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Pre-service teachers' knowledge and awareness about renewable energy

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ABSTRACT

The present study aimed to explore the awareness and knowledge of pre-service teachers regarding renewable energy. For this aim, the study employed survey method and a total of 196 pre-service teachers studying at four different teaching profession departments in a public university in Turkey's Mugla province were enrolled in the study. Renewable Energy Awareness Scale and Renewable Energy Knowledge Level Test" were used to gather the data from the preservice teachers in the study. The quantitative data obtained from the participants was analyzed using multivariate analysis of variance, Pearson product moment correlation coefficients and simple regression analysis. The study results revealed that the knowledge level of the pre-service teachers regarding renewable energy showed differences across the departments while their awareness did not vary. It was also found that the pre-service teachers' knowledge level and awareness in this topic had a positive correlation. Thus, this topic must be given importance in the education programs must be implemented more effectively and meaningfully. In addition, more comprehensive information regarding renewable energy issues must be included in the teacher education.

1. Introduction

The most important need of human in every activity of daily life is energy. The energy used in every activity can be found in different forms such as chemical, nuclear, mechanical (potential and kinetic energy), geothermal, hydraulic, solar, wind, electric energy, and can be converted into each other using appropriate methods. The air we breathe and hence, the environment is affected in various ways as a result of the process by which energy is converted into another form. Fossil fuels are used in energy production because developed countries give importance to the industry and the world population continuously increases. Fossil fuels such as petroleum and coal, which are widely used, are preferred by most countries because of being cheap and of the improvements in production technologies in the last two centuries. However, as a result of burning these fuels, the concentration of greenhouse gases such as CO_2, CH_4, CFCs, halon, N_2O, ozone, peroxyacetyl nitrate in the atmosphere increases, and accordingly the surface temperature of the earth increases, and the earth's internal heat increases by the heat dispersed from the earth's surface [14,2]. The energy production and usage based on fossil fuels leads to many negative impacts on human and environmental health. Especially the utilization of this kind of fuels results in air pollution, acid rain, global warming and climate changes [16,40,49]. Especially in climate change which is among the biggest concerns of humanity in the 21st century. This is the most important environmental problem related to energy. As a result of the increase in the frequency and density of the heat waves, human health can be affected, the risk of malnutrition, flood, drought, and disasters can increase [40,46]. In addition, these gases pale the leaves of plants, corrode marble constructions, have a corrosive effect on iron and steel, decrease the visibility distance, and sunrays rasp the upper respiratory system and lungs of people, and may have lethal effect when in high concentrations [15]. Many scientific studies show that the CO_2 level 31% in 200 years, global gas emission because of energy production have increased by about 37%, and the world average temperature increased by about 0,7 °C [40,49].

Society has embarked on a quest of more sustainable production methods such as minimizing the wastes, reducing the air pollution arising from vehicles, increasing renewable energy production, protection of the natural forests and decreasing greenhouse gases emissions [43]. On the other hand, the petroleum crisis in 1973 encouraged countries to look for new energy sources and thus, a great interest towards renewable energy sources and technologies [1]. Renewable energy sources such as solar, wind, geothermal and hydraulic energy are clean energy sources which don't emit toxic and greenhouse gases that pollute the environment, which can always be used, and which renew themselves naturally. Thus, renewable clean energy usage should be supported [10,21].

A need for more energy has arisen due to the reasons like population increase, rapid development and urbanization.

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Considering the electric energy production in 2013 in our country, it is seen that approximately 71% of the electric energy is produced from fossil fuels and 29% is produced from renewable energy resources. Fossil fuels which meet a huge part of the energy need not only decrease in time but also cause severe environmental and air pollution. When it is taken into consideration that 50–75% of energy need is provided from renewable energy sources, the common and effective use of these sources must be ensured in order to reduce environmental pollution [26]. Especially the developed and developing countries change their energy policies with the aim of searching for ways of obtaining energy which is harmless to the environment and is renewable. For that purpose, these countries primarily focus on formal and informal energy education to increase the awareness of their citizens towards achieving this aim [1]. However, studies have shown that society has low awareness about renewable energy use in energy production [29,30,48]. In this case, individuals need to have knowledge about issues such as environmental sensitivity in energy production, energy sources and effective use of energy. Hence, energy education must be introduced in schools in different levels like high school, university, and other academic institutions [27]. Thus, students will be aware about the energy crisis and acquire knowledge about renewable and non-renewable energy types, the technology involved in using these sources, understanding the related political issues, and in proposing alternative strategies for the solution of the energy crisis [1]. However, it is obvious that renewable energy issue is not sufficiently included in Turkish science curricula [3,44]. In addition, studies regarding this issue show that based on the renewable energy curriculum, high school students [19,50,51], primary and secondary school students [12,28] have insufficient knowledge and awareness.

Awareness, values, attitudes, abilities, and behaviors which are required for a sustainable development is possible only with a relevant education program and qualified educators. The World Commission on Environment and Development highlights the importance of teachers in large-scale social changes and education of students for an ecologically sustainable development. Celikler [8], and also highlights the importance of teachers in raising an awareness in students about the renewable energy issue. Within this context, teacher education regarding renewable energy is important. Teachers who have sufficient knowledge about renewable energy will help students gain true knowledge and values related to this issue of being aware of the benefits of renewable energy to society and the environment [20,30]. However, it is seen that both teachers and pre-service teachers have negative awareness towards this issue [17,27,7–9], and their knowledge on this issue is insufficient [30,52].

Within this context, teachers who have the sufficient knowledge, and awareness regarding renewable energy are required for the purpose of producing individuals who interrogate global warming, who propose opinions in this direction, and who are interested in and develop awareness towards the use of related technologies of renewable energy that do not harm the environment. When examining the educational programs in teacher education, the relation between the knowledge and awareness of teachers about this issue must be defined at first. Accordingly, the purpose of the study is to examine and define the relations between knowledge and awareness of pre-service teachers regarding renewable energy.

The research questions were as follows:

(1) Is there any significant difference in the knowledge level and awareness regarding renewable energy of pre-service teachers in the four departments?
(2) Is there any correlation between the knowledge and awareness of pre-service teachers regarding renewable energy?
(3) To what extend does the knowledge of pre-service teachers regarding renewable energy predict their awareness?

Table 1.
Distribution of the pre-service teachers according to their departments.

Department	Number	%
Elementary Science Education	41	20.9
Social Sciences Education	42	21.4
Early Childhood Education	23	11.7
Primary School Teaching	90	45.9
Total	196	100

2. Method

2.1. Participants

The population of the research consists of pre-service teacher who study in education faculties in 2013–2014 academic year. The sample consists of 196 pre-service teachers, 120 (61.2%) of whom were female, 76 (38.8%) of whom were male, and who are in their final year of study in Mugla Sitki Kocman University Faculty of Education. The sample was selected by using the stratified random sampling method. Distribution of pre-service teachers according to the departments is indicated in Table 1.

2.2. Research tools

The “Renewable Energy Awareness Scale” (REAS) and the “Renewable Energy Knowledge Level Test” (REKLT) were used as a data collection tool.

2.2.1. Renewable Energy Awareness Scale (REAS)

This scale was developed by Morgil, Secken, Yucel, Oskay, Yavuz and Ural [34] with the aim of measuring the awareness of pre-service teachers towards renewable energy. The REAS consists of 39 Likert-type questions and Cronbach's alpha internal consistency coefficient was found to be α = .94. Sentences in the scale were ranked as “5” for “completely agree”, “4” for “agree”, “3” for “indecisive”, “2” for “don't agree” and “1” for “don't agree at all”.

2.2.2. Renewable Energy Knowledge Level Test (REKLT)

The knowledge test was used to measure how much an individual benefits from a particular class or educational program [39]. Twenty items were generated based on studies found in the literature [19,51]. The opinions of four experts were considered to ensure each question in the prepared draft form measured the desired target. In addition, the knowledge level test was checked by four experts in this area in terms of level, scope, content and language. Corrections were made based on the opinions of the experts. Item difficulties ranged between .39 and .65, and discrimination indices ranged between .32 and .58. The KR-20 (Kuder Richardson-20) reliability coefficient of the test whose answer options are “correct”, “wrong”, and “don't know” was found to be .84. Based on this result, the test is considered to be highly reliable [24].

2.3. Data analysis

Data were analyzed using SPSS 20 statistical package software. Multivariate analysis of variance (MANOVA), which is a technique that questions the effect on more than one dependent variable, was used to define whether knowledge level and awareness of pre-service teachers regarding renewable energy show any difference between the pre-service teachers in the four departments. The eta square (η2) value was taken into consideration to define the effect of the independent variable on the dependent variable. To test the relation between the knowledge level and awareness of pre-service teachers regarding renewable energy, to define relation direction and degree, the Pearson product-moment correlation coefficient statistical method was used. Besides,

Table 2.
Distributions of responses to the renewable energy knowledge level test (REKLT).

Items	*Correct %*	*Wrong %*	*Don't know %*	*MX*	*SD*
1. Nuclear fuels are among renewable energy resources.	41	33	26	4.28	2.13
2. Wind turbine is used to collect wind energy and to convert it into electric.	64	25	11	8.78	2.07
3. Geothermal energy is not among the renewable energy resources.	37	32	31	5.22	1.45
4. Geothermal energy is the usage of radioactive heat in the magma of the earth.	42	30	28	7.64	1.89
5. Energy cannot be produced from organic wastes (plant and animal origin).	45	32	23	4.56	2.03
6. Fossil fuels are among the renewable energy sources.	28	39	33	4.18	1.94
7. Electric energy can be produced thanks to sun lights.	69	11	20	8.44	2.45
8. Hydroelectric energy is produced using the potential energy of the water	54	17	29	6.36	2.12
9. Wind is among the renewable energy sources.	63	9	28	8.74	1.56
10. Biomass energy is produced using plant and animal wastes.	34	42	24	4.96	1.45
11. Petrol is among the renewable energy sources.	72	7	21	3.62	1.84
12. Wave energy is produced using ocean and sea waves.	14	68	18	3.84	1.79

simple regression analysis was used to determine to what extend the awareness of the participants regarding renewable energy was predicted by their knowledge level. Regression analysis is a method to examine the connection between predicted variable/s and predicting variable/s [38].

3. Results

In this section, findings about pre-service teachers' knowledge level regarding renewable energy are given. Means and standard deviations of the REKLT are given in Table 2.

When Table 2 is examined, 41% of pre-service teachers think that nuclear fuels are among renewable energy sources, and 45% consider that energy is not produced from organic wastes. A total of 42% of the participants don't know that plant and animal wastes are used in biomass energy. In addition, 72% of pre-service teachers think that petrol products are among renewable energy resources. From these data, it is seen that pre-service teachers have confusion between renewable and nonrenewable energy sources, cannot properly distinguish between both and don't have much knowledge about how each energy resource are produced.

To find an answer to the first question of the research, which is “Is there any significant difference in the knowledge level and awareness regarding renewable energy of pre-service teachers in the four departments?” descriptive statistical analysis results of participants' knowledge and awareness are shown in Table 3.

In Table 3, it is seen that pre-service teachers' renewable energy knowledge and awareness levels differ from department to department. To determine whether these differences are significant, a MANOVA test was carried out. Parametric test assumptions were examined at first. As a result of Kolmogorov-Smirnov test, the data showed a normal distribution ($p > .05$). The Levene test showed that variances of knowledge level test ($F_{(3192)} = .491$; $p = .689$) and awareness scale ($F_{(3192)} = .912$; $p = .436$) displayed homogeneous distribution. In addition, before the MANOVA test, M statistics of Box was investigated along the groups to test whether covariance matrices are equal, and covariance equality, which is basic assumption, was ensured ($F_{(9-67679)} = 1.593$, $p = .111$). The results of the MANOVA test, which was carried out after the assumptions were ensured, are indicated in Table 4.

Table 3.
Distribution of pre-service teachers' knowledge and awareness based on departments.

Independent variable		Knowledge level		Awareness	
		MX	*SD*	*MX*	*SD*
Department	Elementary Science Education	7.68	1.60	161.12	18.07
	Social Science Education	6.19	1.91	154.23	23.87
	Early Childhood Education	5.26	2.11	150.56	24.38
	Primary School Teaching	6.12	2.10	157.85	24.70

According to Table 4, pre-service teachers' renewable energy knowledge levels show significant difference between the departments ($F_{(3, 192)} = 9.087$, $p = .00 < .05$; Wilks' Lambda = .831). To ascertain difference in renewable energy knowledge between the departments, the post hoc Tukey test was used. According to test results, the mean of knowledge of pre-service teachers who study in elementary science education (x = 7.68) is higher than the mean of the ones who study in social science education (x = 6.19), early childhood education (x = 5.26) and primary school teaching (x = 6.12) departments. The eta squared value of .124 indicated that this was a big difference [11]. However, the awareness levels of the pre-service teachers don't show a significant difference between departments ($F_{(3, 192)} = 1.253$, $p = .292 < .05$; Wilks' Lambda = .831).

To answer the second question, which is “Is there any correlation between the knowledge and awareness of pre-service teachers regarding renewable energy?”, the Pearson's correlation coefficient was computed and is given in Table 5.

As it is seen in Table 5, the mean of renewable energy knowledge level of 196 pre-service teachers was $X_B = 6.36$ and mean of awareness level was $X_T = 156.91$. The correlation coefficient between both means was r = .702 and the determination coefficient was $r^2 = .49$ ($p < .05$). When Table 5 is examined, it is observed that there is positive high level relation between renewable energy knowledge and awareness of the participants (r = .702, $p < .05$) which is higher than the value of .70 suggested by Roscoe [42].

To answer the third question, which is “To what extend does the knowledge of pre-service teachers regarding renewable energy predict their awareness?” a simple regression analysis was carried out. Analysis results are given in Table 6.

When Table 6 is examined, it is seen that the renewable energy knowledge of pre-service teachers are significant and is a high predictor of their awareness points (R = .702, $R^2 = .493$, $F_{(1-195)} = 198.012$, $p = .000$). Also, it can be stated that 49.3% of the total variance regarding renewable energy awareness is explained by knowledge of renewable energy.

4. Discussion and conclusion

As a result of this research, which examines the knowledge and awareness of pre-service teachers regarding renewable energy, it was found that the knowledge of the participants regarding renewable energy shows significant differences between departments. It is seen that the knowledge level of the pre-service teachers who especially study in the Elementary Science Education program is significantly higher than those who study in Social Science Education and Early Childhood Education programs. However, the awareness of the pre-service teachers does not show a significant difference between departments. It thus appears that the subjects on renewable energy in the Elementary Science Education undergraduate teacher education

Table 4.
Multivariate analysis (MANOVA) results.

Source	Dependent variable		Sum of squares	*df*	Mean square	*F*	*p*	*η2*
Department	Knowledge	Constant	10.836	3	35.279	9.087	.000*	.124
		Error	745.445	192	3.883			
	Awareness	Constant	2033.563	3	677.854	1.253	.292	.019
		Error	103,852.784	192	540.900			

* Significant at p < .05.

Table 5.
Correlation between pre-service teachers' knowledge and awareness levels regarding renewable energy.

	N	*MX*	*r*	r^2	*p*
Knowledge level	196	6.36	.702	.493	.000*
Awareness		156.91			

Table 6
Simple regression analysis results regarding the prediction of renewable energy awareness point.

Variance	*B*	*Standard error*	*Â*	*t*	*p*	*Binary r*	*Partial r*
Invariant	107.062	3.815	–	28.062	.000	–	–
Knowledge level	7.835	.570	.702	13.748	.000	.702	.702
R = .702, R^2 =.493$F_{(1–195)}$ = 198.012, p = .000							

program is the most effective undergraduate education program among the departments are that have been investigated. The compulsory course on “Environmental Science”, and the elective courses such as “The Energy within Life”, “Environmental Education”, and “Fun and Innovative Science” which are included in educational program of this department deal with energy education. In the educational programs of the other departments, this topic is mentioned in the elective courses “Environmental Problems of Turkey” and “Energy Sources” in Social Sciences, in the compulsory course “Environmental Education” in Primary School Teaching, in the elective course “Science Technology and Nature Activities” in Early Childhood Education in contrast to the courses in Elementary Science Education. The knowledge of the pre-service teachers who graduate from these departments regarding renewable energy is limited to the scope of these courses. The fact that the content of these courses is limited and that these courses are elective may have affected the knowledge level of pre-service teachers. As the pre-service teachers don't have sufficient knowledge on this issue and don't have opportunities to apply their limited knowledge, their awareness towards this topic can be regarded as low. Studies that have been conducted indicate that pre-service teachers don't have enough knowledge on this issue of renewable energy and show limited awareness [7,9]. Celikler and Kara [9] state that the awareness of the pre-service teachers on renewable energy differs on the basis of department. Also the awareness of the pre-service teachers who have courses in undergraduate programs which include environmental problems and limited natural resources is higher. Similarly, Firat, Sepetcioglu and Kiraz [17] emphasize that the awareness of the pre-service teachers who study in the departments which give more emphasis to environmental education and which pursue courses devoted to nature and environment is higher. In addition, Tanriverdi [44] and Arsal [3] emphasize this issue in their studies by stating that renewable energy resources are not sufficiently included in education programs.

When newly-prepared primary school programs on renewable energy are examined, it is observed that 15 outcomes within the scope of science courses, 2 outcomes within the scope of social science course, 5 outcomes within the scope of social studies course, and certain days and weeks at the early childhood teaching program take place regarding this topic. This situation shows the necessity for teachers to be equipped with sufficient knowledge on energy education. However, the absence of the courses on this topic in educational programs in teacher education, the lack of teacher-centered renewable energy issues, and lack of correlation with daily life might be some reasons for pre-service teachers having limited awareness. Another reason for the limited awareness of the pre-service teachers might be the limitations of this topic in teacher education programs. In that, educational programs give more emphasis to the sources like fossil fuels and solar energy as the only energy sources. The studies on this topic show that information regarding renewable energy is limited in educational programs and information is given mostly about solar energy [27,51,7].

Another result of this study asserts that a high level of relationship is observed between the knowledge and awareness of the pre-service teachers regarding renewable energy. By extension, the pre-service teachers who lack the knowledge on renewable energy show limited awareness towards this issue. Pre-service teachers' inability to distinguish energy sources as renewable and non-renewable, disowning the knowledge of renewable energy sources, inability to express an opinion on energy sources in relation to the environment, and nonexistence of discussions and activities that include daily life on this issue have been shown to be the reasons behind this situation. Studies on this subject indicate that depending on the increase of the knowledge level regarding renewable energy, the individuals have higher awareness [25,29,30,48]. Liarakou, Gavrilakis and Flouri [30] emphasize that if teachers have sufficient knowledge on this topic and have high awareness about it, students will benefit and will experience effective learning. Also, the lack of information that is given to pre-service teachers about how the energy sources in our country and around us produce energy, and whether they harm the environment might be the cause of their limited awareness. As it is seen in this study, only the pre-service teachers who have acquired sufficient knowledge show high awareness about the issue of renewable energy. The pre-service teachers who know that renewable energy sources are more environment friendly that non-renewable energy sources like fossil fuels that release CO_2 are able to compare and discuss energy sources in terms of their environmental relations will always prefer renewable energy sources. Thus, they will have greater awareness. In parallel to this finding, another result of the research shows that the knowledge about renewable energy of the pre-service teachers is a good predictor of their awareness regarding the use of renewable energy. Studies that have been conducted in this context, are of the notion that there is a relationship and connection between knowledge and awareness [13,41,45,47].

As a conclusion, this present research results showed that the pre-service teachers had a lack of knowledge and awareness on renewable energy. In that regard, it is seen that there is a variety of research concerning how to improve knowledge and awareness related to renewable energy. Those researches have argued that undergraduate education programs are required to include specific courses regarding renewable energy [18,23,33]. Also, those researches have contended

that the courses relevant to renewable energy should focus on hands-on activities and laboratory practices [1,31,35]. Lund and Jennings [31] developed picture book laboratory sessions to increase awareness of the students on knowledge of renewable energy. They stated such these practices help the students design the experimental processes, increase their experiences, and obtain their own data. Acikgoz [1] argued that in order to increase awareness and interests of students on renewable energy, the student need to be engaged in the activities in which they can experience renewable energy knowledge on their own. In addition to this, the activity booklet developed by Education Office at the National Renewable Energy Laboratory would make more contribution to students' awareness and knowledge when it is used in renewable energy education. This booklet includes the some experiments, models, and activities including wind energy, hydroelectricity energy, biomass energy, solar power and etc. National Renewable Energy Laboratory ($year$) [35]. Also, some studies revealed that use of web-supported activities and simulation software programs can help students acquire knowledge and awareness of renewable energy [18,22,23,37]. Similar to this, Bilbao et al. [4,5,6] stated that in different countries students acquire experience on renewable energy through specific courses and practical sessions at the laboratory with specific material of laboratory practices and simulation software, more information could be read at. Garg and Kandpal [18] argued that while teaching of simple concepts on renewable energy education should start in elementary grades, teaching concept by experiments should start in Junior High School, and teaching concepts relevant to renewable energy education in biology, chemistry, and physic subject matters should start in Senior Secondary School, and the teaching complex concepts and knowledge, and engaging students in laboratory experiments should start in undergraduate level.

Therefore, in the courses related to renewable energy education, using problem solving, collaboration, creativity, critical thinking, life cycle thinking, and systems thinking [32], focusing on student-centered methods and techniques [8], employing interdisciplinary approaches and web-based activities [23], giving more attention to web-supported and hands on activities [22,37], doing laboratory practices and implementing picture book laboratory sessions [31,35], taking account of the materials based on internet [1], and using both common and local activities addressing RES suppliers, as basic and specialized training and updating events, workshops, meetings, visits to exchange know-how and working experiences, E-learning common platform [6] enable students to acquire knowledge and awareness of renewable energy.

To sum up, as a result of this study, it was seen that teacher education programs in Turkey are limited regarding renewable energy and pre-service teachers are not effectively informed about this issue. In this sense, pre-service teachers show limited awareness about renewable energy. Lack of knowledge among pre-service teachers negatively influences their awareness about renewable energy. Besides, Newborough and Probert [36] define energy unconsciousness as the lack of education and interest. In light of the results of this study, teacher education programs must be examined, and more compulsory courses on this issue must be offered. Zyadin et al. [51] emphasize this issue and state that universities must review their curriculum for the development of new courses regarding renewable energy in particular. In addition, energy sources in immediate surroundings must be introduced with student-centered methods and techniques and their relation with the environment must be discussed.

5. Limitation of study and recommendation for future research

One limitation of the research would be stated that the research did not include examination, problem, and practical cases for evaluating the pre-service teachers' knowledge and awareness on renewable energy education. Instead of this, the research focused on more quantitative process by SPSS. However, future research may cover more qualitative techniques to broadening our understanding related to pre-service teachers' knowledge and awareness on renewable energy education and focuses on exploring effective practical methods to be used in learning settings for helping pre-service teachers.

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