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Research Article

Öğretmen Adaylarının Yenilenebilir Enerji Kavramına ilişkin Görüşleri

Prospective Teachers' Views on the Concept of Renewable Energy

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ABSTRACT

The purpose of this study is to reveal the prospective teachers' views on renewable energy. The study employed a qualitative research method. A total of 30 prospective science teachers attended the study. A purposeful sampling method was used to choose the participants. Prospective teachers who had taken courses related to Environmental Education before participated in the study. Three open-ended questions prepared by the researchers were used to collect data. Questions on the importance of using renewable energy sources, obstacles to the usage of renewable energy sources, and increasing the usage of renewable energy sources were posed to the prospective teachers. Their answers to questions were collected in writing. Content analysis was used to analyze the collected data. The findings were divided into categories and then the themes were specified. Prospective teachers' views about the concept of renewable energy were demonstrated through the themes and categories. The results of the study showed that prospective teachers had various views of renewable energy sources but that their views were not at the desired level. The results could provide policymakers with new information about renewable energy in the process of planning teacher training in the long term to raise society's awareness in the national arena.

Keywords: Renewable energy sources, content analysis, prospective teachers, renewable energy, view, qualitative research.

ÖZ

Bu çalışmanın amacı, öğretmen adaylarının yenilenebilir enerjiye yönelik görüşlerini ortaya çıkarmaktır. Çalışmanın yürütülmesinde nitel araştırma yöntemi kullanılmıştır. Araştırmaya toplam olarak 30 fen bilgisi öğretmen adayı katılmıştır. Katılımcıların seçimi sırasında amaçlı örnekleme yöntemi kullanılmıştır. Çalışmaya daha önce Çevre Eğitimi ile ilgili dersler almış olan öğretmen adayları katılmıştır. Araştırmacılar tarafından hazırlanmış olan üç açık uçlu soru veri toplamak için kullanılmıştır. Öğretmen adaylarına yenilenebilir enerji kaynaklarının kullanılmasının önemi, yenilenebilir enerji kaynaklarının kullanımının önündeki engeller ve yenilenebilir enerji kaynaklarının kullanımının artırılması konularında sorular sorulmuştur. Sorulara verilmiş olan cevaplar yazılı olarak toplanmıştır. Toplanan verilerin analizi sırasında içerik analizi kullanılmıştır. Elde edilen bulgular kategorilere ayrılmış ve daha sonra temalar belirlenmiştir. Öğretmen adaylarının yenilenebilir enerji kavramına ilişkin görüşleri temalar ve kategoriler aracılığıyla ortaya konmuştur. Araştırmanın sonuçları, öğretmen adaylarının yenilenebilir enerji kaynakları konusunda çeşitli görüşlerinin olduğu fakat bu görüşlerinin istenilen düzeyde olmadığını göstermiştir. Sonuçlar, politika yapıcılara, ulusal alanda toplumun farkındalığını artırmak için uzun vadede öğretmen eğitiminin planlanması sürecinde yenilenebilir enerji hakkında yeni bilgiler sağlayabilir.

Anahtar Kelimeler: Yenilenebilir enerji kaynakları, içerik analizi, öğretmen adayları, yenilenebilir enerji, görüş, nitel araştırma.

INTRODUCTION

The rapid increase in World population, urbanization, increase in income, and advances in technology are all indicators of the fact that global energy demand will also increase regularly (British Petroleum [BP], 2011). Dependence on energy needs on fossil fuels causes environmental pollution, and especially it results in climate change. Meeting the need for energy with fossil fuels (non-renewable energy sources), the global need for energy, and local and global environmental pollution are the problems necessitating global solutions (Bojic, 2004). Such problems can only be overcome by using renewable sources of energy; because these sources have an important role in reducing greenhouse gases that cause climate change (Lloyd & Subbarao, 2009). However, there is a consensus among scientists and politicians about the usage of renewable energy sources rather than fossil fuels as the basic energy source (Bayulgen & Benegal, 2019). The oil shock which was experienced in 1973 in particular caused countries to search for new sources of energy, and thus renewable energy sources and technologies received great interest (Acikgoz, 2011). Thus, investment in such renewable sources of energy as solar, thermal, wind, hydropower, geothermal, ocean, biomass, and tidal energy has increased in all countries in the world (Karabulut et al., 2011).

International agreements and policies on the environment stress the need to revise the models of energy for the use of sources such as fossil fuels. For instance, the European Union put a series of actions and support precautions into operation so that success could be achieved in member states in developing renewable energy sources. The most important step in developing a joint European policy of energy was the integrative target which is known as the "20-20-20" target. Especially according to the "road map for renewable energy"- which was approved in 2007-, the EU made commitments till 2020 such as having at least a 20% decrease in greenhouse gases in comparison with the year 1990, having 20% of energy consumption from renewable energy sources and ultimately increasing energy productivity by 20%. So, several binding targets were set for member countries to raise the share of renewable energy sources (Kaldellis et al., 2012; Liarakou et al., 2009). However, it seems quite difficult to achieve this target in greenhouse gas emissions (European Commission, 2019). So the changes in energy policies and energy consumption can only be made through a holistic approach requiring taking many factors as well as the economy, technology, politics, and society into consideration and evaluating them altogether (Zyadin et al. 2012).

1.1. Renewable Energy, Society, and Education

Students need to have a conceptual understanding of energy in order to understand the relationship between energy and society (Driver & Millar, 1986). Because it will be possible for practices related to renewable energy to spread not only through encouragement made by institutions but also (and especially) through the contributions made by the young (Zyadin et al., 2012). Since the successful implementation of renewable energy is generally dependent on the public, research in this field has focused on public acceptance (Karasmanaki & Tsantopoulos, 2019). Because, the reason for the inefficacy of renewable energy applications in any state may be low public awareness, policy failures, and the structure of the market (Assali et al, 2019). However, the spread and success of the energy projects/investments that will contribute to the reduction of the negative effects of fossil fuels will be possible depending on the acceptance, knowledge level, positive attitudes, understanding, and openness of society to innovations (Bayulgen & Benegal, 2019; Halder et al., 2012; Karasmanaki & Tsantopoulos, 2019; Klick & Smith, 2010; Liarakou et al., 2009; Liu et al., 2013; Van Rijnsoever & Farla, 2014; Walker, 1995; Wüstenhagen, Wolsink, & Bürer, 2007; Zografakis

et al., 2010; Zyadin et al., 2012). On the other hand, the fact that some of the positive effects of renewable energy are manifested in the long term rather than very soon causes undesirable effects on the understanding of renewable energy sources of society (Wiggering et al., 2006). The solution to it lies in education (Liarakou et al., 2009). It is possible through education to raise society's awareness of using renewable energy sources (Liarakou et al., 2009); because education is one of the most influential ways of offering solutions to the problems societies encounter such as global warming (Kandpal & Broman, 2014). The courses about renewable energy sources that teachers take during their education will also be reflected in their practices in the classroom (Liarakou et al., 2009). For this reason, educational programs have been launched in several countries across the world in the last 30 years about renewable energy sources. Most of them are post-graduate educational/instructional programs or are in the form of elective courses in traditionally applied science or engineering curricula. Besides, it was put efforts into including energy-related subjects in schools and higher education curricula (Kandpal & Broman, 2014). Especially energy consumption and increase in prices demonstrate the importance of using energy efficiently and of efforts to investigate and develop renewable sources of energy. It, in turn, causes to rise in awareness of the importance of both energy and educational programs related to energy that is developing (Karabulut et al., 2011).

Also, most of the sociocultural and institutional obstacles in front of the widespread of renewable energy technologies can be overcome only by raising the public's and policymakers' awareness of energy. Governments can use education as an effective way to achieve their goals for the development of renewable energy sources (Liarakou et al., 2009). Actually, governments' attitudes and choices as well as the attitudes and choices of the public should be changed for wider acceptance and use of renewable energy technologies (Kandpal & Broman, 2014). Besides, the increase in the share of renewable energy sources in energy generation and the development of new technologies for the use of those sources are dependent on the availability of a sufficient number of educated and competent individuals (Berkovski & Gottschalk, 1997; Hashim & Ho, 2011; Lalic et al, 2011; Negro, Alkemade, & Hekkert, 2012).

1.2. The Importance of the Study

Karasmanaki and Tsantopoulos (2019) stated that there is not much information about the attitudes of higher education students toward renewable energy sources. Thus, determining the views held by prospective teachers (PT) about renewable energy sources could contribute to the area. In particular, studies conducted with university students will help disseminate renewable energy sources-related implementations and increase the social acceptance that will reinforce the development of this sector (Assali et al., 2019). Moreover, when the literature is reviewed, it is determined that no research is examining the views of pre-service teachers about what are the obstacles to the usage of renewable energy sources and what will be done to increase the usage of renewable energy sources. Besides, the existence of such studies is important in the inclusion of subjects related to renewable energy sources while including courses about the environment and environmental education in teacher training programs. The content of those courses and subjects can be updated based on prospective teachers' views. In addition, in the literature, there are various studies related to renewable energy conducted with prospective teachers (Açışlı Çelik, 2021; Cebesoy & Karisan, 2017; Çelikler, 2013; Demirbağ & Yılmaz, 2020; Ergül & Çalış, 2022; Genç, 2019; Guven & Sulun, 2017; Karakaya Cirit, 2017). However, in the literature, the number of studies in which the views of prospective teachers about renewable energy are taken is limited. In a study conducted by Başaran et al. (2021), it was tried to determine the views of prospective science teachers about renewable energy sources. At the end of the study, it has been determined that prospective science teachers have views such as renewable energy sources are sustainable, environmentally friendly, and protect the environment. In another study conducted by Çolak, Kaymakçı, and Akpınar (2015), the views of prospective social studies teachers were examined. At the end of

the study, it was determined that the majority of prospective teachers are not aware of renewable energy sources. In a study conducted by Doğru and Çelik (2019), a semi-structured interview form was used to determine the opinions of prospective science teachers. At the end of the study, it was determined that the majority of the first and fourth-grade prospective teachers in the old and new programs have positively approached renewable energy. As a result of semi-structured interviews conducted by Koca and Bulut (2015) with prospective social studies teachers, they stated that Turkey does not sufficiently benefit from renewable energy sources. Thus, the results of this study-which reveal prospective teachers' views on renewable energy sources-are thought to make positive contributions to the literature.

1.3. The Purpose of the Study

Failure to eliminate societies' lack of knowledge, especially about energy consumption, fossil fuels, and renewable energy sources can cause negative consequences. The next generations can be the sides who are harmed by the unconscious energy consumption of the previous generations and by the negative environmental effects of such energy consumption. Setting out from this point, the educational levels of the next generations can be raised, environmental awareness can be raised and thus they can be trained as energy consumers who take on the responsibility (Liarakou et al., 2009). Bojic (2004) stressed that good quality, comprehensive and intensive training should be offered about renewable energy, research should be done and technological applications should be made widespread about it for solving environmental problems.

Teachers who are knowledgeable about and who have awareness of renewable energy sources are needed in raising individuals who inquire about global warming, who suggest ideas to prevent global warming, and who have awareness of the usage of renewable energy technologies (Guven & Sulun, 2017). Training such teachers is possible only by including such courses in the teacher training programs. Effective teacher development programs are one of the important factors that increase teacher effectiveness (Darling-Hammond, 2017). Acikgoz (2011) emphasized that the focus should primarily be on formal and informal education about energy to increase individuals' awareness of the usage of renewable energy sources in developed and developing countries. Teachers/educators who have awareness of the benefits of renewable energy sources for society and the environment can help their students to gain accurate knowledge and values about the issue (Halder et al.2011). Although teachers have positive attitudes and perceptions toward renewable energy sources, they are not sufficient to teach the concepts of renewable energy to their students (Antink-Meyer & Aldeman, 2021). According to Antink-Meyer and Aldeman (2021), it is seen that besides the fact that the teachers do not have sufficient knowledge about renewable energy sources, prospective teachers also have difficulties understanding these scientific issues. In addition, some studies in the literature revealed that prospective teachers who will be teachers of the future do not have sufficient knowledge about renewable energy. (Cebesoy & Karisan, 2017; Goulgouti et al., 2019; Spiropoulou et al., 2007). For this reason, it is crucial that universities equip prospective teachers, who will be shaping the future generation, with knowledge about renewable energy sources. However, assessing the level of knowledge that prospective teachers have on renewable energy sources can be done by evaluating their views on the matter. In addition, the results of this study could provide policymakers with new information about renewable energy in the process of planning teacher training in the long term to raise society's awareness in the national and international arena. Based on the fact that there is a lack of studies that reveal the awareness of university students in the sciences directly related to the environment concerning the implementation of renewable energy sources (Karasmanaki & Tsantopoulos, 2019), especially the opinions of prospective teachers who are informed of renewable energy sources were asked in the current study.

From this point of view, this study aims to analyze prospective teachers' views related to the concept of renewable energy. In this context, the research questions of this study are as follows.

1. What are the prospective teachers' views on the importance of the use of renewable energy resources?
2. What are the prospective teachers' views about the obstacles to the usage of renewable energy sources?
3. What are the prospective teachers' views on the increasing usage of renewable energy sources?

METHOD

This study used a qualitative research method. The qualitative research methods are used to describe or answer questions related to the contextual formation and participants' points of view towards events, beliefs of practices (Gay & Airasian, 2000). They try to understand the experiences of participants in a context. Researchers are particularly interested in finding and investigating the answers to various exploratory and descriptive questions. Thus, rather than generalizing the results, they try to understand in depth of their experiences from the perspectives of the participants selected for the study (Maykut & Morehouse, 1994). Moreover, Maykut and Morehouse (1994) stated that researchers who purposefully chose events, beliefs, activities, or people for a study accepted the limitation of the generalizability of the results obtained with this approach. From this point, a qualitative case study method was used as the research method in this study. The case study method provides researchers with the opportunity to investigate real phenomena that are complex in some basic contexts in-depth in their context in many ways (Kaarbo & Beasley, 1999).

The study sought approval from the Hacettepe University Ethics Committee before starting data collection to ensure that its research methods aligned with ethical standards. The committee reviewed the application and granted approval, confirming that the research did not violate ethical guidelines.

2.1. Participants

A total of 30 prospective science teachers were attended the study. All the participants (25 females and 5 males) were in the 21-23 age range and attended the study voluntarily. A purposeful sampling method was used to choose the participants. Purposeful sampling is a method based on the examination of the conditions having rich information deeply to elicit the focus questions of a study (Patton, 1987). So we selected prospective teachers who took courses such as Environmental Protection, Environmental Education, Chemical Wastes and Environmental Pollution. It was important for this study to get the prospective science teachers' self-constructed views after these courses, rather than memorized information. Unlike random sampling which attempts to provide variation using a large sample set and a random selection, the purposive sampling method attempts to increase the possibility that common variability in any social phenomenon is represented in the data (Maykut & Morehouse, 1994). Moreover, the aim is not that the selected sample represents a wider sample, but to have individuals collect more information on the subject in the selected sample (Gay & Airasian, 2000). Also according to Zyadin et al. (2012), renewable energy education should be started at the earliest possible age and one of the most appropriate course is Science and Technology, considering the criteria for starting education on renewable energy sources at the earliest in Türkiye (Çolak et al., 2015). In this respect, it is important to choose prospective science teachers as the group that will train secondary school students in our country.

2.2. Data Collection

The researchers prepared three open-ended questions that were used to obtain the data. Prospective teachers were expected to answer these questions in the form of an essay. Their writing answers in this way enabled more data to be obtained. These questions are;

1. Is it important to use renewable energy sources?
2. What are the obstacles to the usage of renewable energy sources?
3. How may the use of renewable energy sources be increased?

The study questions were prepared after the literature review. While determining open-ended questions in the research, the studies published in Turkey by Dönmez et al. (2016) and Karakaya Cirit (2017) were primarily examined. While preparing the first question, the results of such studies were taken into consideration, as it was aimed to reveal the awareness, knowledge, attitudes and general perspective teachers on renewable energy (e.g. Assali et al., 2019; Hashim & Ho, 2011; Kaldellis et al., 2012; Karasmanaki & Tsantopoulos, 2019; Zografakis et al., 2010). In addition to the studies conducted in Turkey for the second and third questions, other studies related to education/training about renewable energy were taken into consideration (e.g. Acikgoz, 2011; Bozdogan & Yigit, 2014; Cebesoy & Karısan 2017; Guven & Sulun, 2017; Kandpal & Broman, 2014). Expert opinion was also taken for the questions. Data collection was conducted in the spring semester. The participants answered the questions in 30-40 minutes. Their answers to questions were collected in writing.

2.3. Data Analyze

Content analysis was used to analyze the collected data. Content analysis is conducted to clarify the data by reaching the concepts and relations (Strauss & Corbin, 1990). Researchers have done the analyses separately and their analyses were compared. The findings were divided into categories and then they specified the themes.

2.4. Validity and Reliability

Before the study, participants were informed of some issues such as the content of the study, the data collection process, and the confidentiality of their names for the validity of the study. In the analysis of the data, firstly, each coder read the data set line by line according to the question order. While reading the data set, each coder determined the words or word groups that they identified as codes. The coders grouped these codes under categories. The categories made by the coders were compared and finalized. Thus, different categories were obtained under three themes. Also, it was consulted an expert opinion about analyzing the data for internal validity. In coding data, similarities and differences between the two coders were determined and compared and interrater reliability was calculated as 92% (Miles &Huberman,1994).

FINDINGS

Firstly, the findings related to the first research question are shown in Table 1. The prospective teachers' views about the first research question were combined with the theme of "the importance of using renewable energy sources". After that, the views were considered in three categories labeled as "negative effects caused by the use of fossil fuel", "properties of renewable energy sources" and "benefits of renewable energy sources". On examining the statements in the first category, it was found that 16 out of 30 prospective teachers (53.3%) said that fossil fuels caused environmental problems with negative effects, 13 (43.3%) said that fossil fuels harmed the environment and 12 of them (40%) said that such fuels would be depleted in the near future. The fact that the harmful gases they produced caused the

greenhouse effect (23.3%) and that they caused global warming and climate change (16.6%) were referred to as other negative effects. An evaluation of the second category showed that the prospective teachers considered renewable energy sources as rather non-depletable (53.3%) and environmental-friendly (43.3%). The statements in the third category showed that the participants found renewable energy sources useful in that they reduced dependence on foreign sources (60%), provided society with job opportunities/employment (53.3%), and that they were giving little damage to the environment (43.3%). Some examples of the answers given by the prospective teachers are presented below.

> **Category of benefits of renewable energy sources**; PT1: *We can find solutions to problems such as unemployment by creating local business areas with renewable energy sources.*
>
> **Category of negative effects caused by the use of fossil fuel;** PT30: *The use of renewable energy sources is essential. Because fossil fuels cause a lot of damage to the environment and there is no energy continuity.*
>
> **Category of properties of renewable energy sources:** PT11: *Renewable energy sources are important in terms of being environmental-friendly, inexhaustible, and not dependent on foreign sources.*

Table 1

Participants' Views on the Importance of Using the Renewable Energy Sources

Theme	Categories	Codes	Frequency
The importance of using the renewable energy sources	**Negative effects caused by the use of fossil fuel**	Causing environmental problems	16
		Causing environmental damage	13
		Will be depleted soon	12
		Causing greenhouse effect of harmful gases they produced	7
		Causing global warming and climate change	5
		Be dependent on fossil fuel import	4
		High fossil fuel import expenses	4
		Energy insecurity with the oil crisis	3
	Properties of renewable energy sources	Non-depletable	16
		Environmental-friendly	13
		Local source	3
		Dependable energy	4
		Clean energy	1
	Benefits of renewable energy sources	Reducing dependence on foreign energy	18
		Providing jobs for the society	16
		Giving little damage to the environment	13
		Being economical except for the initial cost of installation	6
		Ensuring a comfortable/modern life	6
		Ensuring energy continuity	4
		Resorting migration problems	4
		Reducing fossil fuel consumption	2
		Reducing environmental pollution	2
		Reducing the amount of money spent on energy imports	2
		Existing naturally in the universe	2

* Frequency values are given in Table 1. Since the codes in Table 1 can be expressed by different prospective teachers, the frequency values may be greater than the total number of prospective teachers.

Secondly, the findings related to the second research question are shown in Table 2. The participants' views about the second research question were combined in the theme of "the obstacles to the usage of renewable energy sources". "After that, prospective teachers' views

about the obstacles to the usage of renewable energy sources were considered in five categories labeled as "disadvantages of renewable energy sources", "social reasons", "economic reasons", "time" and "insufficiencies". An examination of the statements in the first category demonstrated that the prospective teachers referred to the disadvantages of the sources as obstacles in front of the use of renewable energy sources. The disadvantages listed by the participants included the fact that solar energy and wind energy were discontinuous (43.3%), that they had no stability (33.3%), and that they involved tiring/tedious bureaucratic procedures (20%). In the second category, the unconsciousness of consumers (30%) and the need for experienced/well-qualified staff (30%) were mentioned as the obstacles in front of renewable energy sources. Especially the high cost of installment (70%), insufficient incentives (46.6%), and the insufficiency of financial resources allocated to Research and Development (R&D) activities (33.3%) were the obstacles listed in the third category. The inadequacy of the 10-year warranty given by the government (43.3%) was the obstacle mentioned in the fourth category. Insufficient R&D/scientific work (20%) and uncoordinated/unplanned R&D/scientific work (20%) were the obstacles mentioned in the fifth category. Some examples of the answers given by the prospective teachers are presented below;

> **Category of economic reasons**; PT1: *The use of renewable energy sources requires a financial investment. Even if the initial investment price is high, more profit is obtained later than the initial investment price.*
>
> **Category of time**; PT4: *Discontinuous energies such as solar or wind energy cannot meet the supply and demand.*
>
> **Category of insufficiencies** P7: *Renewable and sustainable energy resources cannot be used within their potential, since sufficient R&D and awareness raising cannot be done for our country.*

Table 2

Participants' Views About the Obstacles to the Usage of Renewable Energy Sources

Theme	Categories	Codes	Frequency
The obstacles to the usage of renewable energy sources	**Disadvantages of renewable energy sources**	Solar and wind energy interruptions	13
		Lack of energy stability	10
		Struggling bureaucratic procedures	6
		In some cases, sight and sound pollution formation	5
		Generating interference of wind turbines on radar	4
		Difficulties in transporting generated energy	4
		Causing bird deaths by wind turbines	2
		Damaging to forests/habitats of hydroelectric power plants	1
		Causing some explosions during biomass energy production	1
		Sea traffic barrier for wave energy	1
	Social reasons	Being unconscious of consumers	9
		Experienced/qualified staff needs	9
	Economic reasons	High initial installation cost	21
		Insufficient incentives	14
		Lack of financial resources allocated to R&D activities	10
		High cost of geothermal resource exploration work	6
		Lack of investment	6
		Easier and cheaper fossil fuel preference	4
		Effortless use of fossil fuels	2

Time	Being the low of the period of the government's 10-year purchase warranty	13
	The mismatch between supply and demand	4
	Need for a time until profit	2
Insufficiencies	Lack of substation and transmission lines	7
	Insufficient R&D/scientific studies	6
	Uncoordinated/unplanned works	6
	Lack of technical knowledge	5
	Lack of technology for current use	4
	The need to investigate the source potential well	2
	Geographic insufficiency	1

* Frequency values are given in Table 2. Since the codes in Table 2 can be expressed by different prospective teachers, the frequency values may be greater than the total number of prospective teachers.

Thirdly, the findings related to the third research question are shown in Table 3. The participants' views about the third research question "what can be done to increase the usage of renewable energy sources" were combined in the theme of "increasing the use of renewable energy sources". After that prospective teachers' views about the obstacles to the usage of renewable energy sources were considered in six categories labeled "social recommendations", "educational recommendations", "recommendations on the usage of fossil fuel", "political recommendations", "economic recommendations" and "study recommendations". An evaluation of the statements in the first category showed that the majority of the participants (76.6%) recommended making society/individuals conscious and raising their awareness of the issue (through brochures, seminars, conferences, public service ads, etc.). Recommendations such as organizing activities (6.66%) and opening relevant departments in universities (6.66%) were in the second category. The third category included such recommendations as reducing the use of fossil fuels (10%) and introducing restrictions on using fossil fuels (10%). Including those issues in state policies were recommended by 13.3% of the participants in the fourth category. In the fifth category, giving state incentives to firms (63.3%) and allocating sufficient state budget (46.6%) were recommended by most of the participants. In the sixth category, 26.6% recommended researching appropriate sources, 23.3% made recommendations for technology development activities and 23.3% recommended that public bodies and research institutions should do scheduled work. Some examples of the answers given by the prospective teachers are presented below.

Category of social recommendations; PT2: *Seminars, public service announcements, brochures, etc. can be made to raise awareness of people.*

Category of study recommendations; PT17: *Public institutions and research institutes should work on a planned schedule.*

Category of economic recommendations; P20: *States should include renewable energy sources in their budget planning.*

Table 3

Participants' Views on the Increasing Usage of Renewable Energy Sources

Theme	Categories	Codes	Frequency
The increasing use of renewable energy sources	**Social recommendations**	Raising consciousness/awareness of society/people (brochures, seminars, conferences, public spots, etc.)	23
		Training of qualified staff	4
		Explaining the damages of fossil fuels to nature	4
	Educational recommendations	Organizing activities in universities	2
		Opening relevant departments in universities	2
		Adding topics related to courses in schools	1
		Staffing in this area in vocational high schools	1
	Recommendations on the use of fossil fuel	Reducing the use of fossil fuel	3
		Introducing restrictions to using fossil fuels	3
	Political recommendations	Placing these issues in state policies	4
		Legal regulations	2
	Economic recommendations	Government incentives	19
		Sufficient state budget allocation	14
		Taking costs to the appropriate level	2
		Longer price guarantees to companies	2
		Recognition of privilege for renewable energy companies	1
	Study recommendations	Researching appropriate sources	8
		Technology development studies	7
		Programmatic study of public institutions and research institutes	7
		Adequate R & D studies	6
		More project development	4

* Frequency values are given in Table 3. Since the codes in Table 3 can be expressed by different prospective teachers, the frequency values may be greater than the total number of prospective teachers.

DISCUSSION AND CONCLUSION

A general examination of the prospective teachers' views about the first research question made it clear that they made comments on the importance of renewable energy sources in the context of the properties of the sources, the benefits they offer, and the context of the negative effects of fossil fuels. The majority of prospective teachers expressed a belief that fossil fuels have detrimental effects on the environment, cause environmental issues, and will become depleted soon. A smaller group specifically mentioned the negative impacts of fossil fuel emissions on the greenhouse effect, global warming, and climate change. Renewable energy sources were more commonly viewed as non-depletable and environmentally friendly, but fewer participants considered them to be dependable and locally available. Similarly, Ergül and Çalış (2022) conducted a study with prospective science teachers and found that prospective teachers defined renewable energy sources as non-depletable energy sources. The pre-service teachers who participated in the study of Başaran Uğur et al. (2021) defined renewable energy sources as environmentally friendly and sustainable resources. Prospective teachers perceived renewable energy sources as advantageous due to their potential to decrease reliance on foreign sources, provide employment opportunities, and have a minimal environmental impact. Nonetheless, a minority of participants highlighted additional benefits, including the reduction of fossil fuel use, mitigation of environmental issues, and decreased spending on energy imports.

On examining the prospective teachers' views on the second research question in general, it was determined that they commented on the obstacles to the use of renewable energy sources in the context of the disadvantages of those sources, social and economic reasons, the use of fossil fuels and in the context of time and inadequacies. As Kandpal and Broman (2014) point out; technological, economic, sociocultural, and institutional factors hinder the development and spread of renewable energy technologies. Great technological efforts are needed the increase the widespread use of renewable sources of energy to contribute significantly to global energy needs. The fact that solar energy and wind energy were discontinuous, that they were unstable, and that they involved tiring/tedious bureaucratic procedures were mentioned by the participants as disadvantages while the disadvantages such as bird deaths caused by wind turbines, radio interference caused on radars and sound and sight pollution caused in some cases were the ones mentioned by fewer participants. Some studies in the literature reported that pre-service teachers were aware of the disadvantages of renewable energy sources (Başaran Uğur et al., 2021; Cebesoy & Karısan, 2017). For example, Aksan and Çelikler (2019) stated that pre-service teachers know the advantages and disadvantages of hydroelectric power plants in terms of many factors such as environmental, economic, and biological. The fact that hydroelectric power plants are used more than other energy sources in our country may be one of the reasons why pre-service teachers have more knowledge. Unconscious consumers and the need for experienced/well-qualified staff were listed as social obstacles. While the high cost of installment, insufficient incentives, and insufficiency of financial resources allocated to R&D activities were listed by the majority of the participants as the economic obstacles; the insufficiency of investments and the use of cheap and effortless fossil fuels were listed by fewer participants. The insufficiency of a 10-year warranty given by the government was the obstacle mentioned in the context of time, but the need for time to obtain the profit was the obstacle that was mentioned by very few. The minority of the prospective teachers referred to the insufficiency of transformers and distribution lines, insufficient R&D activities, uncoordinated works, and lack of technical knowledge as the obstacles in front of using those sources.

Concerning the third research question, the prospective teachers made recommendations for social, political, and economic activities to increase the use of renewable energy sources and they specifically made recommendations for the use of fossil fuels. In the studies conducted in the literature, training on renewable energy sources has been recommended (Acikgoz, 2011; Halder et al., 2011; Liarakou et al., 2009). While Yıldırır, et al. (2020) emphasized the interdisciplinary dimension in teaching the concept of energy in field and field education courses, Özyurt and Yalman (2020) drew attention to the number of learning outcomes in curricula and increasing the number of lesson hours. For example, in another study conducted by Baysal and Daşdemir (2023), it was emphasized that different activities and practices should be included in the teaching of renewable energy resources during the undergraduate education of prospective teachers. Accordingly, the majority of them recommended making the public/individuals conscious and aware of the issue by promoting the use of renewable energy sources (through brochures, seminars, conferences, public service ads, etc.), offering state incentives to firms, and allocating a sufficient state budget. On the other hand, recommendations such as doing research for appropriate sources, technology development activities, the scheduled work of public bodies and research institutions, organizing activities and opening relevant departments in universities, including the relevant subjects in the courses, reducing the use of fossil fuels and introducing restrictions to the use of fossil fuels, including those issues in state policies and making the legal regulations were made by very few of the participants.

On revising all these results, it was found that prospective teachers had various views of renewable energy sources. As a result of the studies conducted in the literature, there are studies in which society, teachers, pre-service teachers, and students have different and various

views and perspectives on renewable energy sources (Açisli Çelik, 2021; Doğru & Çelik, 2019; Kaldellis, 2005; Kaldellis et al., 2012; Karasmanaki & Tsantopoulos, 2019; McGowan & Sauter, 2005). While some of these studies supported the results of our study, some of them provided more detailed information about renewable energy sources than the results of this study. In the study conducted by Karasmanaki and Tsantopoulos (2019), it was determined that university students support renewable energy sources and are aware of energy systems that pollute the environment. In addition, it was determined that these students have a positive environmental attitude and are aware of the necessity of transitioning from fossil fuels to renewable energy sources. Also in the study of Açisli Çelik (2021), it was seen that prospective science teachers' have more positive opinions about renewable energy resources than elementary school mathematics and classroom prospective teachers. It was concluded that the reason for this can be shown that the number of courses taken by science pre-service teachers about renewable energy resources during their undergraduate education. Doğru & Çelik, (2019) concluded that prospective science teachers have the most positive opinions about the future use of renewable energy sources. Halder et al., (2014) determined that science teachers were adequately knowledgeable about renewable sources of energy but that they did not have adequate knowledge about their effects on them on the environment. Renewable energy sources were described by science teachers as harmless, healthy, and cheap. Cebesoy and Karisan (2017), on the other hand, found that prospective teachers' knowledge about renewable energy sources was inadequate. Karakaya Cirit (2017) also found that prospective science teachers did not have advanced and adequate knowledge about renewable energy sources and that they mostly described those sources of energy as "clean, renewable and natural energy". In the study conducted by Bozdogan and Yigit (2014), prospective teachers described renewable energy sources as self-renewing, cheap, clean, and natural energy; but they considered such sources of energy as non-depletable and infinite energy and they formed alternate concepts. Another study also determined that society had a weak understanding of wind energy (Klick & Smith, 2010). Zyadin et al. (2012), in a study they conducted with the participation of Jordanian school students, found that students were aware of sources of renewable energy such as wind energy and solar energy, which are widespread, but that they did not have adequate knowledge about some sources of energy such as geothermal energy. The researchers found that 72% of the participants have awareness of the benefits renewable energy sources offered to the environment and that they knew that generating electricity in that way had significant effects on reducing climate change. Liarakou et al. (2009) found that teachers have positive attitudes toward renewable energy sources and their use of them but that, their levels of seeing them as alternative sources of energy in the future were inadequate. The researchers stated that the main reason for it was the inadequacy of teacher training. There are also studies in the literature pointing out that teachers were not adequately knowledgeable about the issue (Liarakou et al., 2009; Zyadin et al., 2014).

The fact that societies and individuals do not have the necessary information, knowledge, and skills is one of the main sources for why energy technologies do not spread enough (Negro et al., 2012). Therefore, the necessity and importance of offering training in renewable energy at all levels are globally accepted (Kandpal & Broman, 2014).

RECOMMENDATIONS

Based on the findings obtained, it can be said that students' environmental awareness, views, and knowledge can be increased with environmental education that will be provided by emphasizing the importance of renewable energy resources at all levels of education. Thus, it can be secured that the next generations, who are to shape the future, will display more conscious behaviors of energy consumption. Besides, positive attitudes towards and awareness

of renewable energy sources in schools where future politicians are trained can assure that nations' energy generation in the future could incline towards renewable energy sources.

Although the participants included in this study took an elective course in Environmental Education, they were found to have no knowledge of energy sources at the desired level; thus, it demonstrated the fact that obligatory courses in environmental education including topics on renewable energy sources should be included in the program of educational faculties- which train teachers- because the environment-related knowledge of next generations that teachers will raise and their awareness of the issue will be possible through the positive awareness of the environment that teachers can have. In addition to that, one of the greatest obstacles in front of using renewable energy sources is inadequate education. Akçöltekin and Doğan (2013) stated in their study that people should be given a good education to understand renewable energy sources. The fact that the environmental education courses to be given in faculties of education are oriented towards practice (Kavcar, 2002) will enable teachers to be more effective in their future courses.

It would be useful to determine teachers' and prospective teachers' levels of knowledge so that courses such as environmental education, environmental chemistry, and renewable energy sources could be included in teacher training programs. This is because courses in environmental education can be configured by considering the inadequacies. Therefore, an increase in the number of studies determining prospective teachers' levels of knowledge about renewable energy and energy consumption on graduation will be beneficial.

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GENİŞLETİLMİŞ ÖZET

Giriş

Dünya nüfusunun hızla artması, sanayileşme, kentleşme, gelir artışı ve teknolojinin ilerlemesi, küresel enerji talebinin de düzenli bir şekilde artacağının göstergesidir (BP, 2011). Özellikle küresel enerji ihtiyacının, sonsuz olmayan fosil yakıtlara bağımlı olması çevre kirliliğine neden olmakta ve bunun sonucu olarak da iklim değişiklikleri ortaya çıkmaktadır. Küresel iklim değişikliği tehdidine yönelik atılacak en önemli sürdürülebilir adım ise fosil yakıtlarının kullanımında azaltmaya gitmektir (Moriarty & Honnery, 2009). Bu konuda bilim adamları ve politikacılar arasında temel enerji kaynağı olarak fosil yakıtlar yerine yenilebilir enerji kaynaklarına geçiş konusunda gittikçe büyüyen bir fikir birliği de bulunmaktadır (Bayulgen & Benegal, 2019).

Yenilenebilir enerji kaynaklarının enerji üretimindeki payının artması ve bu kaynakların kullanımına yönelik yeni teknolojilerin geliştirilmesi yeterli sayıda iyi eğitimli ve ehil bireylerin bulunmasına bağlıdır (Erkovski & Gottschalk, 1997; Hashim & Ho, 2011; Lalic vd., 2011; Negro vd., 2012). Ayrıca, Karasmanaki ve Tsantopoulos, (2019) üniversite öğrencilerinin yenilenebilir enerji kaynaklarına yönelik tutumları hakkında çok fazla bilginin olmadığını belirtmişlerdir. Özellikle de üniversite öğrencileriyle yapılacak olan çalışmalar yenilenebilir enerji kaynakları ile ilgili uygulamaların yayılmasına yardımcı olacak ve bu sektörün gelişmesini destekleyecek olan sosyal kabulü de artıracaktır (Assali vd., 2019). Yine literatür incelendiğinde yenilenebilir enerji kullanımının önündeki engellerin neler olduğuna ve yenilenebilir enerji kullanımını artırmak için neler yapılacağına yönelik öğretmen adaylarının görüşlerinin incelendiği çalışmaların çok fazla olmadığı belirlenmiştir. Bu nedenle, geleceğin öğretmenleri olacak olan öğretmen adaylarının yenilenebilir enerji kaynakları ile ilgili görüşlerinin incelendiği bu çalışmanın sonucu literatüre olumlu katkıda bulunacaktır. Bu çalışmanın sonuçları, politika belirleyicileri için hem ulusal hem de uluslararası alanda, toplumun bilinçlendirilmesinde öğretmen eğitimlerinin uzun vadeli planlama sürecinde yenilenebilir enerji kaynakları konusunda yeni bilgiler sağlayacaktır.

Yöntem

Çalışmada nitel araştırma yöntemi kullanılmıştır. Nitel araştırmacılar bir bağlam içerisinde bireylerin deneyimlerini anlamakla ilgilenmektedirler. Bu nedenle, sonuçları genellemek yerine, çalışma için seçilen katılımcıların bakış açılarından deneyimlerini derinlemesine anlamaya çalışılmaktadırlar (Maykut & Morehouse, 1994). Çalışma Eğitim Fakültesinde okuyan 30 öğretmen adayı ile yürütülmüştür. Katılımcıların seçiminde amaçlı örnekleme yöntemi kullanılacaktır. Amaçlı örnekleme, bir çalışmanın odak sorularını ortaya çıkarmak için zengin bilgilere sahip koşulların incelenmesine dayanan bir yöntemdir (Patton, 1987). Çalışmada veriler üç açık uçlu sorudan oluşan bir test ile elde edilmiştir. Araştırmacılar tarafından literatür incelemesi sonucu hazırlanmış olan testte yer alan sorular şunlardır;

1. Yenilenebilir enerji kaynaklarını kullanmak önemli midir?
2. Yenilenebilir enerji kaynaklarının kullanımının önündeki engeller nelerdir?
3. Yenilenebilir enerji kaynaklarının kullanımını artırmak için neler yapılabilir?

Katılımcılara bu sorulara yazılı cevap vermeleri için 30-40 dakikalık bir süre verilmiştir. Çalışmadan önce ise katılımcılara çalışmanın içeriği, verilerin değerlendirilmesi ve süreçte isimlerinin gizli tutulacağı konusunda bilgilendirme yapılmıştır. Verilerin analizi sırasında, açık uçlu sorulara verilen yazılı cevaplar araştırmacılar tarafından transkript edilerek bilgisayar ortamına aktarılmıştır. Elde edilen veriler içerik analiziyle analiz edilmiştir. Analiz sonucu konu ile ilgili kodlar ve kategoriler belirlendikten sonra temalar oluşturulmuştur.

Sonuç ve Tartışma

Çalışmada öğretmen adaylarının birinci soru ile ilgili görüşleri genel olarak incelendiğinde (Tablo 1), yenilenebilir enerji kaynaklarının önemini, bu kaynakların özellikleri, yararları ve fosil yakıtların olumsuz etkileri bağlamında yorumladıkları görülmüştür. Öğretmen adaylarının çoğunluğu, fosil yakıtların çevreye zarar verdiklerini, çevre problemlerine yol açtıklarını ve yakın gelecekte tükenecek olmalarını bu yakıtların olumsuz etkileri olarak sıralamışlardır. Ürettikleri zararlı gazların sera etkisine yol açması ve yine bu yakıtların küresel ısınma ve iklim değişikliğine yol açması ise daha az öğrenci tarafından sıralanan olumsuz etkilerdir. Yenilenebilir enerji kaynaklarının tükenmez ve çevre dostu olduklarını öğretmen adaylarının çoğunluğu ifade ederken, yerel ve güvenilir bir kaynak olduklarını ise çok az öğretmen adayı düşünmektedir. Öğretmen adayları yenilenebilir enerji kaynaklarını enerjide dışa bağımlılığı azaltmaları, toplum için iş olanağı/istihdamı sağlamaları ve çevreye zararlarının çok az olması bakımından yararlı bulmaktadırlar. Fosil yakıt kullanımını, çevre sorunlarını ve enerji ithalatına harcanan para miktarını azaltmaları ise çok az öğretmen adayı tarafından ileri sürülen yararlardır.

Çalışmada öğretmen adaylarının ikinci soru ile ilgili görüşleri genel olarak incelendiğinde (Tablo 2), yenilenebilir enerji kaynaklarının kullanımının önündeki engelleri, bu kaynakların dezavantajları, sosyal, ekonomik nedenler, fosil yakıt kullanımı, zaman ve yetersizlikler bağlamında yorumladıkları görülmüştür. Küresel enerji ihtiyacına anlamlı bir katkıda bulunma yolunda yenilebilir enerji kaynaklarının yaygın kullanımının artması için büyük teknolojik çabalar gerekmektedir. Güneş ve rüzgâr enerjilerinin kesintili olmaları, enerji istikrarının sağlanamaması ve yorucu/uğraştırıcı bürokratik işlemler öğretmen adaylarının çoğunluğu tarafından ifade edilen dezavantajlar olurken, rüzgâr türbinlerinin kuş ölümlerine yol açması, radarda parazit oluşturması, bazı durularda ses ve görüntü kirliğine yol açması çok azı tarafından ileri sürülen dezavantajlardır. Tüketicilerin bilinçsiz olması, deneyimli/kalifiye eleman ihtiyacı sosyal engeller arasında sıralanmıştır. Yüksek ilk kurulum maliyeti, teşvik yetersizliği ve AR-GE çalışmalarına ayrılan mali kaynak yetersizliği öğretmen adaylarının çoğunluğu tarafından sıralanan ekonomik engeller iken, yatırım yetersizliği, daha ucuz ve zahmetsiz fosil yakıt kullanımı ise daha azı tarafından ileri sürülen engellerdir.

Öğretmen adaylarının üçüncü soru ile ilgili görüşleri genel olarak incelendiğinde (Tablo 3), yenilenebilir enerji kaynaklarının kullanımını artırmak için sosyal, eğitimsel, politik, ekonomik ve çalışma önerileri ile spesifik olarak fosil yakıt kullanımına yönelik önerilerde bulundukları belirlenmiştir. Öğretmen adaylarının çoğunluğu yenilenebilir enerji kaynaklarının kullanımı artırmada bu konuda toplumu/insanları bilinçlendirme ve farkındalık oluşturma (broşür, seminer, konferans, kamu spotu vb.), firmalara devlet teşviki sağlama ve yeterli devlet bütçesi ayırmayı önermişlerdir. Uygun kaynak araştırma çalışmaları, teknoloji gelişme çalışmaları ve kamu kurumları ve araştırma enstitülerinin programlı çalışması, üniversitelerde etkinlikler düzenleme ve üniversitelerde ilgili bölümler açma, derslere ilgili konular ekleme, fosil yakıt kullanımını azaltma, fosil yakıt kullanımı için sınırlandırma getirme, ülke politikalarında bu konulara yer verme ve yasal düzenlemeler gibi öneriler ise çok azı tarafından ifade edilmiştir.

Öneriler

Bütün öğretim seviyelerinde verilecek olan çevre eğitimi ile öğrencilerin çevre bilinçleri, görüşleri ve farkındalıkları geliştirilebilir. Böylece geleceğe yön verecek olan nesillerin daha bilinçli enerji tüketimi davranışı sergilemeleri sağlanmış olabilir. Ayrıca geleceğin politikacılarının yetiştirildiği okullarda yenilenebilir enerji kaynaklarına yönelik oluşturulacak olan pozitif tutum ve farkındalıklar ülkelerin gelecekteki enerji üretimlerinin yenilenebilir enerji kaynaklarına yönelmesini sağlayabilir. Bütün öğretim seviyelerinin müfredatlarında çevre eğitimi dersleri yer almazsa da öğretmen yetiştiren eğitim fakültelerinde zorunlu dersler haline getirilmesi gerekmektedir. Çünkü öğretmenlerin yetiştirecekleri yeni nesillerin çevre ile ilgili bilgileri ve farkındalıkları ancak öğretmelerinin sahip olabileceği olumlu çevre bilinci ile gerçekleşecektir.