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Investigation of the effect of preservice science teachers' E→STEM activity development processes on environmental awareness levels

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Abstract

The aim of the present research is to reveal the effects of preservice science teachers' E→STEM approach-based activity development processes on their environmental awareness levels and their views on the process. The research was performed with explanatory sequential mixed design. In the quantitative dimension, a single group pre-test post-test quasi-experimental design; and in the qualitative dimension, a holistic single case design, a type of case study, was applied. Eleven preservice science teachers studying in the 3rd grade of the faculty of education at a state university based in the Western Black Sea Region of Turkey are included as the study group. The quantitative data obtained after the six-week process were gathered through the environmental awareness scale and the Wilcoxon signed-row test, and the qualitative data were collected through a semi-structured interview form and analyzed descriptively. It was determined that the activity development process based on the E→STEM approach increased in the environmental awareness levels of the preservice teachers and their opinions were positive for the process they experienced. They established connections that the E→STEM approach provided the development of environmental awareness and was an effective application area in environmental education. Suggestions were made based on the results of the research. Based on the changes resulted by the E→STEM approach activity development process experience in preservice teachers, it was suggested to enrich the content of teacher education and science courses with this approach.

Keywords: Environmental education; interdiscipliner education; E→STEM; preservice science teacher

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1. Introduction

The environment, conceptualized as a commodity and independent from humans, is a living system that also makes humans one of its components. Some problems have happened due to the deterioration of the interaction and balance of the living and non-living elements of this system, especially when the balance factor cannot be provided. These problems, accelerated by human intervention, have become common and disturbing with industrialization (Dunlap & Jorgenson, 2012). The capitalist lifestyle, depending on the cruel growth desire that came with the industrial revolution, causes people to create effects that may be responsible for the destruction of their own race (Roth, 2019). Environmental problems, which have increased with urbanization (Long et al., 2021) and have drawn attention in a 150-year period (Tıraş, 2012), are a global problem. Studies on environmental problems and their causes have focused on the deterioration in human-environment relations and have held people responsible (Görmez, 2015), and the harmful and toxic pollutants they cause in the environment have caused global concerns (Long et al., 2021). Environmental problems are defined as air pollution, water pollution, soil pollution, waste, noise pollution, erosion, destruction of the natural environment from a local perspective (Ministry of Environment, Urbanization and Climate Change, 2020), it is diversified as air, water, soil, thermal and noise and radioactive pollution according to its effects on human health (Ahluwalia, 2015). Environmental problems can also be classified as natural disasters, soil pollution, loss of biodiversity, deforestation, ozone depletion, acid rain (Papp, 2022).

Since the environmental problems have been felt, solution proposals have been developed, the functionability of a process to be carried out in individuals for the solution of these problems has been discussed, and it has been accepted that these problems can be solved with environmental education for the last sixty years (Shobeiri, Omidvar & Prahallada, 2006). Environmental education is both a solution and a precaution. With this education, it is expected that the actions of individuals towards the environment will turn positive, the destructive power of environmental problems will decrease and the possibility of derivatives of the problems will be weakened as this education affects the future. Environmental education, with the clearest definition, is the aim of ensuring the continuity of the balance of the environment by people. For this solution, it is desired to raise individuals who acquire basic ecological information about the environment, have feelings for the environment with this information, and take action towards the solution of problems, that is, individuals with environmental awareness. These three stages in the form of knowledge-positive attitude-beneficial behavior towards the environment constitute the basic elements of environmental awareness (Erten, 2005, 2012, 2019). The journey of environmental consciousness formation, which takes place cumulatively and gradually in individuals, requires being completely “conscious”. Behaviors that are the result of an attitude fed by knowledge, not actions towards the environment that are shown randomly, are accepted as an indicator of environmental awareness. It is a fact that the environmental education delivered for the development of environmental awareness should be given in contact with the lives of individuals without being limited and integrated into the process. The structure of environmental education should focus on real situations in order to determine the causes and solutions of environmental problems. Since it is known that education is important for finding sustainable solutions for the environment (Artvinli & Demir, 2018), there are many studies on the effect of educational environment or model in environmental education (Buldur & Ömeroğlu, 2021; Çetin, 2019; Gülersoy et al., 2020; Özgel, Aydoğdu & Yıldırım, 2018; Scott & Sulsberger, 2019). One of the results of the search for the best in environmental education is the use of disciplines together. The current interdisciplinary environmental education approach is E→STEM.

1.1. E→STEM approach

As one of the interdisciplinary approaches, E→STEM, is one of the extended versions of the STEM approach. Expansion means the integration of a new discipline into the rooted STEM structure. It is known that the STEM approach can establish new partnerships with many disciplines and expand its application area (e.g. STEAM with the integration of the art discipline). STEM acronym is formed by initials of Science, Technology, Engineering, and Mathematics disciplines, and this new structure expresses a larger formation than each part of STEM disciplines (Shanahan, Carol-Ann Burke & Francis, 2016). The approach enables effective and diversified learning with the use of disciplines together (Takeuchi et al, 2020), and skill development is also supported. These skills are engineering-based problem-solving skill, skills for establishing relevance, engineering-based design skills, innovation skills, digital competence, creativity, communication and collaboration (Şen, Sonay & Kıray, 2018), and they are specialized within the STEM structure within the scope of 21st century skills. The E→STEM approach - environmental education with its deeper expression-, formed in partnership with the environmental discipline, offers a versatile and powerful way for environmental education by adding goals such as sustainable development, environmental awareness and environmental literacy in addition to these skills that come into existence organically thanks to STEM. E→STEM approach aims to solve the environmental problems that the world is exposed to, just like STEM (Capraro, Capraro & Morgan, 2013), which offers students the opportunity to research with the focus of the integrated use of disciplines in order to solve real-life problems. E→STEM acronym, which consists of environment and STEM disciplines, formed by the initials of Environment, Science, Technology, Engineering and Mathematics disciplines. It is included in the literature as Green STEM (National Wildlife Federation, 2015) and E→STEM (Fraser et al., 2013; Gupta et al., 2018; North American Association for Environmental Education [NAAEE], 2013). The reason why the E→STEM acronym is expressed in this way in present study is because

E→STEM is included in the literature as Entrepreneurship and STEM (Aydoğdu et al., 2020; Eltanahy, Forawia & Mansourb, 2020).

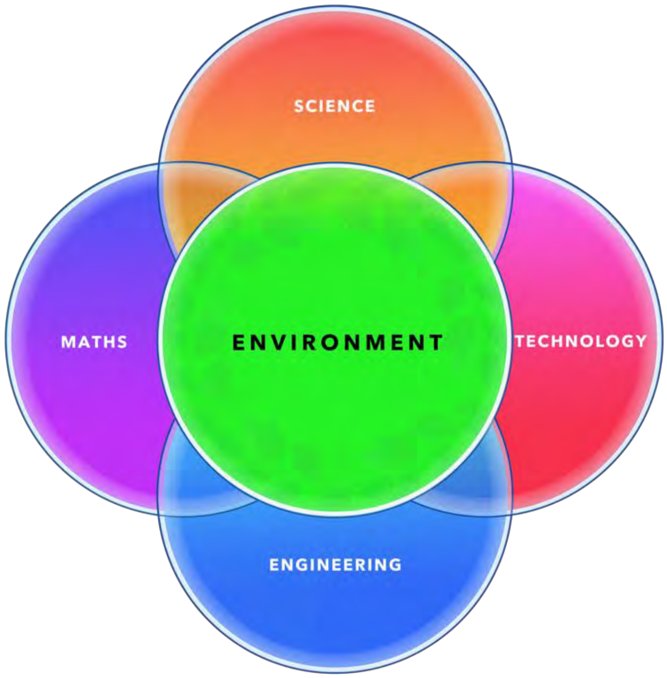

Figure 1. E→STEM disciplines

It is important to combine the environment and STEM in order to raise individuals who can solve environmental problems (Yıldırım, 2021). In the emergence of the E→STEM approach, in addition to its compatibility with 21st century skills, the combination of environment and STEM also plays an important role in providing a more comprehensive learning. While STEM helps achieve the goals of environmental education, environmental education makes sense of the STEM approach (Kuvaç & Koç-Sarı, 2018). The common goals between environmental education and science education are realized through the partnership established thanks to this interdisciplinary approach. E→STEM (Gupta et al., 2018), which contributes to the interest in science professions, can be a solution to the rapid increase in available jobs in the fields of environment, science, technology, engineering and mathematics (Caldwell, Garcia & Cagle, 2018).

The STEM approach can find its place in many models and methods in education (e.g. 5E learning model, cooperative learning, inquiry-based learning, problem-based learning) and it wants to clarify the implementation process in this way. One of the most prominent applications of STEM education is engineering design-based science education. Engineering design-based science education process, which has a great potential for harmony with the E→STEM approach, serves to realize the common goals of science education and environmental education.

1.2. E→STEM approach and engineering design-based science education

The application of the process of engineering design for solving real-world problems and realizing deep learning is engineering design-based science education (Daugherty, 2012). The process consists of a combination of scientific research and engineering design stages (Apedoe et al., 2008). In engineering design-based science education, where the process of engineering design is structured at the center and the research process surrounding it, these two processes run parallel to each other. The modeling of the process staged by Barnett et al. (2008) and Wendell et al. (2010) is given in Figure 2.

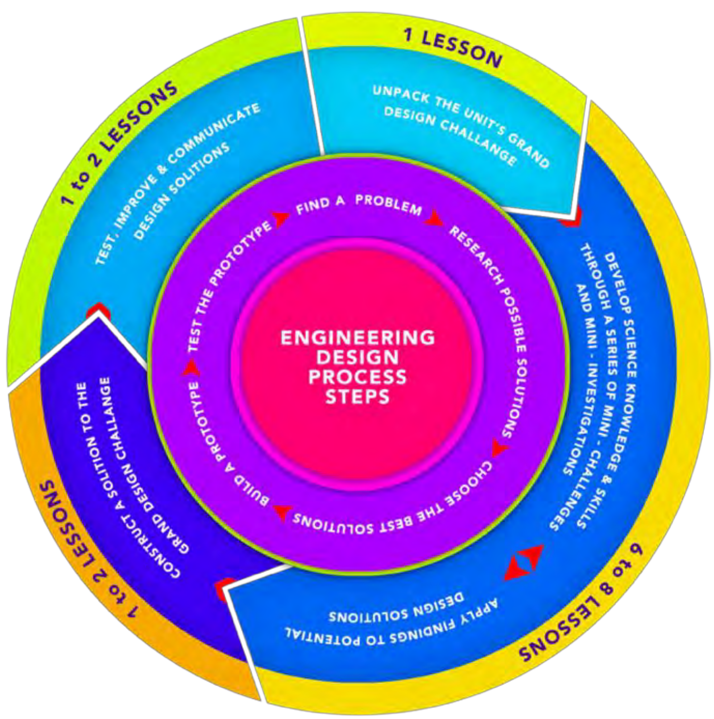

Figure 2. Engineering design-based science curriculum unit phases

The process in Figure 2 is followed as:

1. Identifying the problem - Assigning the major design task

2. Determining the solution proposals and choosing the best solution-Determining the best solution for the major design task with minor studies and minor designs *the ability to make decisions is very important for the success of this phase.*

3. Making the prototype-Making the prototype of the best solution determined in the previous stage

4. Testing the prototype-Testing the functionality of the prototype and improving the determined aspects or redesigning the prototyping process

By detailing the process of engineering design steps by Hynes et al. (2011), a 9-step process was designed and flexibility was provided in the transitions between the steps. In this way, greater harmony with the process of engineering design was achieved. The process of engineering design was also used in the National Aeronautics and Space Administration (NASA) trainings, and the development of STEM disciplines is aimed with the eight-step process of them applied (NASA, 2015).

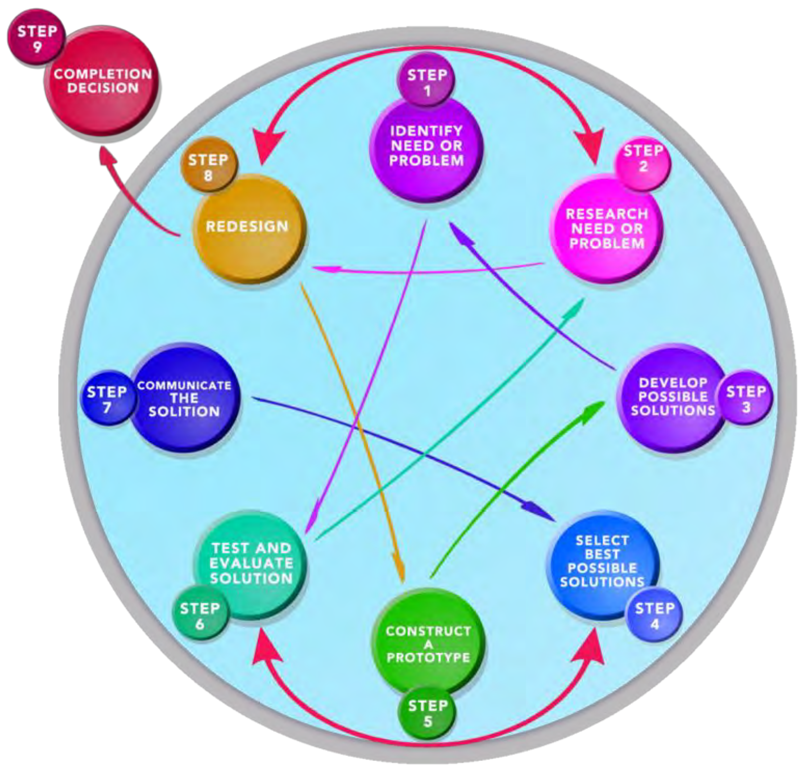

Figure 3. The process of engineering design (Hynes et al., 2011)

In studies, a combination of Wendell et al. (2010) and Hynes et al. (2011) processes is used. Instead of Wendell et al. (2010)'s five-step design process, the process created by integrating Hynes et al. (2011)'s detailed nine-step process is implemented.

The following contents can be applied for the application of the E→STEM approach in the engineering-based science education process (Candan-Helvacı, 2021):

1. The selected daily life problems should be determined for environmental problems. In this way, the environment is brought into focus from the first stage.

2. The maximum benefit of the environment should be considered while determining the solution proposals and choosing the best among them. The focus of sustainable development on protecting the environment should be based on the effort to provide the greatest economic profit. Environmental awareness and environmental literacy level have a great influence on this selection. Environmental awareness and environmental literacy can also be changed/improved in an atmosphere created with a focus on environmental benefits.

3. In the process of prototype design and development, the beneficial behavior dimension of environmental awareness should be the focus. The models created, the model formation process, and the resulting waste should all protect the environment.

4. The resulting prototype must be created "consciously". In other words, environmental knowledge-attitude-beneficial behavior formation processes should be realized by the internalization of the individual with an awareness of protecting the environment. Only in this way, the process can gain value within the scope of environmental education.

1.3. Aim of research

The STEM approach, which directs international education systems, has also taken place in the Turkish education system. This approach is emphasized in the 2018 Science Course Curriculum, and in texbooks Science, Engineering and Entrepreneurship activities are included (Ministry of National Education [MoNE], 2018). It is known that the STEM approach can be used for individuals to develop solutions for the environment (Ua-Umakul & Chaiwatchatuphon, 2018), and the application of the STEM approach is primarily the responsibility of teachers (Türk et al., 2018). Considering that environmental education processes are more lacking for students at the basic education level than other disciplines (Caldwell, Garcia & Cagle, 2018), it is very important for educators to be able to integrate the environment into the STEM approach, that is, to have E→STEM approach competence. Science teachers, who are directly related to STEM education, differ in this respect. In particular, preservice science teachers should be able to develop activities for appropriate gains in possible future transformations. Considering that one of the pillars of the E→STEM approach is to bring about the development/change of environmental awareness in students, it is an important research area that educators are affected by the E→STEM approach before students. There is a lack of study in the field of researching E→STEM experiences of preservice teachers (Burgess & Buck, 2020). From this point of view, the aim of the research is to determine the effects of the E→STEM approach-based activity development process on the environmental awareness levels of preservice science teachers and their views on the process. The problem statement of the study "What is the effect of the E→STEM-based activity development process on the environmental awareness levels of preservice science teachers, what are their views on the process?".

1. Is there a significant difference between the environmental awareness scale pretest-posttest scores of the experimental group in which the E→STEM-based activity development process was carried out?

2. What are the views of the experimental group on the implementation process, in which the E→STEM-based activity development process was carried out?

2. Method

2.1. Research design

In present study, explanatory sequential design was used, as one of the mixed research method types. In this design, quantitative data is first collected and analyzed in order to answer the research problem. Qualitative data are obtained based on quantitative findings, and qualitative findings help to explain quantitative findings (Creswell & Plano-Clark, 2018; Yıldırım & Şimşek, 2018). In the quantitative part of the study, a single-group pre-test-post-test quasi-experimental design was used. In the qualitative part, from a case study type, a holistic single-case design was used (Yin, 2009).

2.2. Participants

Third grade (junior) pre-service teachers at the education faculty of a state-run university based in Western Black Sea region of Turkey were included in the study. The study was carried out with 11 students in the 2021-2022 academic year. The quantitative and qualitative dimensions of the research consist of the same study group. The study group characteristics are given in Table 1.

Table 1. Features of the study group

	Female	**Male**	**Department**	**Grade Level**
Experimental Group	5	6	ST*	3

*Science Teaching

2.3. Data collection tools

2.3.1. Data collection tool for quantitative dimension

In the quantitative dimension of the study, the Environmental Awareness Scale (EAS) developed by Schrenk (1994) and used in Turkish studies by Erten (2005) was used. The scale consists of three sub-dimensions. Environmental awareness scale consists of a total of 60 items, 20 from each of the dimensions of environmental knowledge, positive attitude and beneficial behavior. The items in the scale are in the form of a 5-point Likert type from positive to negative. The Cronbach α reliability coefficient of the scale was stated as .71. Within the scope of this research, it was decided that the scale was reliable by calculating .79 in the pilot study conducted before the application and it was used in the study. After the main application, it was calculated as .75.

2.3.2. Data collection tool for qualitative dimension

A semi-structured interview form was used after the application to reveal the opinions about the activity development process that took place within the scope of the application. In the preparation of the questions of the form, attention was paid to include the dimensions of the research (Yıldırım & Şimşek, 2018). Two open-ended questions were created to get information about the implementation process, and the form was finalized by taking the opinion of the field expert. As in the whole research process, the interview data were obtained in written form by providing the condition of voluntary participation before the interviews. All of the experimental group that made up the study group participated in the interviews.

2.4. Procedure

The study was realized based upon the Science Teaching Laboratory Practices course, which is a compulsory field course in line with 2018 Science Teaching Undergraduate Program. The implementation process was carried out for a total of 18 lesson hours along six weeks. The application process was carried out by the researcher. Before the implementation of the application, the preservice teachers examined the activities in the 2018 Science Course Curriculum textbooks, which is the current curriculum due to the content of the Science Teaching Laboratory Practices course. In connection with the program, STEM and engineer design-based science education content was transferred. It is within the scope of the course content and has been excluded from the research process. After this process, the implementation process was started and the pre-test was applied. In the first three weeks of the application, content transfer and E→STEM application examples for the integration of Environment and STEM were presented (Candan-Helvacı, 2021; Kuvaç & Koç-Sarı, 2018). The integration of engineering design-based science teaching cycle with environmental education is emphasized. During the following three weeks, preservice teachers were asked to develop an E→STEM-based activity in line with the 5-8th grades science curriculum, focusing on the solution of an environmental problem that they determined as a result of their research. The researcher was involved in this process as a guide. When the activity development process was completed at the end of six weeks, the post-test was applied and semi-structured interviews were conducted.

2.5. Analysis of data

In data analysis process, quantitative and qualitative analysis methods were used in the study. In the analysis of the quantitative data, the EAS scores, which were practiced as pre-test-post-test, were analyzed using the Wilcoxon signed rank test, which is one of the non-parametric tests. The parametric assumption of normality is not particularly sufficient for a sample size of less than 30, and non-parametric tests are generally a good option for these data (Hoskin, 2012). In calculating the effect size of the research, the effect size was calculated with the formula $z/\sqrt{N}$, using the z value obtained from the Wilcoxon signed rank test. Impact power values were evaluated as following: between .00-.10 will be ignored, between .10-.30 small, between .30-.50 medium, between.50-.70 wide, between .70-.90 is very wide, between .90 and 1.00 excellent (Hopkins, 2002).

Semi-structured interview forms, in which qualitative data were obtained, were analyzed with descriptive analysis. In the interview forms, the students were asked to hide their names, and during the analysis phase, the forms were coded with an encryption consisting of letters and numbers. 27% of the 11-page data obtained from the preservice teachers in writing was coded separately by the researcher and a field expert. With the reliability formula of Miles & Huberman (1994), the percentage of consistence between coders was calculated as 85.3%. Since this value is recommended to be 85% or more (Miles, Huberman & Saldana, 2014), the research was considered reliable by looking at the percentage of consistence between coders obtained within the scope of the research.

2.6. Providing the validity and reliability criteria of the research

The validity and reliability of the quantitative design part of the mixed method, which are concretely demonstrated by numerical values, cannot be obtained with the same ease for the qualitative part due to the nature of the research. Qualitative studies are based on four criteria: credibility, reliability, confirmability and transferability. The credibility criterion is important in ensuring the validity and reliability of the research (Lincoln & Guba, 1985). Expert review for *credibility*; application, data collection and analysis phases for *confirmability*; the detailed information about the study group and the views s on the process were given with quotations for *transferability*, and Miles & Huberman (1994) inter-coder consistence percentage obtained for reliability was calculated for *credibility*.

3. Results

In this part of the research, there are the results of the semi-structured interview form, by which the qualitative data were gathered, and the analyzes of the EAS scores, by which quantitative data were obtained. Findings related to the interview form are presented with citations.

3.1. Findings Regarding Environmental Awareness

In this part, which constitutes the quantitative findings, the first sub-problem of the study, “Is there a significant difference between the environmental awareness scale pretest-posttest scores of the experimental group in which the E→STEM-based activity development process was carried out?” question was answered. The pre- and post-application EAS scores of the experimental group, which is the only group of the study, were analyzed with the Wilcoxon signed rank test, one of the non-parametric tests. The obtained results are given in Table 2.

Table 2. Wilcoxon signed ranks sum test results of experimental group EAS and its dimensions' total pretest-posttest scores

		Post-test / Pre-test	N	Mean Rank	Sum of Ranks	z	p	r
Environmental Awareness Scale		Negative Ranks	0	,00	,00	-2,89*	,00**	-0,87
		Positive Ranks	11	6,00	66,00			
		Ties	0					
Dimension of Environmental Awareness Scale	Environmental Knowledge	Negative Ranks	0	,00	,00	-2,89*	,00**	-0,87
		Positive Ranks	11	6,00	66,00			
		Ties	0					
	Positive Attitude	Negative Ranks	0	,00	,00	-2,89*	,00**	-0,87
		Positive Ranks	11	6,00	66,00			
		Ties	0					
	Beneficial Behavior	Negative Ranks	2	1,00	2,00	-2,75*	,00**	-0,82
		Positive Ranks	10	6,40	64,00			
		Ties	0					

*Based on negative ranks

**p<.05

According to the results of the Wilcoxon signed ranks sum test between the environmental awareness scale total pretest-posttest scores of the experimental group (see Table 2), the application differs significantly in favor of the post-test (z=-2,89; *p*<,05). When the effect size value of this significant difference was examined (r=-0,87), it was determined that the E→STEM approach-based activity development process had a very strong effect. In the Wilcoxon signed sum test results, which was carried out in the sub-dimensions of the scale to investigate the reasons for this difference, a significant difference was found in favor of the post-test in the dimensions of environmental knowledge, positive attitude towards the environment and beneficial behavior. ($z_{environmental\ knowledge}$=-2,89; *p*<,05; $z_{positive\ attitude}$=-2,89; *p*<,05; $z_{beneficial\ behaviour}$=-2,75; *p*<,05). The positive effect on the effect of the process, which was determined in the whole of the EAS scale, was determined in the same way in the sub-dimensions. It was determined that the effect size of this positive effect was very strong for all dimensions ($r_{environmental\ knowledge}$=-0,87; $r_{positive\ attitude}$=-0,87; $r_{beneficial\ behaviour}$=-0,82). Based on the findings obtained for EAS scale and its sub-dimensions, it was determined that the activity development process based on the E→STEM approach enabled the change/development in the environmental awareness levels of the participants.

3.2. Findings regarding the views about the application process

In this part, which constitutes the qualitative findings, the second sub-problem of the research, "What are the views of the experimental group on the implementation process, in which the E→STEM-based activity development process was carried out?" question was examined. The data obtained with the semi-structured interview form were analyzed by descriptive analysis. Opinions on the application process were gathered under the themes of E→STEM approach and environmental awareness, E→STEM activities development process.

E→STEM Approach and Environmental Awareness

E→STEM, which is an interdisciplinary approach that finds application within the scope of environmental education, adopts the goal of creating a positive increase in the level of environmental awareness, environmental literacy and approach to solving environmental problems in individuals. It is very valuable that environmental awareness supports all dimensions of knowledge, positive attitude and beneficial behavior at the same time. Sample expressions for preservice teachers to establish a connection between the E→STEM approach and environmental awareness are presented as follows, emphasizing the codes:

"E→STEM is very effective for environmental education…**doing useful things for the environment improves** students' **environmental awareness (S3)**." "I think that **environmental awareness can be improved by adding environmental issues** to STEM activities in the curriculum. **(S4)**." "Students like **to do something useful for the environment**… It is very important **to do concrete things for environmental education** as well **(S7)**." "It fits with the aims of the science course… **E→STEM**

includes both protecting the environment and loving it (S8)." "E→STEM embodies everything related to the environment, **you suddenly start to notice the environmental problems, you listen** to the problems in the news **more carefully** (**S9).**" "Students can use what they **do in the activity in their daily lives to prevent that problem**, and only **if they really love the environment**, I think it is a very good thing **(S11)**."

E→STEM Activities Development Process

E→STEM approach STEM approach is structured in a process that evolves the product development output that comes from its nature to operating for environmental problems. Engineering design-based science education is a suitable way for the STEM approach, and therefore for E→STEM, due to the flexible nature of the science education and its tolerance to the possible mistakes of the students in the application stages. Sample expressions, codes are presented by emphasizing as follows:

"I heard about E→STEM for the first time and it made **a lot of sense…**environmental education was just like verbal knowledge, but now it has become **much more comprehensive** for me, **I learned a lot of things** while researching a topic for the activity **(S1)**." "Developing an activity, **you really have to think about both economically and environmentalistically… activity cannot be developed for every environmental problem**, I think the student **must have knowledge about the subject of the activity** in order to do it **(S5)**." "Even though the activity is educational, the student should definitely **have a prior knowledge…** I think that if I learned so much, who knows how much it would contribute to the students (S6)." "After this activity development process, I realized **how little environmental activity is in the program…** There are things like preparing posters for the environment, but **I learned that for the environment, it is necessary to know, feel and do (S10)**." "**It is very enjoyable to apply**, but I think it is difficult, **I had great difficulty in finding materials (S11)."**

4. Discussion

In the present research, preservice science teachers' views on the change in environmental awareness levels and the process during the activity development process for the E→STEM approach were investigated. Following the findings, it was decided that the environmental awareness levels of the preservice teachers increased, they expressed positive opinions about the process they experienced, and they made statements compatible with the E→STEM approach.

In the first question, which constitutes the quantitative dimension of the research, the effect of the activity development process for the E→STEM approach on environmental awareness was examined. It has been determined that the E→STEM content presented to the preservice teachers contributes to the development/change of environmental awareness levels. When the environmental awareness scale scores before and after the application were examined, it was decided that the post-test scores of a large part of the preservice teachers increased. In the literature, there are studies that have determined that environmental education-oriented STEM or approach applications based on the partnership of STEM and other disciplines make a positive difference in environmental awareness (Gupta et al., 2018; Nugyen et al., 2020; Yıldırım, 2021). While examining the effect of the application on the environmental awareness dimension, it was revealed that it was also effective in the development/change of environmental knowledge, positive attitude and beneficial behavior. This finding supports studies that indicate that STEM or STEM-based applications for environmental education increase the realization of environmental goals (Syahmani et al., 2021; Widowati et al., 2021; Yeşilyurt, Özdemir-Balakoğlu, Erol, 2020). In addition to the fact that this increase in environmental awareness occurred in all dimensions, it is valuable that it occurred in preservice teachers. The fact that an educator has environmental awareness is in a structure that will ensure that s/he can transfer it to her/his students. (Alkan & Aktemur-Gürler, 2020; Büyükak & Aslan, 2019; Lewin-Benham, 2006). For this reason, environmental awareness in preservice teachers includes continuity in terms of development/change effect.

In the second question, which constitutes the qualitative dimension of the research, the views of preservice teachers on the activity development process of the E→STEM approach were investigated. While preservice teachers stated that environmental awareness can be improved with E→STEM applications, they stated positive statements about the activity development processes. They stated that they made beneficial practices for the environment and that they embodied environmental education in this way. Since STEM education can contribute to individuals' understanding of environmental problems and taking action towards their solution (Burgess & Buck, 2020), it is thought that these views of preservice teachers stem from the process they spent with an environmental education integrated into STEM. The idea of structuring STEM activities in the current science program towards the environment is also a valuable finding. Combining STEM and the environment is important for raising individuals who can solve environmental problems (Yıldırım, 2021). The ideas of the teachers who will educate these individuals to blend the STEM activities within the program with the environment show that they internalize the process. Since the limited experience of teachers in STEM education is known (Burgess & Buck, 2020), it is observed that this has been eliminated with the perspective of changing the existing STEM activities in the practice. Preservice teachers stated that there was a change in their knowledge and interest in the environment during the E→STEM activity development processes they experienced, and that they found environmental education activities to be few in the current science program. Although more importance is given to environmental education in studies aimed at improving education, it is known that currently, there is a lack of teaching materials (Derman & Gurbuz, 2018). Preservice teachers stated that E→STEM activities could not be carried out for the solution of all environmental problems, they had to have prior knowledge and it was difficult to find materials. This finding coincides with studies that determined that teachers are worried about not being able to find materials on the basis of the STEM approach (Çınar & Terzi, 2021).

5. Conclusions

The environment, which is perceived as an abstract concept, is a system in which concrete experiences are experienced with the unity of harmony and balance. Environmental education, which instills the protection of the environment, also has unlimited application areas. Although many ways have been tried and chosen for environmental education, the E→STEM approach differs with its interdisciplinary structure and the possibility of being applied in or out of the classroom. The importance of individuals receiving education in this approach is equivalent to the necessity of educators to be able to design this application. For the process of designing an E→STEM activity with preservice teachers, who are the educators of the future, the impact on the level of environmental awareness and the views on the process were examined, and it was determined that the application had a positive effect in both respects. In this process, preservice science teachers have deepened their environmental knowledge, their attitudes towards the environment have increased, and a good effect has been created, supported by references to the behavioral dimension of the process. Their awareness of the limitations of environmental activities and their desire to change the activities within the scope of the science curriculum based on the environment are indicators of their internalization of the process.

6. Recommendations

The most effective way to address environmental problems is to turn environmental ideas into actions through an effective environmental education program. It is of great importance to clarify the framework of the studies to be carried out to combine the action and product-oriented STEM approach with nature. Based on the results of the research, it is thought that researches on the application of the E→STEM approach in environmental education should be intensified and applications covering a wide period of time should be made for more information. It is recommended to enrich the Environmental Education course content with E→STEM content in teacher education and to include these approach activities in the science course curriculum in parallel.

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