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Exploring preservice science teachers' attitudes toward environmental technologies

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Abstract

Understanding attitudes toward environmental technologies appears essential because of the need for profound societal changes associated with using new technologies to protect the environment. However, a lack of research investigating the attitudes of preservice science teachers toward environmental technologies exists in the current research literature. Therefore, this study aimed to examine preservice teachers' attitudes toward environmental technologies. A total of 196 students enrolled in a large Russian public university formed the participants of this research. Researchers used a scale for data collection. We administered the scale to the participants in the spring semester of the 2022 year. This scale included three sub-dimensions and 24 items. We analyzed pre-service teachers' attitudes in age, branch, and gender. The results showed that the developed scale consisted of three dimensions: positive, benefit, and negative. The results demonstrated that the participants in this research demonstrated moderate and low mean scores regarding the positive aspects of environmental technologies. The participants also demonstrated very positive attitudes regarding the benefits of environmental technologies. Regarding the negative aspects of environmental technologies, the participants had the lowest mean scores compared to the other items of the first two factors. The results also revealed some significant differences in participants' age, branch, and gender. In conclusion, we discuss educational implications for promoting the environmental attitudes of preservice teachers about environmental technologies.

Keywords: environmental technologies, preservice science teachers, science education, attitude

INTRODUCTION

Since the 1980s, environmental education (EE) has received considerable research attention worldwide (Mahasneh et al., 2017). Research has primarily examined participants' attitudes, behaviors, and knowledge to understand how participants view potential environmental changes and their attitudes toward these alterations. In particular, these include participants' attitudes, behaviors, perceptions, and views about biodiversity loss, climate change, ozone layer depletion, global warming, hazardous chemicals, and the potential impact of new technologies on the environment. The negative effects of human activities have led to the need to educate individuals in schools to raise awareness and make EE important to all education stakeholders. The goal of EE in the educational programs of many countries is to educate people who have the

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Contribution to the literature

- Understanding attitudes toward environmental technologies seems essential since using new technologies to protect the environment requires profound societal changes.
- The current literature lacks research on preservice science teachers' attitudes toward environmental technologies.
- The results show that participants had moderate and low mean scores on the subfactors of environmental technologies. Participants had more positive attitudes toward the benefits of environmental technologies.

necessary attitudes, awareness, knowledge, and behaviors to overcome the negative effects of environmental problems, engage in environmentally friendly behaviors, participate in environmental research, and be involved in the problem-solving process regarding the negative consequences of environmental developments (Chen et al., 2020; Ordon et al., 2021; Reid et al., 2021). Thus, the main principle of EE is for individuals to gain a critical perspective, make informed decisions about environmental issues, and take an active role in addressing environmental problems and protecting the environment (Arvai et al., 2004; Li et al., 2020; Ordon et al., 2021). Researchers and policy documents have agreed that all goals related to the environment can be achieved with a well-established EE and informed people about the environment. Education is key for EE to develop attitudes toward the environment and environmental issues that affect humanity's current and future environmental problems (Esa, 2010). Since EE aims to improve the quality of people's lives and educate students about a healthy and sustainable environment, it is important that the attitudes of preservice teachers, who will be the future teachers and teach about environmental issues and problems, about the environment, be captured at the EE level (Goulgouti et al., 2019; Husamah et al., 2022).

New environmental technologies include many specific methods that scientists have developed through new applications and developments of environmental sciences, such as carbon capture and storage (CCS) technology (Sun et al., 2020), to reduce CO2 emissions and thus prevent the harmful effects of climate change and environmental problems. Considering that many countries in the world have accepted CCS technology to promote scientific research and the development of applications and projects, it is important to prepare students and teachers to adapt and provide that they use such new technologies to solve and overcome environmental problems. All these environmental technologies can be grouped under the term green energy. In the last decade, the number of research papers on green energy and environmental technologies in the literature has increased dramatically (Tan et al., 2021). In general, new environmental technologies such as green energy include a total of environmental know-how that involve new applications and developments to solve environmental problems by developing new technologies to monitor and reduce the harmful effects of human activities in the world. Undeniably, the acceptance of new technologies depends on people's social acceptance and social support (Sun et al., 2020). In particular, skepticism, negative attitudes, and prejudice will lead to uncertainties in accepting and using these technologies. Challenges arising from new technologies will negatively affect people's attitudes and behaviors. In particular, education plays a crucial role in providing and promoting the acceptance of new environmental technologies in people's lives and helping them to solve environmental problems. Therefore, it is essential to understand the attitude of preservice science teachers (Niyazova & Khuziakhmetov, 2021).

Over the years, much research has highlighted the importance of attitudes in cultivating people with pro-environmental behaviors in schools and examined preservice science teachers' attitudes toward the environment. In the last decade, the number of studies on attitudes toward the environment has increased. To this end, many studies have been conducted to understand preservice science teachers' attitudes toward environmental protection. For example, Özden (2008) studied the awareness and attitudes of preservice teachers in Turkey. The results showed that female elementary school teachers in the final year of a training program, who have less than three siblings with high socioeconomic levels and live in the Marmara region, have more positive attitudinal attitudes than the other student teachers. Female student teachers had a more positive attitude in all dimensions of environmental attitude. Elementary school teachers had more positive attitudes toward environmental issues than math and social studies teachers. Koc and Kuvac (2016) examined preservice science teachers' attitudes toward the environment and differences concerning gender and grade level. Their results showed that preservice science teachers have moderately positive attitudes toward the environment. In addition, a significant gender difference was found in favor of female teachers on the dimensions of overall activism and environmental movement, environmental threat, and support for population growth policies. In addition, they found significant differences in favor of senior preservice teachers according to grade level on overall and human utilization of nature, support for the population growth policy of EAI. In a recent study, Basheer et al. (2022)

investigated the level of awareness about green chemistry and sustainability and attitudes toward environmental education of preservice and in-service science teachers in Israel. Their results showed that teachers' awareness of sustainability and green chemistry was generally low, although their attitudes toward environmental education were mostly positive. It was found that teachers in education have more knowledge about green chemistry and sustainability than pre-service science teachers. In a study conducted with Malaysian preservice science teachers, Esa (2010) investigated the environmental knowledge, attitudes, and practices of pre-service secondary school teachers enrolled in a biology education course as part of a science education degree program. Results indicated that students had positive attitudes toward the environment and scored an average of 78% overall. Most students believe that today's environmental problems are due to human activities.

Teksoz et al. (2010) investigated prospective chemistry teachers' level of environmental literacy and their perceptions of environmental education. The prospective chemistry teachers demonstrated promoting environmental awareness, developing an awareness and sensitivity to the whole environment, and acquiring social values to protect natural resources through teaching environmental topics. The results also showed that these participants had a positive attitude toward the environment and a sense of personal responsibility for creating a better environment. However, pre-service chemistry teachers did not soundly understand environmental issues. Although the participants lacked the necessary subject matter knowledge, they were willing to incorporate environmental topics into their teaching practices. In another study, Ozsoy (2012) investigated the attitudes of Turkish pre-service science teachers toward the environment and the differences in their attitudes concerning grade level and gender. The study results show that pre-service science teachers have a high level of environmental attitudes. The results also showed a statistically significant mean difference between males and females in favor of females, with a small effect size. The results also showed no significant differences between teachers enrolled in different grade levels regarding their environmental attitudes. In Jordan, Abu-Alruz and Salah Hailat (2018) investigated the attitudes of science students at a public university toward sustainable development. The results show that the attitude of science students towards the environment as a pillar of sustainable development is negative. Regarding the environmental dimension, the overall mean of the students' responses to this dimension reflected a negative response. In other words, students had a negative attitude toward the environment as a practice of sustainable development. They believed that human environmental intervention could have disastrous consequences on people's quality of life. In addition, students believed that industrial growth, agricultural production, and building developments were more important than environmental protection.

Rachmatullah and Ha (2018) investigated the impact of fieldwork activities on Indonesian pre-service biology teachers' attitudes toward the environment and self-reported conservation behavior. Their results showed that fieldwork was a moderating factor in establishing the relationships between ecocentric concern and personal conservation behavior and between attitude toward human use and personal conservation behavior. They concluded that higher scores among Indonesian pre-service biology teachers on their attitude, concern, and sense of environmental loss would increase the frequency of their daily conservation behavior. Regarding preservice science teachers' moral reasoning and attitudes toward a sustainable environment, Alpak-Tunç and Yenice (2017) found that the preservice science teachers had an ecocentric attitude, and their attitude toward a sustainable environment was high. They also found that when the participants' scores on the ecocentric, antropocentric, and hostile attitudes toward the environment increased, their scores on the scale of sustainable environment attitude increased. However, when their scores increased in the hostile attitude dimension, they decreased in the sustainable environmental attitude scale. Gan and Gal (2017) examined self-efficacy for promoting sustainability education, including pro-environmental behaviors and environmental attitudes. Their results revealed that pre-service teacher characteristics with high levels of self-efficacy in promoting education for sustainability included positive attitudes toward the environment, pro-environmental behaviors in private and public settings, and belief that the education for sustainability course taught relevant skills for promoting education for sustainability. The results of this study showed a discrepancy between attitudes and actual behaviors. They found that positive attitudes toward the environment were higher than the willingness to engage in social and environmental change in both the private and public spheres.

In addition to these research studies, other studies in the literature have investigated other variables, including attitudes toward the environment (Evert et al., 2022) and environmental education (Basheer et al., 2022; Niyazova & Khuziakhmetov, 2021; Perez-Rodriguez et al., 2017; Sinan et al., 2022), environmental awareness (Özden 2008), environment-friendly behaviors (Uçar & Canpolat, 2019), knowledge (Esa, 2010; Özden 2008), and practice (Esa, 2010). The research findings presented above indicate that studying future teachers' attitudes is necessary to understand the contribution of future teachers to cultivating and promoting environmentally friendly people in schools. However, to our knowledge, no study has been conducted in the current literature that addresses the attitudes of preservice science teachers. Furthermore, none of the existing studies on preservice science teachers' attitudes toward environmental attitudes have examined their attitudes toward environmental technologies. For this reason, the present study has the potential to contribute to the existing literature. We believe that the results of this study will provide teachers and educators with important insights into the role of environmental technologies. Therefore, this study aimed to examine preservice teachers' attitudes toward environmental technologies.

METHOD

This study aimed to examine preservice teachers' attitudes toward environmental technologies. We used a quantitative research approach with a survey to answer the research question and determine preservice science teachers' attitudes toward environmental technologies. Using the survey method, we aimed to describe the situation in which preservice science teachers find themselves.

Participants

The participants in this study consisted of 196 preservice science teachers enrolled in undergraduate studies at a large public research college in Russia. Participants were 181 (92.3%) female and 15 (7.7%) male preservice science teachers and were between 18 and 22 years old. Of the participants, 112 were enrolled in science education (57.1%), 29 in chemistry education (14.8%), and 55 in biology education (28.1%). Participants' ages varied from 18-19 (n=113, 57.7%), 20-21 (n=59, 30.1%), and 22 and older (n=24, 12.2%).

Data Collection

We collected data by obtaining participants' personal information and using an attitude scale. We requested the participation of the preservice teachers and answer the scale. We observed that they answered the attitude scale in about thirty minutes during the spring semester of 2022. The research was conducted in May 2022. We invited the preservice teachers to participate in the study, and all volunteered to participate. We guaranteed that their responses to the scale would be anonymous and confidential.

Data Collection Instrument

For data collection, we adapted a scale developed by Şenel Zor and Kan (2021) for the present study. Şenel Zor and Kan (2021) developed their scale to measure preservice science teachers' attitudes toward nanotechnology. They designed the scale in the form of a five-point Likert scale. Their analyzes yielded a total of 24 items and a three-factor structure. They named the factors as a benefit, negative, and positive. To use this scale in this research, firstly, three academicians translated the scale's items into Russian to complete the adaptation process of the scale. They had advanced Russian and English language skills and degrees in science education. The authors informed the academicians about the study's purpose and the scale's structure. Later, the translated items from English to Russian were sent to three academics to check the translation of the items. We asked the academician to choose the appropriate translation for each item. We requested them to choose the most appropriate translation for each item. When we reviewed the feedback on the translated items, we found that many items had the appropriate translation. Then, two authors reviewed the feedback of the expert academicians and completed the final versions of the items.

In this research, we first examined the factor structures of the scale developed by Şenel Zor and Kan (2021). For this purpose, we conducted an exploratory factor analysis (EFA) to reveal the factor configuration of the scale items and to test the appropriateness of the factor structures of the original scale. The EFA was performed to determine the factor structures. We found a KMO value of .899 to test the sample's suitability. Therefore, we continued to analyze the factor structures. As a result of this analysis, we found three factors with an eigenvalue greater than 1 (Hair et al., 2006), and we found that the items were distributed among the corresponding factors, as in the study of Şenel Zor and Kan (2021). In addition, the scree plot showed a structure with three factors. Moreover, the R program's correlation heatmap confirmed the original factor structure's three-factor structure (see **Figure 1**). Three groups of "items" are positively correlated with each other. Later, we performed a CFA with the data according to the original structure of the scale. These results show that items ("states" in the figure) 1-9 belong to the first-factor group, the "positive factor," items 10-18 belong to the second-factor group, the "benefit factor," and the remaining items, 19-24, belong to the "negative factor" group.

The data obtained after applying the scale consisting of 24 items to the participants were transferred to application R, and confirmatory factor analysis (CFA) was performed using this program. In this analysis, we used certain fit indices for the data set to confirm factor structures. These indices are CFI and RMSEA. The Comparative Fit Index (CFI) is less affected by sample size and ranges from 0 to 1, with a value close to 1 indicating a good fit (Shi et al., 2019). Also, another fit indices, Tucker-Lewis Index (TLI), should be close to 1 for a good fit. The TLI was found to be .804 in the analysis. Root Mean Square Errors (RMSEA) are an indicator of approximate fit in the population, and if it is less than or equal to 0.05, it is an indicator of good fit. It can be seen that almost perfect measurement results were obtained for the fit indices (CFI = .824, RMSEA =

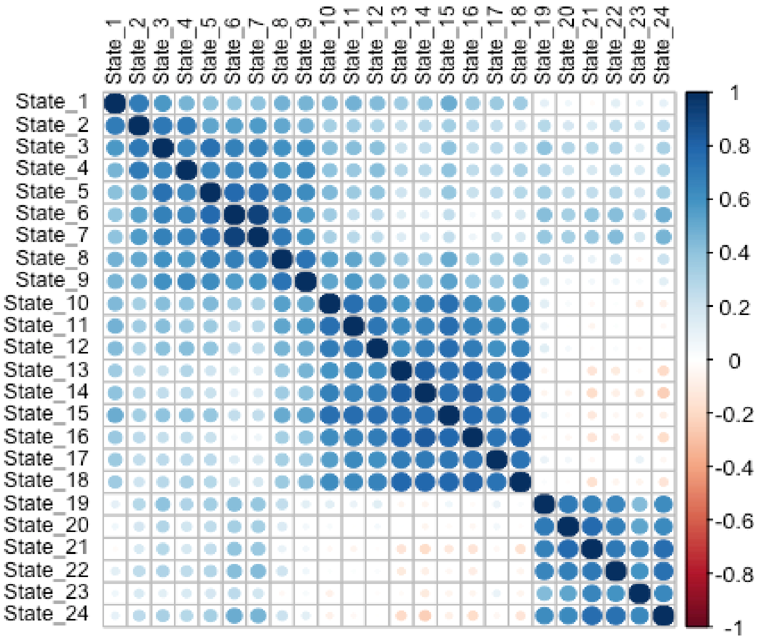

Figure 1. The R program's correlation heatmap (Source: Authors' own elaboration using R program)

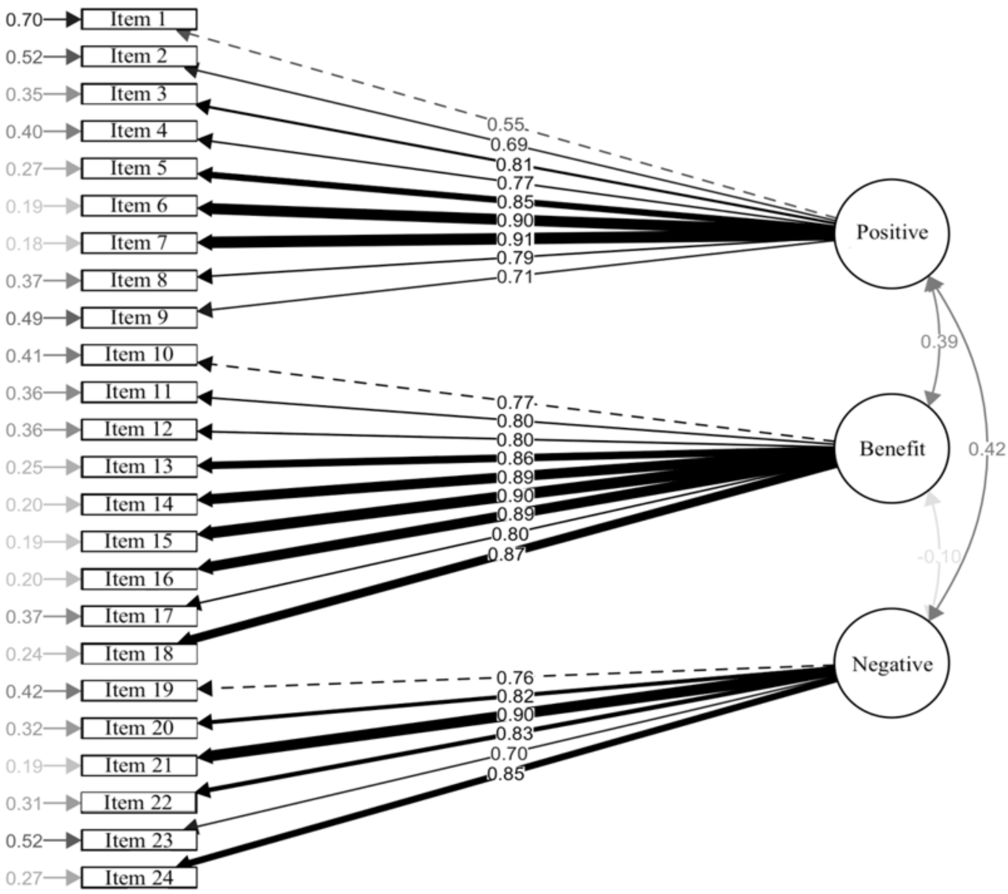

Figure 2. Standardized correlation coefficients of the scale ($p < 0.001$; CFI = .824, RMSEA = .128, TLI = .804) (Source: Authors' own elaboration using IBM SPSS Statistics for Macintosh, Version 29.0)

.128). Moreover, all relationships (paths) between items and factors are statistically significant ($p < 0.001$). The contribution of the items to the factors ranges from 0.55 to 0.90. These results significantly contribute to the factors which are associated with each item. **Figure 2** shows the tested model in confirmatory factor analysis.

We conducted reliability analyses for each scale's subdimension after its factor structures were confirmed (see **Table 1**). According to this analysis, the reliability coefficient of the "factor 1" dimension (Cronbach's alpha - α) was .927, the reliability coefficient of the "factor 2" dimension was .923, the reliability coefficient of the

Table 1. Cronbach's Alpha values for each factor

Factors	Number of Items	Cronbach's Alpha
Factor 1	9	.927
Factor 2	9	.923
Factor 3	6	.901

"factor 3" dimension was .901, and the reliability coefficient for the overall scale was .904. We found Cronbach's Alpha score as .904 after analyses. These values indicate that the reliability of the overall scale and its subscales are very good.

Data Analysis

For the statistical analysis, we used the SPSS program. We used descriptive analysis to determine participants' attitudes toward environmental technologies. We used normality, mean, and standard deviations for the descriptive analysis. When we conducted a normality check in the SPSS program, we found that the data did not show a normal distribution. Therefore, we used non-parametric tests for data analysis to answer the research question, including the Mann-Whitney U test and Kruskal Wallis tests. The significance level for the statistical analysis was set at .05.

RESULTS

Table 2 shows the descriptive statistics for all items of the scale. The first factor of the scale consists of nine items related to the positive aspects of environmental technologies. All items of this factor resulted in moderate and low mean scores regarding the positive aspects of environmental technologies. The five items of this factor received moderate mean values. The items with the highest mean values are the first and the ninth. The first item refers to the organization of environmental technologies when the participants have the opportunity to organize them. The ninth item refers to feeling comfortable during environmental technologies training and activities. The other two items that received the highest mean scores in this factor were related to creating a website/blog and organizing a course on environmental technologies. These results indicate that the preservice science teachers partially support teaching activities about environmental technologies. However, the sixth item, related to a career in environmental technologies, received the lowest mean scores in this factor.

The second factor included nine items emphasizing the benefits of environmental technologies. As shown in **Table 1**, participants rated the items of this factor very positively, and the items with the highest mean scores

Table 2. Descriptive statistics for all items

Factors	Item Number	Items	Mean	SD
Factor 1	1	If I have an opportunity, I organize environmental technologies activities.	3.84	1.10
	2	I would like to create a website/blog on environmental technologies.	3.27	1.25
	3	I research about environmental technologies.	2.81	1.31
	4	If I have an opportunity, I provide that environmental technologies are given as a course.	3.17	1.18
	5	I follow publications related to environmental technologies.	2.91	1.33
	6	I want to make a career in the environmental technologies field.	2.18	1.29
	7	I want to prepare a environmental technologies curriculum.	2.31	1.31
	8	I like talking about environmental technologies.	3.08	1.23
	9	I feel comfortable in environmental technologies-themed training or activities.	3.49	1.02
Factor 2	10	Environmental technologies affect economic activities positively.	3.97	.85
	11	Environmental technologies provide to obtain more efficient products.	4.22	.75
	12	I believe that environmental technologies will make our life easier.	4.21	.80
	13	I find environmental technologies researches useful.	4.42	.67
	14	I believe that environmental technologies researches are necessary.	4.46	.65
	15	Environmental technologies contribute to social development.	4.31	.73
	16	Environmental technologies increase the quality of life.	4.46	.65
	17	Environmental technologies are a revolutionary development.	4.20	.79
	18	Environmental technologies help us to understand the natural world.	4.31	.71
Factor 3	19	I move away from the environment where environmental applications are talked.	2.32	1.33
	20	I change the channel when I meet news or advertisement related to environmental technologies on television.	2.34	1.24
	21	I get bored when I hear the news, advertising, etc. about environmental technologies.	2.19	1.12
	22	I get uncomfortable with environmental technologies research.	2.21	1.20
	23	I do not explain my opinions in conversations or discussions about environmental technologies.	2.54	1.17
	24	Environmental technologies are not worth learning.	1.64	1.08

Table 3. Descriptive statistics for each factor

	N	Minimum	Maximum	Mean	Std. Deviation
Factor1	196	1.00	5.00	3.00	.98
Factor2	196	3.00	5.00	4.28	.58
Factor3	196	1.00	5.00	2.20	.98

Table 4. Mann-Whitney U test results for three factors in terms of gender

	Group	N	Mean	Sum of Ranks	U	p
Factor 1	Female	181	97.01	17558	1087	.200
	Male	15	116.53	1748		
Factor2	Female	181	99.36	17984	1202	.459
	Male	15	88.13	1322		
Factor 3	Female	181	96.17	17406	935	.045
	Male	15	126.67	1900		

Table 5. Kruskal-Wallis Test results for three factors in terms of age

	Groups	N	Mean Rank	sd	X^2	p	Sig. Difference
Factor 1	18-19	113	91.25	2	11.601	.003	18/19 and 22 and above
	20-21	59	97.71				20/21 and 22 and above
	22 and above	24	134.58				
Factor2	18-19	113	94.98	2	11.835	.003	18/19 - 22 and above
	20-21	59	90.32				20/21 - 22 and above
	22 and above	24	135.19				
Factor 3	18-19	113	92.07	2	3.724	.155	
	20-21	59	105.18				
	22 and above	24	112.35				

were classified into this factor. The result shows that the items of this factor have high recognition values, ranging from 3.93 to 4.46. In particular, the two items related to the quality of life obtained the highest mean scores (M=4.46, items 14 and 16) in this factor. From this result, we can conclude that pre-service teachers favor environmental technologies when they are used to improve people's quality of life. The other two items with higher mean values relate to contributing to social development and understanding of the natural world through environmental technologies (M=4.31, items 15 and 18). Item 10, indicating that environmental technologies positively influence economic activities, has the lowest mean in this factor.

The items of the third factor refer to the negative aspects of environmental technologies. In particular, the six items of this factor received the lowest mean scores compared to the other items of the first two factors. Specifically, the results show that participants do not support the item stating that it is not worthwhile to learn environmental technologies. The results show that participants do not support these items because all items in this factor consist of negative items.

The descriptive statistics regarding three factors in the scale are presented in **Table 3**. It appears in **Table 3** that preservice science teachers' attitudes toward environmental technologies were found to be high for factor 2 in terms of the total mean score ($\bar{X}$=4.28). The results also showed low mean scores for factor 1 ($\bar{X}$=3.00) and factor 3 ($\bar{X}$=2.20). Interestingly, the standard deviations for these two factors are high (.98). In factor 2, the standard deviation score was found as .58.

We conducted a Mann-Whitney U test to determine statistical differences between the mean scores of female and male preservice teachers on three factors of the scale (**Table 4**). The results showed no significant differences between female and male preservice teachers for factor 1 (U=1087, $p > 0.05$). The results also showed no significant differences between genders for factor 2 (U=1202, $p > 0.05$). The results regarding the third factor showed significant differences between female and male preservice teachers (U=935, $p < 0.05$). Therefore, we conclude that the gender variable has an impact on the third factor.

We performed the Kruskal-Wallis test to determine the statistical differences between the age groups of the participants according to each factor. The results in **Table 5** show significant differences between the age groups of the participants in their responses for factor 1 ($X^2_{(2)}$=11.601, $p < 0.05$) and factor 2 ($X^2_{(2)}$=11.835, $p < 0.05$). However, the results regarding the age of the participants and factor 3 showed no significant differences ($X^2_{(2)}$=3.724, $p > 0.05$).

We performed the Kruskal-Wallis test to determine the statistical differences between the participants' branches for each factor. The results in **Table 6** showed no significant differences between the branch groups of the participants in their responses for all three factors ($X^2_{(2)}$=.692, $p > 0.05$; $X^2_{(2)}$=.312, $p > 0.05$; $X^2_{(2)}$=.976, $p > 0.05$).

Table 6. Kruskal-Wallis Test results for three factors in terms of branch

	Groups	N	Mean Rank	sd	X^2	p	Sig. Difference
Factor 1	Science Education	112	95.57	2	.735	.692	-
	Chemistry Teacher Education	29	100.83				
	Biology Teacher Education	55	103.25				
Factor2	Science Education	112	98.47	2	2.328	.312	-
	Chemistry Teacher Education	29	111.47				
	Biology Teacher Education	55	91.72				
Factor 3	Science Education	112	97.74	2	.049	.976	-
	Chemistry Teacher Education	29	99.81				
	Biology Teacher Education	55	99.36				

DISCUSSION

This study aimed to examine preservice teachers' attitudes toward environmental technologies. Overall, the participants in this research demonstrated moderate and low mean scores regarding the positive aspects of environmental technologies. The participants also showed very positive attitudes regarding the benefits of environmental technologies. The items in the second factor revealed the highest mean scores. Regarding the negative aspects of environmental technologies, the participants had the lowest mean scores compared to the other items of the first two factors. In general, our findings are not similar to those of studies that examined the preservice science teachers’ attitudes toward the environment in the literature. The existing studies in the literature reported positive or higher mean scores for the preservice science teachers’ attitudes regarding the environment. In terms of this detail, our findings about the participants’ attitudes toward the environment are not consistent with those of the research studies in the literature (Esa, 2010; Gan & Gal, 2017; Koc & Kuvac, 2016; Ozsoy, 2012; Özden, 2008; Rachmatullah & Ha, 2018; Teksoz et al., 2010). On the other hand, our findings are partly similar to those of Abu-Alruz and Salah Hailat (2018), who found that science students' attitudes at a public university in Jordan toward the environment as a pillar of sustainable development are negative.

The results regarding participants’ gender for each factor revealed no significant differences between female and male preservice teachers for factor 1 and factor 2. The results regarding the third factor showed significant differences between female and male preservice teachers. From this result, we can conclude that gender is a variable that impacts the attitudes toward the third factor, which is related to negative aspects of environmental technologies. In particular, male participants had the highest mean scores compared to female participants regarding the negative aspects. This result means that female preservice science teachers support the activities and application of environmental technologies and have more positive attitudes than male participants. This finding is similar to those of Koc and Kuvac (2016) found that preservice science teachers have moderately positive attitudes toward the environment. In addition, a significant gender difference was found in favor of female teachers on the dimensions of overall activism and environmental movement, environmental threat, and support for population growth policies. This result is also similar to those of Ozsoy (2012), who found a statistically significant mean difference between males and females in favor of females, with a small effect size. The results also show no significant differences between teachers enrolled in different grade levels regarding their environmental attitudes. The findings are also very similar to those of Özden (2008) found that female student teachers had a more positive attitude in all dimensions of environmental attitude.

Regarding participants’ age, our results showed significant differences in environmental technologies' positive and beneficial aspects. The participants who were above 22 age had the highest mean scores regarding environmental technologies. This result is very similar to that of Özden (2008), who found significant differences in student teachers' attitudes toward environmental issues and that fourth-year student teachers have more positive attitudes toward environmental issues than first-year preservice teachers. In addition, our results related to the age of the participants are similar to the findings of Koc and Kuvac (2016), who found a statistically significant difference between senior and other grade levels in favor of older preservice science teachers in terms of attitudes toward the environment. The differences between the different age levels could be due to the experiences of older preservice science teachers with environmental courses at the university. Similarly, Ozsoy’s results (2012) revealed no significant differences between teachers enrolled in different grade levels regarding their environmental attitudes.

Our results with the branches of participants revealed no significant differences among the three science education departments, including biology, chemistry, and science education undergraduate students. Specifically, we could not find any research studies examining the differences among preservice science teachers' branches in literature. For this reason, we do not report differences and similarities between previous studies and the present paper. This finding could be because the preservice teachers had similar experiences with environmental courses and topics and had similar educational backgrounds.

CONCLUSION

This study aimed to examine preservice teachers' attitudes toward environmental technologies. Given the lack of research on preservice science teachers' attitudes toward environmental technologies, the findings of this study are important in contributing to the studies of environmental education in literature. Therefore, this study helped to fill a research gap in the literature and add new findings to researchers' knowledge. The results of this study provide a basis for future research. In addition, this study has some limitations. First, this study's data collection method was limited to quantitative data. Second, the study was conducted to investigate participants' attitudes toward environmental technologies. Further studies should be conducted by including additional variables in attitudes. For example, further studies on preservice science teachers' self-efficacy and beliefs about new environmental technologies should be conducted to provide new contributions to the literature. In conclusion, further research should be conducted to propound new results to the literature and provide new contributions to developing a deeper understanding of preservice science teachers.

RECOMMENDATIONS

Future research needs to address the understanding of teachers-in-training of environmental technologies. To this end, further research is needed to gain general insights into the attitudes of preservice science teachers. Considering that some environmental technologies are new and new technologies will emerge, more education for pre-service teachers is needed to increase their awareness and attitudes toward environmental problems and help them solve them. Educators in universities should provide opportunities for pre-service teachers to develop their knowledge and skills on environmental issues and problems and strive for effective environmental education. For pre-service and in-service teachers, lifelong environmental education can be considered through current teaching methods. When teaching environmental education, the fields of STEM and the potential impact of environmental issues and problems should be considered to be taught in terms of STEM.

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Declaration of interest: No conflict of interest is declared by authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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