own decisions. Such citizens are called scientifically literate. There are different definitions of scientific literacy. Common points of all definitions are the ability to use and evidence and data, evaluate the quality of information and discuss presented by mass media and scientists (Dragos, 2015). Yet, one of the major problems for science is that the public does not know very much about science (Haufler & Sunderg, 2009). One of the ways to educate students as scientifically literate individuals, project-based learning can be an efficient solution.

Project-Based Learning

Project-based learning is that students work individually or in groups to reveal concrete products. It is a kind of student-centered teaching method. It can be defined as a mixture of John Dewey's "problem solving" and Wrigley's "the project method" (Oğuzkan, 1989). It consists of four elements. These are extended time frames, collaboration, an investigation or research and a task-based performance or a demonstration (Gültekin, 2009). The project needs time varying between two or three lessons to a whole year of education (Moursund, Bielefeldt, & Underwood, 1997). Students can work as a team. In this way, time can be used effectively. Projects focus on real-world situations (Curtis, 2002). It requires a real-world problem that is related to the students' everyday life. At the end of the project, a presentation, a performance or a product should occur (Moursund, 1999).

Project-based learning has both advantages and disadvantages. For example, it has the potentials to increase student motivation (Solomon, 2003), students are able to be more involved in science education through doing scientific projects and so, they may have a chance to develop high-level skills such as problem-solving, evaluating themselves, being an independent researcher. It also increases collaboration between students who work within a group. Students can learn how they work and produce as a team (Preuss, 2002). Moreover, students can combine mathematics, science, literature and social sciences in project-based learning. On the other side, it also has some limitations. For instance, it is not suitable for all topics. It is difficult to choose a topic for the aims of the curriculum (Krajcik & Soloway, 1997). It also requires more time (Moursund, 1998). The time allocated in the curriculum may not be sufficient for the projects. Besides, the project outputs are difficult to assess for teachers.

Science-Technology-Engineering-Mathematics (STEM)

STEM is an abbreviation of science, technology, engineering, and mathematics and it can be defined as a connection between activities and materials, measuring, and understanding student learning and connection across disciplines (National Research Council, 2014). It can be also defining a design problem, exploring the problem, creating solutions to the problem and artifacts (Krajcik, Blumenfeld, Marx, & Soloway, 1994). In STEM education, in addition to science and engineering knowledge, it is also important to have practice and problem-solving skills. Individuals need to make their own decisions about the problems they face in their daily life. The purpose of STEM education is to enable people to make their own decisions in the light of science. Science and engineering deal with a lot of issues related to people such as health problems and environmental problems. This makes it necessary to know different disciplines. STEM education has emerged as education to meet all these objectives.

Krajcik and Delen (2017) clarify the challenges of incorporating STEM education. Accordingly, a subject and purpose should be determined first. The course layout and plan must be prepared in advance. Solutions should be considered in order to involve and motivate students. Students should be allowed to do more than one experiment. Feedback should be given at every stage and students should be supported (Akturk & Sahin, 2011). It is necessary to ensure that the students base their studies on scientific knowledge. This should be emphasized continuously. Finally, student studies should be evaluated and feedbacks should be given for further studies.

Importance of the Study and Research Questions

Turkey is a country which is rich in water, counting before the year 2000. Today takes place in groups of countries experiencing water shortages. It is estimated that in the next 20 years it will fall into the water-poor countries (Çalık, Ünal, Coştu, & Karataş, 2008). According to the Turkish Waste Report published in March

2017, those who wasted the most water are university graduates and those who save money are primary school graduates (Aküzüm, Çakmak, & Gökalp, 2010). This is an indication of the failure of traditional environmental education. According to the report of the United Nations will start water storage in 2025 (Güzel et al., 2018). Therefore, it is a necessity to train future generations to use water resources economically. This study was carried out by using Water Explorer Program and focused on water education by mentioning sustainable environmental and environmental awareness issues. In this context, the aim of the study is that to determine the effect of the Water Explorer Program on the topic of sustainable development on 8th-grade students' attitudes of water usage and the behavior of water usage. The research questions were determined as follows:

- Is there a significant difference between students' attitudes of water with respect to teaching based on the Water Explorer Program?
- Is there a significant difference between students' behavior of water usage with respect to teaching based on the Water Explorer Program?
- What are the views of students about the Water Explorer Program?

Method

Participants

Participants were eighth-grade students from a public school in Turkey. The study was done with 87 eighth-grade students, who were enrolled in four different eighth-grade classes. Two classes were assigned randomly as an experimental group (n=42), and the other two classes were determined as a control group (n=45). Their age was between 13 and 14. Table 1 shows participants' distribution concerning the conditions.

Table 1. The Number of Participants

Class	Total
Experiment	42
Control	45

Instruments

Water Use Attitude Scale (WUAS)

The scale was developed by Yildiz Fevzioglu, Akpinar, Unal Coban, Capellaro, and Ergin (2010). It involves 12 items and the internal reliability coefficient was calculated as 0.82 by Yildiz Fevzioglu et al. (2010). It is a Likert type scale and "Absolutely Agree" (5), "Agree" (4), "Hesitant" (3), "Disagree" (2), "Absolutely Disagree" (1) statements are used. The highest score of the scale is 60 and the lowest is 12.

Water Use Behavior Scale (WUBS)

The scale was also developed by Yildiz Fevzioglu et al. (2010). It includes 13 items and the internal reliability coefficient was calculated as 0.87 by Yildiz Fevzioglu et al. (2010). It is a Likert type scale and "Absolutely Agree" (5), "Agree" (4), "Hesitant" (3), "Disagree" (2), "Absolutely Disagree" (1) statements are used. The highest score of the scale is 65 and the lowest is 13.

Reflection Paper

Students were asked to write reflection papers about water usage at the end of the study. It is formed by the researcher to gather qualitative data. The answer to the students was evaluated by using the categorization and frequency table.

Water Explorer Program

Water Explorer Program is an educational program that strengthens students to lead action on water issues. The program has a website that has ready lesson resources for both teachers and students about water education.

Students whose schools are registered to Water Explorer Program can register the website and share their experiences and photos during the water education lessons and write blogs or posts about education. The students can also read other schools' blogs or posts, look at their activity photos and comment or like them. All schools have a virtual water basin in a site. As the schools do the water activities their water basin is flourishing.

Water Explorer Program collects water savings under the four main titles. These are as follows: Fresher Water, Global Water, Secret Water, and Precious Water. Fresher Water focuses on issues that threaten clean water resources. The title emphasizes to protect existing water resources. Global Water focuses on the difficulty of reaching clean water for each individual. Also, the title aims to recognize the inequality of water resources use in the world. The third title of the Water Explorer Program is that Secret Water. It focuses on where water is hidden in our food, clothes and other things that we use in everyday life. The last title is Precious Water emphasizes finding ways in order to save water resources and money. It is also emphasized that not to waste our water resources.

At the end of the program, the first 15 schools with the highest scores are selected by project coordinators. The water workshops are done in the schools by the coordinators. Then the 15 schools organize a water festival in their schools or in a local community organization they want. After the organization, project coordinators choose the first five schools based on the numbers of missions and challenges completed by the schools, evidence of the impact of actions, total points earned, quantity and quality of blog posts, evidence of collaboration with the local community and other schools' groups and good team working. The finalist school represents its country among 11 countries.

Research Design and Implementation

The science teacher in the study was the researcher of the study who participated in Water Explorer Program workshops. Besides, the school is registered for the program. An announcement about the program was made at the school and the study was done with volunteer students. The study lasted four weeks. There were four hours of science classes in a week. At the end of each week, students shared their opinions about water education activities done in that week through blog posts on the website. They also shared photos related to their activity. A different activity from the four titles (Fresher Water, Global Water, Secret Water, and Precious Water) was performed in each week.

In the beginning, the pretests were administered. Then, the website about the program was introduced to the students in the experimental groups. For the first week, the beginning of the course was similar for both of the groups. Photos about dirty water resources were shown to the students and asked them to predict what can be the reasons of this dirtiness. Then students investigated the possible sources for such a problem. The main differences between the control and experimental groups were as follows: Students in the experimental groups developed projects about not polluting water resources. The worksheet that consists of questions about water pollution were distributed to the students. They visited the Water Explorer Program website and wrote blogs on the website and also they visited the local water treatment facility. For the second week, the worksheet derived from the website was distributed to students in the experimental groups. The worksheet included some information about the water usage habits of some countries.

There were also some assignments for the students. Based on the conclusions of the assignments, students examined their school and they reported to the school administration if there is a leaky faucet or a faulty siphon. For the students in the control groups, a traditional approach was followed. A video about the topic was shown and then, the exercises in the textbook were done. In the third week, some basic facts under the title of "secret water" were shared with the students. For example, a single paper spending 10 liters of water or a cup of coffee that spends 130 liters of water are two interesting facts discussed with the students. Then, students in the experimental groups developed a project about how we can decrease the amount of water used for clothes.

At the end of the project, the worksheet from the website was distributed to the students. For the control groups, a presentation was used as an instructional tool and then the students did activities in the science textbook. For the fourth week, the activities were related to the title of 'precious water.' For instance, in the experimental groups, how to use rainwater in daily life was asked as a beginning question. Students shared their thoughts and discussed them. After that, they designed a project about collecting rainwater with barrels. Students in the control groups used the science textbook and discussed saving water and its advantages. At the end of the fourth week, posttests were implemented.

Data Analysis

Both quantitative and qualitative data analysis methods were used together in the study. The data gathered by WUBS and WUAS were analyzed by either independent sample t-test or paired samples t-test. On the other side, reflection papers were analyzed by content analysis.

Results

Firstly, the results for WUBS are presented. After that, findings related to WUAS are given. Lastly, the outcomes of the reflection papers are given.

Findings of Water Use Behavior Scale (WUBS)

WUBS was implemented as both pretest and posttest. Table 2 shows the mean and standard deviation of the control and experimental groups based on the pretest and posttest. The groups' pretest scores were compared and found that there was no significant difference between the groups at the beginning of the study ($t(85)= -1.79$, $p=.077$). The increase of the experiment group's mean score was higher than the control groups' mean score of WUBS. At the end of the study, the groups' posttest scores were compared and found that students in the experimental group developed significantly higher behavior than their counterparts in the control group ($t(85)= -6.49$, $p=.000$). Although the experimental group increased their water use behavior significantly ($t(41)= -5.43$, $p=.000$) from beginning to the end of the study, the students in the control group did not ($t(44)= -0.42$, $p=.673$).

Table 2. The Means and Standard Deviations of the Pretest and Posttest Scores of the Groups Concerning WUBS

		Pretest		Posttest	
Class	N	Mean	Standard Deviation	Mean	Standard Deviation
Experiment	42	3.07	.53	3.78	.76
Control	45	2.87	.50	2.85	.58

Findings of Water Use Attitude Scale (WUAS)

WUAS was also administered as both pretest and posttest. Table 3 shows the mean and standard deviation of the control and experimental groups based on the pretest and posttest. The groups' pretest scores were compared and found that there was no significant difference between the groups at the beginning of the study ($t(85)= -1.10$, $p=.276$). The increase of the experiment group's mean score was higher than the control groups' mean score of WUAS. At the end of the study, the groups' posttest scores were compared and found that students in the experimental group developed significantly higher behavior than their counterparts in the control group ($t(85)= -4.41$, $p=.000$). Students in the experimental group significantly develop their water use attitude ($t(41)= -5.35$, $p=.000$) from beginning to the end of the study but the ones in the control group did not ($t(44)= -1.16$, $p=.251$).

Table 3. The Means and Standard Deviations of the Pretest and Posttest Scores of the Groups Concerning WUAS

		Pretest		Posttest	
Class	N	Mean	Standard Deviation	Mean	Standard Deviation
Experiment	42	4.19	.47	4.58	.42
Control	45	4.06	.62	4.16	.46

Findings Based on the Reflection Papers

Reflection papers gathered from students in the experimental group. Initially, it was realized that most of the students (90%; 40 students) were happy due to being participated in the Water Explorer Program. For example, one of the students said that:

> *I would like to join the program again because it was so much fun. I was excited about the projects, especially I made with my friends. I was also informed about the importance of water*.

More than half of the students (88%) said that the Water Explorer Program affected their water usage. For instance, one of the students stated that:

> *I used to drain the water in the faucet to bring hot water. Now, I'm using a bucket. I also warn the households to take care of water-saving.*

Students' reasons for not wasting water were collected under three headings. These are "water scarcity", "running out of resources", and "economic importance of natural resources". In terms of water scarcity, 71% of the reflection papers focused on that many countries have not enough water. In terms of running out of resources, 37% of the reflection papers mentioned that our world is running out of natural water resources. And in terms of the economic importance of natural resources, 18% of the reflection papers involved that water economically valuable. For example, one of the students said about water scarcity as follow:

> *I have heard that there is a lack of water in some African countries. It made me very sad to learn that one of the reasons for this might be us.*

Another student said about running out of resources as follow:

> *The water* resources *of our world are distressed and this is the concern of everyone in the world. For this, everyone needs to save water.*

About the heading that is the economic importance of natural resources, one of the students stated that:

> *In order to improve the wealth in our country, it is necessary to contribute to the economy by* using *our resources economically.*

Discussion

This study was conducted to investigate the impacts of environmental science projects on middle school students' water usage behavior and water usage attitude. The findings revealed that students who exposed to specific environmental education programs significantly developed their water usage behavior and water usage attitude. These findings generally show that providing environmental education mostly gives rise to improvement in students' behavior and attitude towards the environment. In order to be a good citizen, people need to know the science but knowing science alone is not enough. The citizens should also know how to use that knowledge in their life. In the current study, we enabled students to know more about the importance of water in our lives and encouraged them to use the knowledge in their daily lives. Furthermore, students did not only use science knowledge but also needed to know how to work with other people.

Using traditional methods for environmental education usually do not provide the desired outputs. It is imperative to revise the principles according to the requirements of the age and to use student-centered interactive approaches (Ergün, 2011; Sahin, 2007). In this study, we also reached that student-centered education is more effective than traditional education. Environmental education in schools can be more effective if it is designed with interactive applications in cooperation with non-formal education. In the report published by the Ministry of Turkey Trade, it is emphasized that primary school graduates use resources more efficiently compared to those who have the highest level of education (Güzel et al., 2018). This result can be considered as an indication that the environmental education given in schools does not contribute to the students as behavior and remains in theory. Many studies have emphasized that traditional teaching methods are not useful (Öztürk, 2011; Sahin & Shelley, 2008).

Project-based learning is also an efficient way to develop students' attitudes and behavior about water use. The program, Water Explorer Program, used in the current study is an example that holds these properties. It is a project-based, requires collaborative learning and involves an interdisciplinary approach like STEM. Students' feedback about the program was mostly positive. Their views show that they were motivated. In other words, project-based learning increases students' motivation (Demirer & Sahin, 2013; Oğuzkan, 1989). Project-based learning was usually found effective especially for high school and university students. Yet, in the current study, we reached that it also works with middle school students. Similarly, Gültekin (2009) reached that the project-based learning approach increased fifth-grade students' science achievement.

Conclusion

This study can be concluded by emphasizing the importance of the project-based learning approach for environmental education. Students should be able to use their knowledge in their daily lives especially for environmental education. It is not an easy task to change someone's behavior or attitude towards something, so continuity is important at this point. Further studies are needed to understand this issue better. Similar studies can be done with students from other grades. The impacts of non-formal education on environmental attitudes can be investigated. Longitudinal studies can be designed to observe the changes in behavior and attitudes.

Notes

This study is derived from the first author's master thesis.

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Author Information

Cansu Keskin
Science Teacher, Ministry of National Education
Turkey

Hakan Akcay
Yildiz Technical University
Turkey

Hasan Ozgur Kapici
Yildiz Technical University
Turkey
Contact e-mail: *hokapici@yildiz.edu.tr*