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EXAMINING THE INFLUENCE OF PROJECTS CARRIED OUT WITH TECHNOLOGICAL TOOLS ON PRE-SERVICE TEACHERS' LEVELS OF ENVIRONMENTAL LITERACY

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Abstract. *In all parts of our daily lives, individuals meet technology and technological tools. For this reason, individuals from all professions should be knowledgeable about these concepts. One of these professions covers pre-service teachers, who are considered as to be future teachers. The aim of this research was not only to examine the influence of the projects carried out by science pre-service teachers with technological tools on their levels of environmental literacy, but also to reveal which of the innovator categories in Rogers's (1962) Theory of Diffusion of Innovations they belonged to. In the research, the mixed research design was used since qualitative and quantitative data were required. The research sample included 110 science pre-service teachers. All the science pre-service teachers constituted the quantitative sample, while 10 randomly selected pre-service teachers formed the qualitative sample group. In the research, environmental literacy scale, semi-structured interview technique and researcher reflections were used as the data collection tools. It was found that the science pre-service teachers belonged to the categories of "Innovators" and "Early Adopters" according to Roger's theory in terms of technology use.*

Key words: *environmental literacy, diffusion of innovations theory, technological tools.*

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Introduction

Technology, in today's world, develops in an unbelievable speed. Therefore, almost all individuals use technology in all phases of their lives. Depending on this rapid development of technology, all members of a society should keep up with this development. In this respect, all members of a society are supposed to know how to adapt themselves to the developments in technology (Waetjen, 1985 cited in Boser, Palmer & Daugherty, 1998). According to National Science Education Standards, one goal of technology is to help people become aware of the changes in technology (Hallström & Gyberg, 2011). For this purpose, in formal education process, special efforts should be made to allow students to understand the nature of technology as well as the related changes (Rohaan, Taconis & Jochems, 2010). As a result of these efforts, individuals will be able to keep up with the technological developments, become knowledgeable about information and communication technologies, access information more easily and follow the current developments around (Akbıyık & Seferoğlu, 2012; Kutlu, Schreglmann & Arı, 2013). Also, it is important for teachers to be proficient enough to train students in a way to acquire all these capabilities. Therefore, this draws the whole attention to teacher training institutions. However, in related literature, it is reported that pre-service teachers have limited and inefficient viewpoints regarding technology (Koç, 2013). In addition, it is also pointed out that it is not easy to change pre-service teachers' beliefs about technology use and that this change requires a long process (Funkhouser & Mouza, 2013; Guzey & Roehrig, 2009; Lim & Chan, 2007). In order to change this limited viewpoint of pre-service teachers, different educational activities, project works and technology-based education could be put into practice.

Several studies in related literature demonstrate that projects involving technology use are quite effective (Barnett, Vaughn, Strauss & Cotter, 2011; Ebenezer, Columbus, Kaya, Zhang & Ebenezer, 2012). In addition, it is stated that strong connections could be established between real life and projects involving technology use (ChanLin, 2008) and that projects could help not only increase cognitive level but also solve the problems experienced in

daily life (Koh, Herring & Hew, 2010). Also, technology-based projects are believed to have positive influence on pre-service teachers' active learning and allow them put forward new products (Hickey, Moore & Pellegrino, 2001). Another advantage of technology-based projects is that they will eventually contribute positively to individuals' viewpoints about technology (Mioduser & Betzer, 2007; Reed, 2007; Sasova, 2011). As a result, it is thought that pre-service teachers will become open to technology use and renovations (ChanLin, 2008).

In related literature, a number of researchers claim that projects involving technology use are important for changes in environmental literacy (Kılınç, 2010; Barnett, Vaughn, Strauss & Cotter, 2011; Ebenezer et al. 2012; Benzer & Şahin, 2013). In relation to the environment, which is among the most important issues for today as well as for future if no related measure is taken, pre-service teachers will become aware of their social responsibilities regarding the environment if they produce technology-based projects, conduct research, investigate the causes of environmental problems, follow the renovations and become innovator individuals. It could be stated that changes will occur in pre-service teachers' levels of environmental literacy when they understand the environment better.

Following the renovations above, being a renovator individual and being able to solve problems are all among the skills required for individuals. This is also true according to the Theory of Diffusion of Innovations. This theory, put forward by Rogers (1962), points out that one of the features of the concept of innovation is the process of problem solving (Kılıçer, 2011) and defines innovation as an idea, practice or object perceived by an individual or other parties to be new (Rogers, 1962; pp. 11; Kılıçer, 2008). In this respect, individuals are always likely to face an innovation. Depending on the current use of innovation with a meaning similar to the concept of technology (Rogers, 2002), it could easily be stated that pre-service teachers are always exposed to innovations as they are supposed to have a constant relationship with today's technologies.

The concepts of innovation and technology are mostly used together; therefore, it could be stated that projects to be carried out with technology will not only be an innovation for individuals but also contribute to the development of their innovative thinking skills (Bo & Ye-mei, 2010 cited in Kılıçer, 2011). What is important here is that not all individuals' innovative thinking skills or their responses to innovations are similar. Rogers (1962) refers to this situation in his theory as those adopting innovations. Rogers categorizes individuals as "Innovators", "Early Adopters", "Early Majority", "Late Majority" and "Laggard". In other words, according to this theory, individuals differ in their adopting or rejecting the innovations (Berger, 2005).

Individuals can be thought to have good environmental literacy skills if they provide solutions to environmental problems, investigate the events, use technology in the process of finding solutions and follow the innovations. Rogers (1995) call these individuals innovator individuals and define them as those soling problems, producing renovations and reaching the necessary information. Depending on the fact that an individual with all these capabilities is considered to have good environmental literacy skills, an individual with environmental literacy skills is expected, according to Rogers' definition, to be an innovator individual.

Considering all those mentioned above, it is necessary not only to determine pre-service teachers' efficacies in technology use and their levels of environmental literacy skills but also to reveal the relationship between these efficacies and their innovator characteristics that play an important role in their adopting technology as an innovation. Pre-service teachers are expected to follow and use the developing technology, to think critically and to defend the innovations if they want to train individuals in their future teaching career. In this respect, the present research aimed at determining the science pre-service teachers' levels of environmental literacy and to reveal which category of Rogers' theory they belonged to. In line with the aim, the following research questions were directed in research;

1. What is the role of environmental education projects carried out with technological tools on the change that occurs in science pre-service teachers' levels of environmental literacy?
2. Which category of Rogers' Theory of Diffusion of Innovations do science pre-service teachers belong to?

Limitations

1. In the present research, each science pre-service teacher's innovator characteristics were examined individually.
2. This research is limited to science pre-service teachers.
3. In the research, the general individual capabilities regarding the innovator categories found in Rogers's theory were taken into account.

4. The findings obtained were not compared with the findings of an another similar research as Rogers's theory was not examined at all in studies carried out in the field of environmental education.

Methodology of Research

The aim of this research was not only to examine the influence of the projects carried out by science pre-service teachers with technological tools on their levels of environmental literacy, but also to reveal which of the innovator categories in Rogers's (1962) Theory of Diffusion of Innovations they belonged to. In the research, the mixed research design was used since qualitative and quantitative data were collected. In the present research, because interview questions and researcher reflections were used to collect the qualitative data and because the environmental literacy scale was used to collect the quantitative data. Quantitative data were used to find an answer to the first problem of the research. The scale used for collecting the quantitative data, was applied as pre-test and post-test on a single group. As for the second problem of the research, qualitative data was used for finding an answer. In order to get qualitative data, interview questions were conducted with science pre-service teachers and researcher reflections were utilized during the process. In this way, qualitative data were supported with quantitative data. This allows the researcher to collect data in different aspects (Johnson & Onwuegbuzie, 2004; Creswell & Plano Clark, 2011).

Sample

The research sample included 110 science pre-service teachers who were senior students in the department of Science Teaching at a Turkish University in the spring semester of 2011–2012 academic year (61 female and 49 male aged between 19 and 23). All the pre-service teachers in this research sample participated in the study on a voluntary basis. In the research, the interviews were held with 10 science pre-service teachers randomly selected among all the participating science pre-service teachers. Also, in line with expert views (environmental education and science education), these 10 science pre-service teachers were considered to be enough for the interviews. In the research, while selecting the research sample, special attention was paid to the fact that the science pre-service teachers had similar characteristics. Also, the participants were informed about the application process before the process of technology-based project was started.

Data Collection Tools

In the research, three different data collection tools were used together (Levin & Wadmany, 2006). In this way, data triangulation was done. It is thought that data triangulation is important for structuring the problem (Yin, 2009).

Environmental literacy scale was developed by Özsevgeç, Artun & Özsevgeç (2010). The scale included 24 5-point Likert-type items with a Cronbach Alpha reliability coefficient of .86. The scale explained 54.3% of the total variance. The final version of the scale was made up of four factors. The items in the scale included positive and negative statements. The scale was graded as "I completely agree", "I agree", "I am neutral", "I disagree" and "I completely disagree". The scale was tested for its construct validity using explanatory factor analysis (basic components) as well as for its content validity confirmed in line with expert views. In order to determine whether the data were appropriate to factor analysis, Kaiser-Meyer-Olkin (KMO) and Bartlett test were applied. The value of Kaiser-Meyer-Olkin (KMO) was calculated as .892 and found statistically significant as a result of Bartlett test (1901.9, p=.000).

In the research, another data collection tool included semi-structured interview questions. The questions were developed by the researcher and structured within the framework of 10 questions in total. In other words, the interview questions were directed to identify the change in the science pre-service teachers' levels of environmental literacy and to determine which category of Rogers's theory the science pre-service teachers belonged to. The interview questions were directed to 10 science pre-service teachers on face-to-face basis immediately after the technology-based projects ended. The interviews lasted between 15 and 25 minutes. Examples of the interview questions included "What does environmental literacy remind you of? How did this concept change in your mind after you carried out your projects?" and "Do your projects that you carried out using technology have any effects on the prevention of environmental problems? If any, what are these effects?" The language, legibility and scientific aspects of the interview questions were arranged in a way to help the science pre-service teachers

to understand them easily. For this purpose, academicians expert in the field were asked for their views. Until a consensus was reached, the experts went on their discussions. In the following phase, the questions agreed on were included in the study.

As for the last data collection tool applied in the research, the researcher reflections were used. The research was conducted in 14 weeks. During this period of 14 weeks, 110 science pre-service teachers in the research sample group conducted various projects in groups of three to five members under the supervision of the research by using such technological tools as TI–84, CBL, CO_2 sensor and heat and relative humidity sensors. The science pre-service teachers were in constant contact with the researcher regarding the fact that their technology-based projects should be about environment-related subjects from daily life such as weather pollution, water pollution, soil pollution and environmental wastes. Also, in this process, the researcher organized consultation sessions with the science pre-service teachers for four or five hours twice or three times a week. During this consultation process, each group was provided with feedback individually. Meanwhile, the researcher took reflections. At the end of the process, the technology-based projects were evaluated together with the science pre-service teachers.

Data Analysis

In the scale, there were positive and negative statements. Therefore, the positive and negative items were scored in different ways. The positive items were scored as 5–4–3–2–1, while the negative items were reversely scored as 1-2-3-4-5. The scores for each item were summed to determine the science pre-service teachers' scores. Following this, the data collected were analyzed with SPSS 18 package software. As the research was carried out with a singly sample group (110 science pre-service teachers), Shapiro-Wilk test was applied to determine whether the sample demonstrated a normal distribution or not. The results revealed that the significance level for the data was higher than $p>0.05$. For this reason, the data were found parametric. In order to determine whether the difference between the pre-test and post-test for the environmental literacy scale was statistically significant or not, dependent t-test, one of parametric tests, was applied.

The interview questions directed in the research were subjected to content analysis. For this purpose, first, written texts were formed in a way to reveal the science pre-service teachers' opinions? As a result of reading these, the themes and sub-themes were determined. This was done by three researchers from the field of science education, and the themes found compatible with each other were used in the research. The data obtained were audio-recorded and transcribed into written documents. Following this, the transcriptions were examined by the interviewees to achieve reliability of the data. Analysis of the data gathered from the interview related to the first problem was presented as three themes ("Exploring", "Practice" and "Experience") and 12 sub-themes such as "Conducting Research-Investigation", "Problem solving" and "Reliable information" and so on. For the second problem, the science pre-service teachers' responses during the interview were placed in the categories put forward in Rogers's theory. The themes and sub-themes were demonstrated in Tables. The statements made by and the views reported by the science pre-service teachers with quotations in relation to the themes and sub-themes frequently mentioned by the science pre-service teachers.

The researcher took reflections for 14 weeks. The researcher reflections taken by the researcher in 14 weeks were examined by two researchers from the field of science education and environmental education, and the themes were determined. The data were supported with quotations made from the data gathered from the researcher reflections. Analysis of the data collected from the researcher reflections were given under four themes ("Increase in interest", "Raising consciousness", "Group work" and "Awareness". The distribution of the themes with respect to each week was presented in a Table, and the frequencies were obtained. Also, the data were supported with quotations made from the data collected via the researcher reflections.

In addition, the research examined which categories of Rogers's Theory of Diffusion of Innovations the science pre-service teachers belonged to in terms of technology use. For this purpose, the categories found in Rogers's Theory and the characteristics of these categories were used. Figure 1 presents Rogers's categories and the related characteristics.

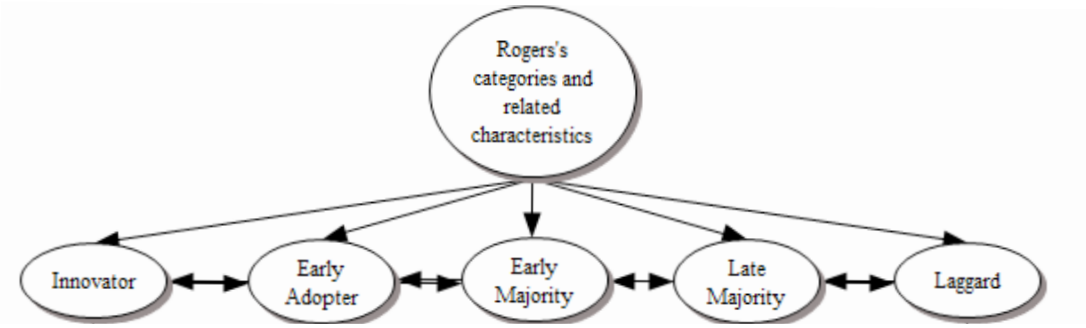

Figure 1. Rogers's categories (Rogers, 1962; Kılıçer, 2011).

Validity and Reliability of the Data Collection Tools

In the research, it was necessary for the data collection tools to be valid and reliable. For the content validity of the data collection tools, three academicians expert in the field were asked for their views. As a result, it was found that the data collection tools were valid and that they could be used in the research. In the research, the Cronbach alpha reliability coefficient for the Environmental Literacy Scale was calculated as .86. This reliability coefficient could be said to be at a good level, and the scale could be used in the research (Büyüköztürk, 2006; Çepni, 2010). In the current study, the validity of the scale for the research sample was not examined, because of similar age group with the scale development study of Özsevgeç, Artun & Özsevgeç (2010). In the current study, Cronbach alpha reliability coefficient for 110 science preservice teachers was calculated as .82.

At the end of the technology-based projects (17 environmental education projects), interviews were held. As a result of the experts' examinations, the interview questions were found valid for the research. Special attention was paid to the fact that the interview questions should be clear enough for the science pre-service teachers understand easily. Detailed information was provided about how the interview data were collected, recorded and analyzed. In addition, special attention was also paid to the storage and protection of the audio and video records in terms of their reliability. The science pre-service teachers were also informed about the fact that they would not be damaged due to the interviews and that symbols would be used to represent their names. In addition, for the analysis of the interview data, themes and sub-themes were formed by three researchers from the field of science education, and the themes and sub-themes that the researchers agreed on were included in the research. For the reliability of the interview data, the three researchers' codings were examined to see whether their codings were in harmony or not. Cohen's Kappa fit coefficient for the data collected was calculated as .61.

For the reliability of the data collected from the researcher reflections, the three researchers' codings were examined in terms of their consistency. In addition, the data collected from the researcher reflections were recorded. For the validity research, the data collected were supported with the data collected via the environmental literacy scale and via the interviews, and quotations were made from the researcher reflections.

Results of Research

Results Related to Science Pre-service Teachers' Levels of Environmental Literacy

In order to find a solution to this first problem, environmental literacy scale, interview questions and the researcher reflections were used. The results obtained with these data collection tools were presented in order.

In order to determine whether the difference between the pre-test and post-test of the Environmental Literacy Scale was statistically significant or not, dependent t-test was conducted on the data. The results obtained are presented in Table 1.

Table 1. Dependent t-test results regarding the Environmental Literacy Scale.

Group	N	∑	Sd	df	t	p
Pre-test	110	85.41	8.90	109	-6.70	.001*
Post-test	110	98.27	17.91	109		

** p<.05*

As can be seen in Table 1, there was a statistically significant difference between the pre-test and post-test scores of the science pre-service teachers in favor of the posttest ($t_{(109)}$= -6.70, p<0.05).

The themes and sub-themes determined based on the findings obtained via the interview questions used in the research are presented in Table 2.

Table 2. Themes and sub-themes obtained via the interview questions.

Themes and sub-themes / Pre-service Teachers'	Sub-themes											
	Conducting Research-Investigation	Learning how to use the data	Developing observation skills	Interrogative	Problem solving	Combining theory with practice	Applying in daily life	Learning by doing-experiencing	In-depth information	Concrete information	Learning the concepts in detail	Reliable information
	Exploring			Practice					Experience			
S1	✓		✓	✓	✓	✓	✓	✓	✓		✓	
S2	✓	✓	✓		✓	✓	✓		✓			✓
S3	✓			✓	✓		✓	✓	✓	✓	✓	
S4	✓		✓		✓		✓	✓	✓		✓	
S5	✓	✓		✓			✓	✓	✓		✓	✓
S6	✓					✓	✓	✓	✓		✓	
S7	✓	✓	✓		✓		✓			✓	✓	
S8	✓			✓	✓		✓	✓	✓	✓	✓	✓
S9	✓		✓		✓	✓	✓		✓	✓	✓	
S10	✓	✓			✓			✓	✓	✓	✓	✓
Total	10	4	5	4	8	4	9	7	9	5	9	4

According to Table 2, three themes were obtained via the science pre-service teachers' responses to the interview questions: "exploring", "practice" and "experience". Of all these themes, "exploring" included three sub-themes; "practice" included five sub-themes; and "experience" included four sub-themes. Among the science pre-service teachers participating in the research , the views of S_7 about the sub-theme of "conducting research-investigation", the views of S_1 about the sub-theme of "learning by doing-experiencing" and the views of S_9 about the sub-theme of "in-depth information" were as follows:

S_7:... We obtained positive data regarding our project and positive results regarding our hypotheses...
S_1:... For example, I ask the janitor of our building about the quality of the coal we use? What is its quality? Also, I check whether there are recycling boxes at schools…
S_9:... I have learnt the standards for drinking water. I have become more knowledgeable about a number of subjects related to environmental pollution. Previously, my knowledge was superficial, but now I have more detailed knowledge...

The researcher took the researcher reflections during the technology-based projects conducted by the science pre-service teachers, and several themes were formed. Table 3 presents the themes obtained.

Table 3. Themes obtained via the researcher reflections.

Weeks	Themes			
	Increase in interest	Raising consciousness	Group work	Awareness
Week 1	x	x	x	x
Week 2		x	x	x
Week 3	x	x	x	x
Week 4	x	x	x	x
Week 5		x	x	
Week 6	x	x	x	x
Week 7		x	x	x
Week 8	x	x	x	x
Week 9		x	x	
Week 10	x	x	x	
Week 11	x	x	x	x
Week 12		x	x	
Week 13	x	x	x	x
Week 14	x	x	x	x
Total	**9**	**14**	**14**	**10**

According to Table 3, four themes such as "Increase in interest", "Raising consciousness", "Group work" and "Awareness" were obtained via the researcher reflections. S_6 and S_3 restated their views as follows, the former regarding the theme of "raising consciousness" and the latter regarding the theme of "awareness":

S_6: …I used to buy salmon sold in open areas, but as result of my project research, I have never bought that fish from these places as I have learnt the related statistical values...
S_3: ... Before the projects, we were unable to see many things around us, and we used to learn about the problems via the news. People around us actually tried to inform about these problems, but we didn't think about them at all. And now, we can be more sensitive to these problems...

Results related to Diffusion of Innovations do science pre-service teachers belong to

Depending on the findings obtained via the interviews, the categories found in Rogers's theory of diffusion of innovations and the ones that the science pre-service teachers belonged to were revealed separately. Table 4 presents all the categories that the science pre-service teachers belonged to.

Table 4. All the categories the pre-service teachers belonged to.

Cate. / PT	Categories				
	Innovator	Early Adopter	Early Majority	Late Majority	Laggard
S1	✓	✓	-	-	-
S2	✓	✓	-	-	-
S3	✓	✓	-	-	-
S4	✓	✓	-	-	-
S5	✓	✓	-	-	-
S6	✓	✓	-	-	-
S7	✓	✓	-	-	-
S8	✓	✓	-	-	-
S9	✓	✓	-	-	-
S10	✓	✓	-	-	-
Total	10	10	0	0	0

According to Table 4, 10 of the science pre-service teachers belonged to the categories of "Innovators" and "Early Adopters", while there was no science pre-service teacher belonging to the categories of "Early Majority", "Late Majority" and "Laggard". Table 5 presents the distribution of the science pre-service teachers belonging to the category of "Innovators".

Table 5. Distribution of the pre-service teachers belonging to the category of "Innovators".

Cate. / PT	Innovator						
	Doing experiments	Willing to take risks	Entrepreneur	Creating innovations	Being a researcher	Reaching reliable information	Proficient in technology use
S1			✓		✓	✓	✓
S2	✓		✓	✓	✓	✓	✓
S3	✓				✓	✓	✓
S4	✓					✓	✓
S5	✓			✓	✓	✓	
S6		✓			✓	✓	
S7					✓	✓	✓
S8	✓				✓	✓	
S9						✓	
S10	✓				✓	✓	✓
Total	6	1	2	2	8	10	6

Table 5 demonstrates that the science pre-service teachers belonged to various sub-categories. Among these sub-categories, regarding "being a researcher" and "reaching reliable information", S_1 and S_5 reported their views as follows:

S_1: …Of course, we are trying hard; for example, let's say preventing erosion. I am searching for information about how to increase the quality of soil...

S_5:... All friends are finding a project subject. We know a bit about these issues, but after the projects, I believe we obtained clearer data and more reliable information …

Table 6 presents the distribution of the science pre-service teachers belonging to the category of "Early Adopters".

Table 6. Distribution of the pre-service teachers belonging to the category of "early adopters".

Cate. / PT	Early Adopter						
	Being a leader of opinion	Being directive	Being a role model	Being technology-focused	Supporting changes	Taking risks	Having a vision
S1	✓	✓	✓	✓	✓		✓
S2	✓	✓	✓	✓	✓		✓
S3	✓	✓	✓	✓	✓		
S4	✓	✓		✓			✓
S5		✓	✓				
S6		✓				✓	
S7	✓		✓	✓			
S8	✓	✓	✓		✓		✓
S9	✓	✓	✓				
S10	✓	✓	✓	✓	✓		
Total	8	9	8	6	5	1	4

It is seen Table 6 that the science pre-service teachers belonged to various sub-categories. Among these sub-categories, S_4 and S_2 reported their views as follows, the former regarding the sub-category of "being a leader of opinion" and the latter regarding the sub-category of "being directive":

S_4: …We visited some places, and we talked to 4-5 people. We informed them about what we did. As a result, we raised only a few people's consciousness. Also, as far as I remember, there were 100 people interested in our presentation. If each group contacts at least 4-5 people, then it makes 500-600 people, and there are others around these people. In this way, the number of people could increase, and I believe this could influence a great many people.....

S_2:... For example, there was a shampoo project. The pH rate of shampoos is important; that is, there were unpacked detergents and those we buy from supermarkets. Consequently, if I share the results of my project with them to raise their consciousness and if I warn them about this, I think I can really get good results…

In the process of projects carried out by the science pre-service teachers using innovative technological tools, they experienced five phases. It was found that the science pre-service teachers planned what to do in groups; that they conducted research using innovative technological tools; that they put the results of their research into practice; and that they finally increased their knowledge and/or gained experience in relation to environmental issues. Lastly, the science pre-service teachers' studies were evaluated.

Discussion

The results revealed a statistical increase in the science pre-service teachers' levels of environmental literacy at the end of the process (See Table 1). Among the probable causes of this increase could be the fact that the science pre-service teachers conducted technology-based projects and that their research, application and learning skills developed thanks to the projects. In literature, there are several studies demonstrating that these projects could

lead to such effects (Barnett, Vaughn, Strauss & Cotter, 2011; Ebenezer et al. 2012). As another cause, it could be stated that technology-based projects might have raised awareness in the science pre-service teachers' levels of environmental literacy by influencing their mental structures in the phase of researching environmental subjects. This result is consistent with the results obtained in research carried out by Wang, Kinzie, McGuire & Pan (2010). In addition, it was found in the present research that the science pre-service teachers' problem solving skills regarding environmental problems developed as they were involved in a research process thanks to the technology-based projects (See Table 2). In related literature, there are several research results indicating that problem solving skills develop in that way (Benimmas, Kerski & Solis, 2011; Barnett, Vaughn, Strauss & Cotter, 2011; Benzer & Şahin, 2013). Development of this skill might have contributed to the increase in the science pre-service teachers' levels of environmental literacy. The science pre-service teachers conducted their technology-based project studies throughout the process not only within the context of theory but also within the context of practice. In the research, it was also revealed that the science pre-service teachers learnt environmental concepts permanently at the end of transferring theoretical knowledge into practice (See Table 2). This could be said to be a cause of the increase in the level of environmental literacy. In other words, practice, besides theoretical research done in the process of the technology-based projects, might help understand various concepts related to the environment (Artun, 2009; Barnett, Vaughn, Strauss & Cotter, 2011; Baran & Maskan, 2012; ChanLin, 2008; Koh, Herring, & Hew, 2010). In addition, group work done by the science pre-service teachers, establishment of interactive learning environment based on group work, and learning and actively using scientific research methods in the process of conducting technology-based projects are all considered to be among the causes of the increase in the level of environmental literacy (Cutter-Mackenzie, 2009; Huh, Reigeluth & Lee, 2014; Mahidin & Maulan, 2010). Another cause of the increase could be the fact that science pre-service teachers do not associate the results of their technology-based projects with the environmental problems they experience and encounter in their daily lives. In related literature, it is reported that such associations are likely to lead to an increase in the level of environmental literacy (Artun, 2009).

In the research, it was found that the science pre-service teachers belonged to the categories of "Innovators" and "Early Adopter" according to Rogers's theory (See Table 4) and that the "Innovators" had certain characteristics (See Figure 1; Table 5). These characteristics of the science pre-service teachers demonstrate that they were "Innovator" individuals. Depending on the research conducted by the science pre-service teachers in the process of technology-based projects, it could be stated that they reached reliable information and that they learned environmental concepts well thanks to the information they obtained. In addition, the fact that the science pre-service teachers used technology while conducting technology-based projects and that they made use of technology in all phases of their studies indicates that they were innovator individuals. This could be said to be among the causes of the increase in the science pre-service teachers' levels of environmental literacy. According to the theory, the "Early Adopters" had certain characteristics (See Figure 1; Table 6). These characteristics of the science pre-service teachers could be said to indicate that they were "Early Adopters" of technology use. In other words, the fact that the science pre-service teachers were "Early Adopters" demonstrates that they give importance to technology, defend the changes in technology and use technology-based projects. It could be stated that as a result of these efforts, the science pre-service teachers' levels of environmental literacy increased.

In the research, it was found that the science pre-service teachers did not belong to the categories of "Early Majority", "Late Majority" and "Laggard" according to Rogers's theory (See Table 4). These three categories were not appropriate to the science pre-service teachers' individual characteristics; thus, it could be stated that these categories did not have any positive influence on the science pre-service teachers' levels of environmental literacy. The fact that the current era makes it compulsory for individuals to use technological tools and that science pre-service teachers feel themselves obliged to use various technologies might have caused them to be away from these categories. In another saying, the findings obtained demonstrate that science pre-service teachers do not belong to these categories and that they are open to innovation and willing to use technology. In other words, the science pre-service teachers participating in the present research reported that they adopted innovations and technologies and that they were enthusiastic about making use of these innovations. All these results demonstrate that science pre-service teachers are open to innovations and being innovative. Field of science, interest in technology and keeping up with current technological innovations might have caused most of the science pre-service teachers in the present research to belong to the categories of "Innovators" and "Early Adopters". In addition, widespread use of technology, which is now indispensable for the society and science pre-service teachers' feeling of being obliged to use technology, might have had a positive influence on them.

Conclusions and Implications

As a result of the project works conducted by the science pre-service teachers regarding technology-based environmental education, a statistically significant increase was found in their levels of environmental literacy. In addition, since the science pre-service teachers took part in the research process thanks to the technology-based projects, their problem solving skills related to environmental issues developed. The science pre-service teachers conducted their technology-based project works not only in theoretical context but also in practical context. The science pre-service teachers learned the environmental concepts permanently after they transferred their theoretical knowledge into practice. In addition, it was found that the science pre-service teachers belonged to the categories of "Innovators" and "Early Adopters" according to Rogers's theory of diffusion of innovations and that they were not in the categories of "Early Majority", "Late Majority" and "Laggards". The results demonstrated that the science pre-service teachers were open to innovations and innovativeness thanks to the projects conducted with technological tools. In addition, it was revealed that technology, which has become inevitable for societies, is used commonly and that technology has a positive influence on science pre-service teachers. Also, the fact the science pre-service teachers were in the category of "Innovators" and "Early Adopters" among Rogers's categories indicates an increase in their levels of environmental literacy. The present research was carried out with a single research sample group within the context of Rogers's theory. The research could be replicated with different sample groups. Encouraging science pre-service teachers to conduct technology-based projects throughout their education lives could provide them with the opportunity to solve the environmental problems they experience in their daily lives. The necessary changes could be done in related curricula so that science pre-service teachers can be open to innovations, become innovator individuals and use technology in their professional lives. The present research was carried out with a limited number of participants. Parallel to increasing the number of the participants in the research sample, a general profile regarding science pre-service teachers' use of technology could be put forward.

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