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RESEARCH ARTICLE

An Examination of Pre-Service Teachers' Awareness of Global Climate Change and Their Literacy on Renewable Energy Sources

Elif Ünal[1] • Ayşe Nesibe Önder[2]✉ • Ezgi Güven Yıldırım[2]

[1]Ministry of National Education, Şırnak/Türkiye
[2]Gazi University, Faculty of Education, Department of Math and Science Education, Ankara/Türkiye

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ABSTRACT

The aim of this study is to examine the literacy of pre-service teachers from different disciplines regarding renewable energy sources and their awareness of global climate change in terms of various variables. For this purpose, the research was conducted using a descriptive survey model. The study group consisted of 196 pre-service teachers selected through purposive sampling. According to the results, no significant difference was found between genders for either variable, whereas, a significant difference was found in favor of the primary education department. Furthermore, when the difference in global climate change awareness was examined according to the levels of literacy regarding renewable energy sources, it was found that those with higher literacy levels also had higher awareness of global climate change. Finally, when pre-service teachers' literacy regarding renewable energy sources was analyzed based on their awareness of global climate change, it was observed that there were significant differences between moderate and low levels, as well as between high and low levels of awareness. To conclude it is important to determine the current situation regarding pre-service teachers' awareness of global climate change and their literacy about renewable energy sources together, as such an examination contributes to addressing the increasingly destructive environmental problems of today.

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1. Introduction

Since the existence of humankind, people have continuously interacted with their environment. In order to solve problems encountered in daily life, meet their needs, and improve their level of welfare, they have inevitably consumed environmental resources. In recent years, however, both the scale and the pace of this consumption have increased dramatically (Erten, 2005). Particularly in the 21st century, the growing use of non-renewable energy resources has become one of the major environmental challenges, contributing significantly to global climate problems. The current dependence on non-renewable energy resources accelerates the depletion of energy supplies. In fact, there is no type of energy in nature that cannot be renewed; however, due to the nature of their formation processes, some energy sources require extremely long periods to regenerate. These sources, which take a long time to renew and are rapidly depleted, are referred to as non-renewable energy resources (Soral, 2020). Most energy needs today are met by fossil fuels. The rapid depletion of fossil fuels and other energy resources negatively affects both national economies and the environment (Göcük & Şahin, 2016). Therefore, the utilization of renewable rather than non-

✉ Correspondence
E-mail address: nkoklukaya@gazi.edu.tr

renewable energy sources is increasingly encouraged. Renewable energy sources are those that, within the natural cycle, are available the next day in the same form, exist within a continuous cycle, regenerate faster than their rate of consumption, and can be reused repeatedly (Gezer, 2013). The excessive and unconscious consumption of energy resources is among the primary causes of climate-related problems.

Climate is defined based on long-term averages of meteorological elements such as wind, precipitation, and temperature, accumulated over millions of years. The climate system is influenced not only by its internal components-such as the Earth's surface, atmosphere, snow and ice cover, and water bodies-but also by natural external factors, including solar radiation and volcanic activity. In addition, human activities are considered anthropogenic factors that significantly affect the climate system. Any change occurring in one element of the system sequentially influences other components as well (Dölek & Yazıcı, 2018; Le Treut et al., 2007).

Climate change has occurred throughout history; however, human impact and the rapid accumulation of carbon today have accelerated this process, negatively affecting all living beings. Raising awareness can help prevent these adverse effects (Deniz et al., 2021). In recent years, the impact of human activities on environmental systems has increasingly gained attention in research. Studies have shown that human-induced changes produce directly observable effects and occur at a much faster rate compared to natural processes (Schlesinger et al., 2007). These impacts are not limited to specific sectors; they can significantly disrupt ecosystem structure, function, and biodiversity (Yasuhara et al., 2012). Therefore, addressing environmental problems requires not only technological or biological solutions but also the implementation of multidisciplinary approaches that place human–environment interactions at the center (Mumtaz et al., 2022). The OECD also emphasizes that environmental education should aim to shift from "knowledge transmission to behavioral change" (OECD, 2021). Societies' concerns about the future have increasingly heightened their interest in environmental issues. Efforts to secure tomorrow have brought environmental problems to the forefront of public awareness (Keleş et al., 2012). However, while individuals attempt to address environmental issues, they may possess insufficient or incorrect knowledge regarding energy, energy resources, and energy consumption habits. These misconceptions hinder individuals from finding solutions to environmental phenomena such as global warming and discourage them from seeking alternative energy options. Education plays a crucial role in fostering literacy and awareness regarding these problems (Akitsu et al., 2017; Bodzin et al., 2013; Demirbağ, 2019). In the field of education, necessary knowledge, skills, and values can first be integrated into the teaching process through teachers to enable students to handle such situations in their daily lives (Liarakou et al., 2009). In particular, the goal of science education is to equip students with scientific process skills and fundamental scientific concepts, while also enabling them to apply these concepts in everyday life (Güven et al., 2019). Achieving these goals, however, requires that teachers and pre-service teachers-who play a pivotal role in education-possess adequate competencies and high levels of awareness in these areas (Cebesoy & Karışan, 2017). Several studies have examined teachers' and pre-service teachers' attitudes, knowledge, and awareness regarding energy resources and global climate change (Baysal & Daşdemir, 2023; Cebesoy & Karışan, 2017; Güven Yıldırım et al., 2022; Karabulut, 2023; Karakaya Cırıt, 2017; Koç et al., 2018; Yılmaz & Aydoğdu, 2020; Yiğit & Özel, 2023). However, no study in the literature has simultaneously addressed both variables. Considering that education begins with families during childhood and continues through teachers in later years, there is a need to examine more deeply the literacy of teachers regarding renewable energy sources and their awareness of global climate change. In this context, the purpose of the present study is to investigate pre-service teachers' literacy concerning renewable energy sources and their awareness of global climate change in relation to various variables. Based on this purpose, the sub-problems of the research were determined as follows.

1. Do pre-service teachers' literacy levels regarding renewable energy sources differ statistically according to their gender and department?
2. Do pre-service teachers' awareness of global climate change differ statistically according to their gender and department?
3. Is there a statistically significant difference in pre-service teachers' awareness of global climate change based on their literacy levels regarding renewable energy sources (low, medium, and high)?
4. Is there a statistically significant difference in pre-service teachers' literacy regarding renewable energy sources based on their awareness levels of global climate change (low, medium, and high)?

2. Method

This study was conducted with the approval of the Gazi University Ethics Committee, dated 13.12.2021, with protocol number 2021/1129.

2.1. Research Design

This study employed a descriptive survey design to examine pre-service teachers' literacy regarding renewable energy sources and their awareness of global climate change. Descriptive survey research aims to determine the existing situation as it is, without intervening in the past or present

conditions (Karasar, 2000).

2.2. Study Group

The study group of the research consisted of a total of 196 pre-service teachers from different disciplines who were enrolled at a state university in Ankara during the 2021–2022 academic year. This method was chosen to ensure the inclusion of participants from specific teaching disciplines relevant to the purpose of the study. The instruments used to collect data included. The demographic characteristics of the study group are presented in Table 1.

Table 1. Demographic characteristics of the participants.

		n	%
Gender	Female	175	89.3
	Male	21	10.7
	Total	196	100.0
Grade Level	2nd Year	123	62.8
	3rd Year	73	37.2
	Total	196	100.0
Department	Science Education	104	53.1
	Primary Education	62	31.6
	Biology	30	15.3
	Total	196	100.0

Among the participants in the study group, 89.3% were female and 10.7% were male. With respect to grade level, 62.8% of the participants were in the 2nd year, while 37.2% were in the 3rd year. Regarding the distribution of their departments, 53.1% were enrolled in Science Education, 31.6% in Primary Education, and 15.3% in Biology Education.

2.3. Data Collection Instruments

Two data collection instruments were used in this study. The first instrument is the "Renewable Energy Literacy Scale" developed by Güven Yıldırım and Önder (2021). The scale, which has been tested for validity and reliability, consists of 20 items on a 3-point Likert-type scale and has two sub-dimensions. The first sub-dimension, "literacy in terms of types of energy sources", consists of 11 items, while the second sub-dimension, "literacy in terms of country and environmental problems", consists of 9 items. The internal consistency coefficients were calculated to determine the reliability of the scale. The internal consistency coefficient of the first sub-dimension was .94, the second sub-dimension was .88, and the overall internal consistency coefficient of the scale was .91. The validity of the scale was ensured through expert opinions.

The second instrument used in the study is the "Awareness Scale of University Students About Global Climate Change" developed by Deniz et al. (2021). This 21-item, 5-point Likert-type scale consists of four sub-dimensions. The reliability coefficients of the sub-dimensions were calculated as follows: "awareness of the effects of global climate change on the natural and social environment", .87; "awareness of global organizations and agreements", .81; "awareness of the causes of global climate change", .814; and "awareness of the energy consumption relation of global climate change", .72. The overall Cronbach's Alpha value of the scale was calculated as .82, indicating good reliability. The validity of the scale was ensured through expert opinions.

2.4. Data Analysis

The data were analyzed using the SPSS 21 statistical software package. Descriptive statistical techniques were used to determine whether the data were normally distributed. Measures of central tendency (mean, mode, median) and measures of dispersion (standard deviation, variance, skewness, and kurtosis) were calculated for the scale scores. For the first and second sub-problems of the study, independent samples t-tests and one-way ANOVA tests were used together. For the third sub-problem, an independent samples t-test was applied, while for the fourth sub-problem, a one-way ANOVA test was conducted.

3. Findings

The normality of the research data was assessed using descriptive analyses. The descriptive statistics for the study data are presented in Table 2 and Table 3.

Table 2. Descriptive statistics of pre-service teachers' literacy regarding renewable energy sources.

Dimension	n	M	SD	Mode	Median	Kurtosis	Skewness	Variance
"Literacy in Terms of Types of Energy Sources"	196	17.76	2.69	20.00	19.00	-.03	-.84	7.26
"Literacy in Terms of Country and Environmental Problems"	196	16.43	1.66	18.00	17.00	.93	-1.12	2.78
"Total Literacy Regarding Renewable Energy Sources"	196	34.19	3.80	38.00	35.00	.11	-.91	14.47

For the data obtained from the Pre-service Teachers' Literacy Regarding Renewable Energy Sources Scale. the closeness of the mode, median, and mean values indicates that the data are normally distributed (Büyüköztürk et al., 2006). Examination of the skewness and kurtosis coefficients in Table 2 shows that both values fall within the ±1.5 range, suggesting

that the data conform to a normal distribution (Tabachnick & Fidell, 2013). Based on these findings, it was concluded that the data on pre-service teachers' literacy regarding renewable energy sources are normally distributed, and thus parametric tests were employed for data analysis.

Table 3. Descriptive statistics of pre-service teachers' awareness of global climate change.

Dimension	n	M	SD	Mode	Median	Kurtosis	Skewness	Variance
"Awareness of the Effects of Global Climate Change on the Natural and Social Environment"	196	40.29	4.38	45.00	41.00	-.11	-.73	19.24
"Awareness of Global Organizations and Agreements"	196	13.77	6.03	6.00	13.00	-1.09	.25	36.44
"Awareness of the Causes of Global Climate Change"	196	7.25	3.05	3.00	7.00	-0.76	.23	9.36
"Awareness of the Energy Consumption Relation of Global Climate Change"	196	13.42	1.84	15.00	14.00	-.00	-.95	3.39
"Total Awareness of Global Climate Change"	196	74.74	9.96	71.00	74.00	-.52	.10	99.31

For the data obtained from the Pre-service Teachers' Awareness of Global Climate Change Scale, the closeness of the mean, median, and mode values indicates that the data are normally distributed (Büyüköztürk et al., 2006). Furthermore, examination of the skewness and kurtosis coefficients in Table 3 shows that both values fall within the ±1.5 range, suggesting that the data conform to a normal distribution (Tabachnick & Fidell, 2013). Based on these findings, it was concluded that the data on pre-service teachers' awareness of global climate change are normally distributed, and parametric tests were therefore employed for data analysis.

3.1. Findings Related to the First Sub-Problem

Under the first sub-problem, the variation in pre-service teachers' literacy regarding renewable energy sources was examined according to gender and department.

First, the results of the independent samples t-test, conducted to determine whether pre-service teachers' literacy levels regarding renewable energy sources differ statistically according to gender, are presented in Table 4.

Table 4. Comparison of pre-service teachers' literacy levels regarding renewable energy sources by gender.

Dimension	Gender	n	M	SD	df	t	p
"Literacy in Terms of Types of Energy Sources"	Female	175	17.76	2.64	194	.08	.93
	Male	21	17.71	3.14			
"Literacy in Terms of Country and Environmental Issues"	Female	175	16.45	1.66	194	.56	.57
	Male	21	16.23	1.70			
"Total Literacy Regarding Renewable Energy Sources"	Female	175	34.22	3.73	194	.30	.75
	Male	21	33.95	4.46			

According to Table 4, there was no statistically significant difference in pre-service teachers' literacy levels regarding renewable energy sources based on gender. Specifically, no significant differences were found in the sub-dimension of literacy in terms of types of energy sources [$t_{(194)} = 0.08$, $p > .05$] or in the sub-dimension of literacy in terms of country and environmental issues [$t_{(194)} = 0.56$, $p > .05$], nor in the total literacy scores regarding renewable energy sources [$t_{(194)} = 0.30$, $p > .05$].

The results of the one-way ANOVA and Post Hoc tests, conducted to examine whether pre-service teachers' literacy levels regarding renewable energy sources differ statistically according to their department, are presented in Table 5.

As shown in Table 5, no statistically significant difference was observed in the sub-dimension of literacy in terms of types of energy sources [$F_{(2, 193)} = 2.25$, $p > .05$] according to the department. However, statistically significant differences were found in the sub-dimension of literacy in terms of country and environmental problems [$F_{(2, 193)} = 4.78$, $p < .05$] and in the total literacy scores regarding renewable energy sources [$F_{(2, 193)} = 4.02$, $p < .05$]. Post Hoc analysis revealed that, in the sub-dimension of literacy in terms of country and environmental issues, the significant differences were between Primary Education (M = 16.88, SD = 1.31) and Science Education (M = 16.34, SD = 1.73), and between Primary Education and Biology Education (M = 15.80, SD = 1.86). Considering the total literacy scores, the differences were observed between Primary Education (M = 35.22, SD = 3.42) and Science Education (M = 33.90, SD = 3.88), and between Primary Education and Biology

Education (M = 33.06, SD = 3.91). These results indicate that pre-service teachers in the Primary Education program have significantly higher literacy levels in terms of country and environmental problems as well as total literacy regarding renewable energy sources compared to those in the other programs.

Table 5. Comparison of pre-service teachers' literacy levels regarding renewable energy sources by department.

Dimension	n	M	SD	df	F	p	Post Hoc
"Literacy in Terms of Types of Energy Sources"							
Science Education (SE)	104	17.5	2.72	2	2.25	.10	-
Primary Education (PE)	62	18.3	2.60				
Biology Education (BE)	30	17.26	2.66				
Total	196	17.76	2.69				
"Literacy in Terms of Country and Environmental Problems"							
Science Education (SE)	104	16.34	1.73	2	4.78	.00	PE >SE
Primary Education (PE)	62	16.88	1.31				PE>BE
Biology Education (BE)	30	15.80	1.86				
Total	196	16.43	1.66				
Total Scale							
Science Education (SE)	104	33.90	3.88	2	4.02	.01	PE >SE
Primary Education (PE)	62	35.22	3.42				PE>BE
Biology Education (BE)	30	33.06	3.91				
Total	196	34.19	3.80				

3.2. Findings Related to the Second Sub-Problem

Under the second sub-problem, the variation in pre-service teachers' awareness of global climate change was examined according to gender and department. First, the results of the independent samples t-test, conducted to determine whether pre-service teachers' awareness levels of global climate change differ statistically according to gender, are presented in Table 6.

Table 6. Comparison of pre-service teachers' awareness levels of global climate change by gender.

Dimension	Gender	n	M	SD	df	t	p
"Awareness of the Effects of Global Climate Change on the Natural and Social Environment"	Female	175	40.44	4.22	194	1.38	.16
	Male	21	39.04	5.49			
"Awareness of Global Organizations and Agreements"	Female	175	13.70	6.01	194	-.45	.65
	Male	21	14.33	6.34			
"Awareness of the Causes of Global Climate Change"	Female	175	7.13	3.00	194	-1.56	.11
	Male	21	8.23	3.38			
"Awareness of the Energy Consumption Relation of Global Climate Change"	Female	175	13.46	1.81	194	.86	.38
	Male	21	13.09	2.07			
Total Awareness of Global Climate Change	Female	175	74.74	9.84	194	.01	.98
	Male	21	74.71	11.21			

As shown in Table 6, no statistically significant differences were observed in pre-service teachers' awareness of global climate change based on gender. Specifically, no significant differences were found in the sub-dimensions of awareness of the effects of global climate change on the natural and social environment [$t_{(194)} = 1.38$, $p > .05$], awareness of global organizations and agreements [$t_{(194)} = -0.45$, $p > .05$], awareness of the causes of global climate change [$t_{(194)} = -1.56$, $p > .05$], or awareness of the energy consumption relation of global climate change [$t_{(194)} = 0.86$, $p > .05$], nor in the total awareness scores [$t_{(194)} = 0.01$, $p > .05$].

Second, the results of the one-way ANOVA and Post Hoc tests, conducted to examine whether pre-service teachers' awareness levels of global climate change differ statistically according to their department, are presented in Table 7.

Table 7. Comparison of pre-service teachers' awareness levels of global climate change by department.

Dimension	n	M	SD	df	F	p	Post Hoc
"Awareness of the Effects of Global Climate Change on the Natural and Social Environment"							
Science Education (SE)	104	39.78	4.56	2	2.07	.12	
Primary Education (PE)	62	41.20	4.15				
Biology Education (BE)	30	40.16	4.03				
Total	196	40.29	4.38				
"Awareness of Global Organizations and Agreements"							
Science Education (SE)	104	13.51	5.97	2	7.07	.00	PE>SE, PE>BE
Primary Education (PE)	62	15.62	5.85				
Biology Education (BE)	30	10.80	5.41				
Total	196	13.77	6.03				
"Awareness of the Causes of Global Climate Change"							
Science Education (SE)	104	6.75	2.94	2	3.78	.02	PE>BE
Primary Education (PE)	62	8.08	3.15				
Biology Education (BE)	30	7.30	2.98				
Total	196	7.25	3.05				
"Awareness of the Energy Consumption Relation of Global Climate Change"							
Science Education (SE)	104	13.22	1.88	2	2.34	.09	
Primary Education (PE)	62	13.83	1.82				
Biology Education (BE)	30	13.26	1.61				
Total	196	13.42	1.84				
Total Awareness of Global Climate Change							
Science Education (SE)	104	73.27	9.88	2	8.28	.00	PE>SE, PE>BE
Primary Education (PE)	62	78.75	9.31				
Biology Education (BE)	30	71.53	9.25				
Total	196	74.74	9.96				

As shown in Table 7, no statistically significant differences were observed in pre-service teachers' awareness levels of global climate change according to department in the sub-dimensions of awareness of the effects of global climate change on the natural and social environment [$F_{(2, 193)} = 2.07$, $p > .05$] and awareness of the energy consumption relation of global climate change [$F_{(2, 193)} = 2.34$, $p > .05$]. However, statistically significant differences were found in the sub-dimensions of awareness of global organizations and agreements [$F_{(2, 193)} = 7.07$, $p < .05$], awareness of the causes of global climate change [$F_{(2, 193)} = 3.78$, $p < .05$], and in the total awareness scores [$F_{(2, 193)} = 8.28$, $p < .05$].

Post Hoc analysis revealed that, in the sub-dimension of awareness of global organizations and agreements, the significant differences were between Primary Education (M = 15.62, SD = 5.85) and Science Education (M = 13.51, SD = 5.97) as well as Biology Education (M = 10.80, SD = 8.41), with the Primary Education mean being significantly higher than those of the other programs. In the sub-dimension of awareness of the causes of global climate change, the significant difference was observed between Primary Education (M = 8.08, SD = 3.15) and Biology Education (M = 7.30, SD = 2.98). Regarding total awareness scores, significant differences were found between Primary Education (M = 78.75, SD = 9.31) and Science Education (M = 73.27, SD = 9.88) as well as Biology Education (M = 71.53, SD = 9.25), with the Primary Education mean being significantly higher than those of the other programs.

3.3. Findings Related to the Third Sub-Problem

In the third sub-problem, the differences in pre-service teachers' awareness of global climate change were examined according to their literacy levels regarding renewable energy sources (low, medium, and high). Since there were no pre-service teachers with low literacy levels based on the scores obtained from the Renewable Energy Sources Literacy Scale, the analysis was conducted only for those with medium and

high literacy levels. The results of the analysis are presented in Table 8.

Table 8. Comparison of pre-service teachers' awareness of global climate change by literacy levels regarding renewable energy sources.

Dimension	Literacy Level (RESL)	n	M	SD	df	t	p
"Awareness of the Effects of Global Climate Change on the Natural and Social Environment"	Medium	55	38.32	4.82	194	-4.07	.00
	High	141	41.06	3.96			
"Awareness of Global Organizations and Agreements"	Medium	55	13.78	6.46	194	.01	.98
	High	141	13.76	5.88			
"Awareness of the Causes of Global Climate Change"	Medium	55	7.41	2.97	194	.46	.64
	High	141	7.19	3.09			
"Awareness of the Energy Consumption Relation of Global Climate Change"	Medium	55	12.25	1.90	194	-6.03	.00
	High	141	13.87	1.60			
Total Awareness of Global Climate Change	Medium	55	71.78	10.33	194	-2.63	.00
	High	141	75.90	9.61			

As shown in Table 8, no statistically significant differences were observed in pre-service teachers' awareness of global climate change according to their literacy levels regarding renewable energy sources in the sub-dimensions of awareness of global organizations and agreements [$t_{(194)} = 0.01$, $p > .05$] and awareness of the causes of global climate change [$t_{(194)} = 0.46$, $p > .05$]. However, statistically significant differences were found in the sub-dimensions of awareness of the effects of global climate change on the natural and social environment [$t_{(194)} = -4.07$, $p < .05$], awareness of the energy consumption relation of global climate change [$t_{(194)} = -6.03$, $p < .05$], and in the total awareness scores [$t_{(194)} = -2.63$, $p < .05$].

3.4. Findings Related to the Fourth Sub-Problem

In the fourth sub-problem, differences in pre-service teachers' literacy regarding renewable energy sources were examined according to their awareness levels of global climate change (low, medium, and high). The results of the analysis are presented in Table 9.

Table 9. Examination of differences in pre-service teachers' literacy regarding renewable energy sources according to their awareness levels of global climate change (ALGCC).

Dimension	n	M	SD	df	F	p	Post Hoc
"Literacy Regarding Energy Source Types"							
Low (ALGCC)	49	16.97	2.74	2	3.27	.04	Medium > Low. High > Low
Medium (ALGCC)	96	17.86	2.48				
High (ALGCC)	51	18.31	2.90				
Total (ALGCC)	196	17.76	2.69				
"Literacy Regarding National and Environmental Problems"							
Low (ALGCC)	49	16.00	1.56	2	3.60	.02	High > Low
Medium (ALGCC)	96	16.41	1.81				
High (ALGCC)	51	16.88	1.36				
Total (ALGCC)	196	16.43	1.66				
Total Literacy Score							
Low (ALGCC)	49	32.97	3.65	2	4.44	.01	Medium > Low, High > Low
Medium (ALGCC)	96	34.28	3.75				
High (ALGCC)	51	35.19	3.78				
Total (ALGCC)	196	34.19	3.80				

As shown in Table 9, statistically significant differences were observed in pre-service teachers' literacy regarding renewable energy sources according to their awareness levels of global climate change in the sub-dimensions of literacy regarding energy source types [$F_{(2, 193)} = 3.27$, $p < .05$], literacy regarding national and environmental issues [$F_{(2, 193)} = 3.60$, $p < .05$], and in the total literacy scores [$F_{(2, 193)} = 4.44$, $p < .05$]. According to the Post Hoc test, in the sub-dimension of literacy regarding energy source types, significant differences were found between pre-service teachers with medium (M = 17.86, SD = 2.48) and low (M = 16.97, SD = 2.74) awareness levels, as well as between those with high (M = 18.31, SD = 2.90) and low (M = 16.97, SD = 2.74) awareness levels. In the sub-dimension of literacy regarding national and environmental problems, a significant difference was observed between pre-service teachers with high (M = 16.88, SD = 1.36) and low (M = 16.00, SD = 1.56) awareness levels. Considering the total literacy scores, significant differences were found between medium (M = 34.28, SD = 3.75) and low (M = 32.97, SD = 3.65) awareness levels, as well as between high (M = 35.19, SD = 3.78) and low (M = 32.97, SD = 3.65) awareness levels.

4. Discussion and Conclusion

The findings of the study initially demonstrated that pre-service teachers' literacy regarding renewable energy sources, as well as their awareness of global climate change, did not vary significantly by gender. A review of the existing literature shows that research on literacy related to renewable energy sources is limited and predominantly concentrates on attitudes and awareness toward renewable energy. For example, Genç (2019), in a study involving science and primary education teacher candidates, reported no significant gender-based differences in pre-service teachers' attitudes toward renewable energy. In contrast, Şen and Özer (2018), who examined university students' awareness of climate change and environmental issues, found that gender had a positive influence on students' attitudes toward environmental problems, with female students exhibiting more favorable attitudes than their male counterparts. Similarly, Ağıralan and Sadioğlu (2021) identified statistically significant gender differences, noting that women demonstrated higher levels of climate change awareness and societal consciousness compared to men.

When pre-service teachers' literacy levels concerning renewable energy sources and their awareness of global climate change were compared across departments, no statistically significant difference was identified in the sub-dimension related to literacy on types of energy sources. However, statistically significant differences emerged in the sub-dimension addressing literacy regarding national and environmental issues, as well as in the overall literacy scores on renewable energy sources, with the advantage favoring primary education. In terms of pre-service teachers' awareness of global climate change, no statistically significant differences were found across departments in the sub-dimensions pertaining to awareness of the effects of global climate change on the natural and social environment and awareness of the relationship between energy consumption and global climate change.

However, statistically significant differences were identified in the sub-dimensions related to awareness of global organizations and agreements, the causes of global climate change, and the overall awareness scores, with these differences favoring primary education. A review of prior research supports these findings. Genç (2019) compared the attitudes of primary education and science teacher candidates toward renewable energy sources and reported results in favor of primary education. Conversely, Balbağ and Balbağ (2019) found no statistically significant differences between primary education and science teacher candidates regarding their attitudes toward renewable energy. Similarly, Tiftikçi (2014) examined the awareness levels of senior university students from various departments, including science and biology education, concerning renewable energy sources, and determined that students in the science education department had significantly higher mean scores than those in other departments. Collectively, these studies indicate a general trend favoring students in science and primary education programs. In terms of awareness of global climate change, Tok et al. (2017) reported that primary education teacher candidates demonstrated high levels of climate change awareness. Likewise, in the study conducted by Demir et al. (2016) to assess students' attitudes, awareness, and interest regarding global climate change, it was revealed that the majority of university students, irrespective of their department, perceived global warming and climate change as major concerns.

Subsequently, the study investigated whether statistically significant differences existed in teacher candidates' awareness of global climate change based on their levels of literacy in renewable energy sources (low, medium, and high). As no teacher candidates were categorized under the low literacy level, the analysis was carried out using data from those with medium and high literacy levels. The findings revealed that there were no statistically significant differences in the sub-dimensions related to awareness of global organizations and agreements and the causes of global climate change. However, statistically significant differences were identified in the sub-dimensions concerning awareness of the effects of global climate change on the natural and social environment, awareness of the relationship between energy consumption and global climate change, as well as in the overall total scores.

Similarly, the study examined whether statistically significant differences in renewable energy literacy existed among teacher candidates based on their levels of awareness of global climate change (low, medium, and high). Statistically significant differences were identified in the sub-dimensions of

energy source literacy, country and environmental issues literacy, and in the total scores of the renewable energy literacy scale. Specifically, in the energy source literacy sub-dimension, significant differences were observed between medium and low, as well as high and low levels of climate change awareness; in the country and environmental issues sub-dimension, significant differences emerged between high and low levels of climate change awareness; and in the total scores, significant differences were found between medium and low, as well as high and low levels of climate change awareness. Based on these findings, it is recommended that comprehensive qualitative studies be conducted to explore strategies for enhancing teacher candidates' literacy regarding renewable energy sources and their awareness of global climate change. Furthermore, while this study examined literacy and awareness in relation to gender and departmental variables, future research could broaden the scope by investigating these constructs across additional variables. The study was limited to a single university sample and self-report instruments, which restricts generalizability.

Compliance with Ethical Standards

This study was conducted with the approval of the Gazi University Ethics Committee, dated 13.12.2021, with protocol number 2021/1129.

Conflict of Interest

The authors have no conflict of interest to declare.

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