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THE CORRELATION BETWEEN RENEWABLE ENERGY KNOWLEDGE AND ATTITUDE: A STRUCTURAL EQUATION MODEL WITH FUTURE'S EDUCATORS

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Abstract. *It is important to create positive attitudes and enough knowledge for pre-service science teachers about renewable energy for future. The aim of this research was to show the correlation between renewable energy knowledge and sub-dimensions of attitude towards renewable energy with Structural Equation Modeling (SEM). The research was conducted by the analysis of 1145 pre-service teachers' answers to questionnaires data using SEM. Two questionnaires used for data collection which first was renewable energy knowledge scale that Cronbach's alpha was .82 and the second was renewable energy attitude scale that Cronbach's alpha was .87. Initially, Kaiser-Meyer-Olkin and Bartlett's tests were done with SPSS to test appropriateness of subdimensions to factor analysis. Exploratory factor analysis was done for the subdimensions that were seen to be suitable for factor analysis and then structural model was tested with LISREL. At the end of the SEM test, it was found that there are positive relations between renewable energy knowledge of preservice teachers and their attitudes towards renewable energy. The more knowledge and attitudes about renewable energy can be improved, the more positive attitudes and behaviors will be provided to individuals and the efficient use of renewable energy types will be realized.*

Keywords: *renewable energy knowledge, attitude towards renewable energy, structural equation modelling, preservice science teachers.*

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Introduction

The rising world population, the development and increased use of technology, and the use of more energy for a comfortable lifestyle have resulted in a constant increase in the need for energy, and the energy problem has now become a global problem. The quality of education to be provided for the correct and effective use of energy resources, which is likely become a greater problem day by day, is of great importance. Considering that the supply of resources such as coal, oil and natural gas, which used to be widely used in the past, is becoming limited, and the scale of destruction that they cause to the planet (climate change, wars started for fossil fuel resources, etc.), it can be seen how essential orientation towards renewable energy sources has become. The first step towards educating generations who are informed about renewable energy sources is to have teachers who inform.

Countries' energy needs are rising day by day and yet this increasing energy need is predominantly met by fossil fuels such as oil (Koroneos, Spachos, & Moussiopoulos, 2003; Satman, 2007). A major result of the use of these fuels is the increase in the rate of carbon dioxide, methane and nitrogenous derivatives, known as greenhouse gases, in the atmosphere. The increase in the rate of retention of greenhouse gases in the atmosphere brings with it a number of negative events such as global warming, acid rain, climate change, disasters and migrations. Moreover, climate change affects the future of the planet by creating environmental, social and economic threats. Therefore, for the future of the earth and sustainable development, it is necessary to reduce the use of fossil fuels and increase the use of renewable energy (RE) sources. When the related literature is examined, the known renewable energy sources appear before us as solar, wind, hydroelectric, hydrogen, geothermal, marine (wave, tidal and current energy) and biomass energies (Koroneos et al., 2003). Renewable energy sources are known to be environmentally friendly and the harm they do to the environment is less than that done by fossil fuels (Koroneos et al., 2003). Moreover, renewable energy sources are regarded as alternatives to the reduction of gases known as greenhouse gases such as carbon dioxide, methane and nitrogenous derivatives (Liarakou, Gavrilakis, & Flouri, 2009). The importance of using the renewable energy (RE) sources has steadily increased recently.

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Literature Review

The renewable energy sources are resources such as solar, wind, wave, hydrogen, hydroelectric, biomass and geothermal energies (Liarakou, Gavrilakis, & Flouri, 2009). Solar energy, which forms the world's main energy source and is effective in the creation of other renewable energy sources, is, with thermal solar technology and solar batteries, the most commonly used energy source (Bayraç, 2011; Varınca & Gönüllü, 2008). Wind energy is motion (kinetic) energy that uses warm and cool air currents and, via wind turbines, this energy is first converted into mechanical energy and then into electrical energy. Biomass energy is the energy obtained from combustibles released as a result of the processing of urban, industrial, agricultural, wood and forestry wastes, ethanol and biodiesel (Hatunoğlu, 2010). Hydrogen energy is an energy source obtained by utilising primary energy sources (water, biomass, fossil fuels), and is stored with compounds that it makes with minerals in nature and, due to combustion, is released into the atmosphere only in the form of water vapour (Tutar & Eren, 2011). Geothermal energy comes from natural hot water sources heated by the core at the centre of the earth and is an important energy source for tourism and greenhouse cultivation (Külekçi, 2009). Hydroelectric energy is the energy obtained by the conversion of kinetic energy created by the movement of water into electrical energy (Aksu, 2009). Wave energy is the energy obtained from the waves created by winds formed as a result of different warming of the oceans, seas and land masses on the earth. Wind speed and wave size determine the amount of energy obtained (Gülsaç, 2009). As can be seen, renewable energy sources depend either directly or indirectly upon solar energy.

If countries aim to use RE sources and to increase the use of these resources, then they need to determine strategies for creating more knowledge, attitudes, awareness, perceptions and behaviour regarding these resources. It is possible for individuals' knowledge, perceptions, awareness and attitudes to be developed by means of education (Liarakou et al., 2009). It can also be understood from this that in order to increase the use of RE sources, it is necessary for teachers who have the duty to educate, and the preservice teachers who will have this duty later, to have sufficient knowledge about RE sources and to have positive perceptions and attitudes towards the use of these resources. The importance of increasing knowledge and improving positive attitudes of teachers and preservice teachers with regard to RE sources is frequently stressed in the literature (Liarakou et al., 2009). Increasing knowledge, perceptions and awareness of teachers and preservice teachers and developing their positive attitudes towards RE sources will also be reflected in their in-class teaching practices (Liarakou et al., 2009). However, it is reported in studies conducted on the subject that teachers' knowledge of RE sources is limited (Liarakou et al., 2009; Zyadin, Puhakka, Aphonen, & Pelkonen, 2014). For example, in their research, in which teachers' knowledge and attitudes regarding RE sources were examined, Liarakou et al. (2009) determined that teachers had knowledge about RE sources and that they had positive attitudes towards the use of RE sources, but they found that the teachers did not sufficiently regard the use of resources such as solar energy or wind energy as alternative energy sources in the future. Therefore, they stated that teachers with this characteristic would not choose to teach their students about RE sources in their classes, nor would they choose methods that could enable the development of positive attitudes about this subject in their students.

Moreover, in a research conducted by Zyadin at al. (2012), the knowledge, perceptions and attitudes of students, in a country that is overdependent on fossil fuels despite the presence of many renewable energy sources, were investigated. The results of this research reveal that the students had limited ability to distinguish renewable energy sources from non-renewable sources.

Similarly, in Saraç and Bedir's (2014) research, primary school classroom teachers' knowledge and perceptions related to renewable energy sources were examined. The research findings revealed that some classroom teachers lacked knowledge and had misconceptions about renewable energy sources. It was revealed that some teachers confused renewable and non-renewable energy sources with each other. Moreover, it was concluded that educational trips, materials and seminars related to the teaching of energy sources were needed.

In Çolak, Kaymakcı, and Akpınar's (2015) research, it was revealed that preservice teachers did not have an adequate level of knowledge about renewable energy sources. Moreover, in Cırıt's (2017) research, the knowledge of preservice science teachers at different grade levels regarding renewable energy sources was examined. The findings of the research showed that the teacher candidates did not have sufficient knowledge about renewable energy sources. In a research made by Güven and Sülün (2017), the awareness and knowledge of preservice teachers with regard to renewable energy were investigated. Knowledge levels related to RE were examined among different departments. According to the research findings, it was seen that there were differences among the knowledge

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levels of the preservice teachers according to their department, and that the preservice teachers' knowledge levels and awareness about this subject were positive.

Besides these studies, there are other studies examining knowledge and attitudes related to RE. For example, in a questionnaire research by Zyadin et al. (2014) conducted with 260 classroom teachers in Jordan, the teachers' knowledge, perceptions and attitudes related to renewable energy were investigated. The research findings revealed that the teachers had limited levels of knowledge about renewable energy. On the other hand, it was seen that the teachers had open positive attitudes towards renewable energy development. Similarly, in Keramitsoglou's (2016) research, the knowledge, perceptions and attitudes of adolescents towards renewable energy sources were examined in order to determine certain educational needs. In a research carried out by Liarakou, Gavrilakis, and Flouri (2009), the knowledge and attitudes towards renewable energy sources, especially towards wind and solar energy, of secondary school teachers in Greece were explored.

In Cebesoy and Karışan's (2017) research, the aim was to explore the knowledge and attitudes of preservice teachers towards renewable energy sources, as well as their self-efficacy perceptions regarding teaching this subject. The research findings revealed that the knowledge levels of the preservice teachers towards renewable energy sources were insufficient, whereas their attitudes were shaped according to various variables. In a research by Németh, Jakopánecz and Törõcsik (2013), the attitudes of the public towards traditional and renewable energy sources were examined with regard to different variables.

In Çelikler, Yılmaz, and Aksan's (2016) research, the knowledge and attitudes of students in different schools in a province towards renewable energy sources were examined. The research findings revealed that there were significant differences among the attitude levels of science high school students towards renewable energy sources according to different variables.

In a research by Us, Florkowski, and Klepacka (2015), the factors affecting knowledge about renewable energy types among 200 inhabitants of 13 villages in a province, and their attitudes towards RE sources, were investigated. The findings showed that among five types of energy, the participants were best informed about wind energy and that they were least well-informed about biofuels.

Besides these studies, there are other studies examining attitudes towards to RE sources. For example, in a research made by Bilen, Özel, and Sürücü (2013), the attitudes of preservice science teachers towards renewable energy sources were investigated. The questionnaire was applied to a total of 254 preservice science teachers. The analyses revealed that the teacher candidates had positive attitudes towards renewable energy sources. Similar to this research, in Clare et al's (2012) project carried out between the years 2010 and 2011, the attitudes of rural and urban people in Pennsylvania towards renewable energy, their views about the effects of renewable energy production facilities and their opinions about their willingness to pay for renewable energy were examined. It was determined that especially their attitudes towards renewable energy varied.

In their research, Fırat, Sepetcioğlu, and Kiraz (2012) investigated whether or not the attitudes of preservice teachers regarding renewable energy differed significantly according to certain variables. According to the research findings, it was determined that the preservice teachers' environmental attitudes varied based on their department, gender, grade level and environmental education they had received at university, whereas the variables of parental education level and environmental education received at high school did not make a significant difference.

As can be seen from the above studies, different studies exist related to the knowledge and attitude dimensions regarding renewable energy. However, at this stage no studies are found that express the relationship between the knowledge and attitude dimensions. It is seen that educating conscious and sensitive individuals who are aware of the importance of environmentally-friendly renewable energy sources is vital for the sake of bequeathing a liveable world to future generations. Considering that raising informed individuals depends on education, more place must be given to subjects containing information about renewable energy sources at every level of education. Indeed, the importance of starting renewable energy education at the earliest possible age in order to increase knowledge levels and to develop positive attitudes in individuals regarding renewable energy sources is stressed in the research by Zyadin et al. (2012).

Importance of the Research

Renewable energy sources appear to be mankind's most suitable alternative solution to all these problems. When an evaluation of the past is made, it cannot be said that education systems are very helpful in our under-

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standing of choices of energy sources and of the effects of energy on the environment and society. Education, which has an impact on social changes, plays a vital role for a sustainable society.

With education, in increase in knowledge and attitudes about new developments can be enabled. With education, the professionals who will develop the systems and tools to be used in the future can be trained (Jennings, 2009). Increasing the use of renewable energy sources will reduce the dependence on fossil fuels and lower the cost of renewable energy sources. For this reason, information and positive attitudes created in society about renewable energy sources are very important to be able to have clean, sustainable and environmentally-friendly energy resources in the future. The importance of key elements such as attitudes and knowledge about renewable energy sources is constantly increasing. It is very important for the correlations among these variables to be determined and revealed. Consequently, it is important for knowledge, perceptions, awareness and attitudes related to renewable energy sources to be developed. Therefore, in this research, a model was established for examining the relationships between the knowledge and attitudes about renewable energy sources of preservice teachers.

Research Question

Is there a correlation between preservice teachers' renewable energy knowledge and attitudes towards renewable energy?

Research Methodology

General Background

This research carried out based on analysis with structural equation modelling (SEM) to find out how and to what extent preservice teachers' knowledge of renewable energy sources affected their attitudes towards renewable energy sources. Structural equation modelling is a comprehensive statistical approach for testing models in which causal and correlation between manifest and latent variables exist together, and it enables correlation sets between one or more independent variables and one or more dependent variables to be examined (Anagün, 2011; Yılmaz, Çelik, & Ekiz, 2006). Considering that direct measurement of the variables affecting knowledge and attitude is not possible, in order to explain these variables, it is necessary to measure clearly observed variables that define or are believed to define them. Since using latent variables also facilitates determination of errors in the variables in question, the variable values estimated in SEM studies can be calculated much more reliably (Şimşek, 2007). Moreover, the strength of SEM is that it permits both confirmatory factor analysis for the measurement models and path analysis for processing latent variable models at the same time (Jöreskog & Sörbom, 1996; Kelloway, 1998). Path analysis also enables estimation of the correlations between latent variables. For any model, the acceptance intervals of the measures most commonly used in the evaluation of goodness of fit and correctness of the established model are shown below (Schermelleh-Engel, Moosbrugger, & Müller, 2003, p. 52):

Table 1. Evaluation of SEM fit.

Fit measure	Perfect fit	Acceptable fit
χ^2	$0 < \chi^2 \leq 2df$	$2df < \chi^2 \leq 3df$
p value	$.05 < p \leq 1.00$	$.01 < p \leq .05$
χ^2/df	$0 \leq \chi^2/df \leq 2$	$2 < \chi^2/df \leq 3$
RMSEA	$0 \leq RMSEA \leq .05$	$.05 < RMSEA \leq .08$
SRMR	$0 \leq SRMR \leq .05$	$.05 < SRMR \leq .10$
NFI	$.95 \leq NFI \leq 1.00$	$.90 \leq NFI < .95$
NNFI	$.97 \leq NNFI \leq 1.00$	$.95 \leq NNFI < .97$
CFI	$.97 \leq CFI \leq 1.00$	$.95 \leq CFI < .97$
GFI	$.95 \leq GFI \leq 1.00$	$.90 \leq GFI < .95$
AGFI	$.90 \leq AGFI \leq 1.00$	$.85 \leq AGFI < .90$

Note: AGFI=Adjusted Goodness-of-Fit-Index, CFI= Comparative Fit Index, GFI = Goodness-of-Fit Index, NFI = Normed Fit Index, NNFI=Nonnormed Fit Index, RMSEA=Root Mean Square Error of Approximation, SRMR= Standardized Root Mean Square Residual

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Sample

The research sample consisted of 1145 preservice science teachers (51.7% females, 48.3% males). In this research, sampling error was determined as (d) = ± 0.05 (p = .5; q = .5). Accordingly, in this research, the sample size capable of representing the universe is 964 (Yazıcıoğlu & Erdoğan, 2004, p.50). Non-volunteer teacher candidates were not included in the research. In this context, 1200 prospective teachers were reached, but 55 inaccurate and incomplete questionnaires were not included in the study and 1145 scales were analyzed. The sample group was chosen from pre-service teachers receiving education in different cities in Turkey (Bursa, Edirne, Düzce, Kars, Afyon and Bolu) in the 2018-2019 academic year. In this research the data were collected directly by the researchers from the students on a voluntary basis, so for sampling, convenience sampling was used, since this allows for participants to be selected by availability (McIntyre, 2005; p. 106).

Data Collection Tools

The instruments used to determine the preservice teachers' knowledge of renewable energy and attitudes towards renewable energy were as follows:

Renewable energy knowledge (REK) scale: This scale, which was developed by İpekoğlu, Üçgül and Yakut (2014) and consists of 16 items, was used to assess the sample's knowledge levels on the subject of renewable energy. In this scale, as well as questions directed towards how energy sources such as wind turbines, geothermal energy, biodiesel, bioethanol, hydroelectric power and wave energy are obtained and what they are used for, items are also included inquiring about the effects of systems using renewable energy sources on the environment, humans, plants and animals. In the scale, 5-point Likert-type scoring, with responses ranging from "I strongly disagree" (scoring 1 point) to "I strongly agree" (scoring 5 points), was used. The Cronbach's alpha value of the scale in the original research carried out by İpekoglu et al. (2014) was found to be .82, and the item factor loadings ranged between 0.845-0.422. The findings obtained for the present research are given in Table 3.

Renewable energy attitude scale: This scale was developed by Güneş, Alat and Gözüm (2013). The scale contains 26 items and consists of 4 subscales: application request (AR), importance of education (IoE), country interest (CI), and environmental awareness and investments (EAI). The scale items are of the 5-point Likert-type and responses range from "I strongly disagree" (scoring 1 point) to "I strongly agree" (scoring 5 points). Reverse scoring is used in negative items. In the original research for the scale, which was developed to determine the attitudes of preservice science teachers towards renewable energy, the Cronbach's alpha value of the whole scale was stated to be .87. For the subscales, the reliability coefficients were calculated as .97 for application request (factor loadings between .85-.46), .80 for importance of education (factor loadings between .87-.47), .78 for country interests (factor loadings between .70-.56), and lastly, .72 for environmental awareness and investments (factor loadings between .71-.46). The findings obtained for the present research are given in Table 3.

Data Analysis

Firstly, to determine whether or not the scale items were suitable for factor analysis, the Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were performed. Next, to clarify the factor structures of the scale and to calculate the factor loadings of the items, explanatory factor analysis (EFA) was used. As a result of the EFA, items with factor loadings below 0.40 and double-loaded items were removed from the research model. Following the EFA, all variables were included separately in the model and tested with LISREL. Finally, again with the aid of LISREL, confirmatory factor analysis (CFA) was applied in order to determine the effects of renewable energy knowledge on attitudes toward renewable energy. In the analyses, maximum likelihood was used as the estimation method and RMSEAs were reported with 90% confidence intervals. Path analysis further allows chains of association between latent variables to be estimated. The theoretical structural model and latent variable path models in this research are shown in Figure 1.

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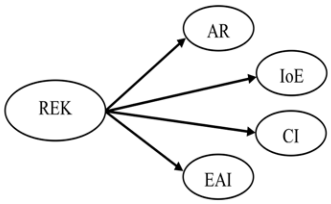

Figure 1. Theoretical structural model for effects of renewable energy knowledge on sub-dimensions of attitudes towards renewable energy

Research Results

Explanatory Factor Analysis (EFA) Results

Prior to the EFA, the Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were performed to determine whether or not the data set was suitable for factor analysis, and the results of these are given in Table 2.

Table 2. Results of examination of suitability of scale for factor analysis.

KMO test	Bartlett's test		
	χ^2	*SD*	*p*
.895	15255.924	861	< .001

As can be seen in Table 2, the KMO test value was calculated as .895 and the results of the Bartlett's test (χ^2 = 15255.924; *SD* = 861; *p* <.001) were found to be significant. A KMO value greater than .60 and a significant Bartlett's test show that data are suitable for factor analysis (Çokluk, Şekercioğlu, & Büyüköztürk, 2010). Factor loadings, Cronbach's alpha values, and skewness and kurtosis values for each sub-dimension are presented in Table 3.

Table 3. Item codes, factor loadings, and Cronbach's alpha values for whole factors

Factors	Item code	Mean	Standard Deviation	Factor Loading	Cronbach's Alpha α	Skewness	Kurtosis
Renewable Energy Knowledge	rek1	4.39	.80	.71	.82	-2.08	2.91
	rek2	4.44	.75	.85		-1.94	2.54
	rek3	4.41	.83	.70		-2.26	2.04
	rek4	4.11	.93	.76		-1.07	1.14
	rek5	4.05	.90	.44		-.83	.60
	rek6	3.83	.99	.57		-.84	.91
	rek7	4.16	.91	.43		-1.37	2.36
	rek8	3.67	.97	.63		-.39	.33
	rek9	4.14	.88	.42		-1.10	1.79
	rek10	3.33	.79	.43		.30	2.16
	rek11	3.70	1.06	.56		-.60	-.02
	rek12	3.70	1.40	.75		2.01	2.74
	rek13	3.70	1.14	.94		-.63	-.43
	rek14	3.77	1.11	.85		-.79	.05
	rek15	3.66	1.04	.59		-.55	.03
	rek16	3.26	1.13	.64		-.12	-.66

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Factors	Item code	Mean	Standard Deviation	Factor Loading	Cronbach's Alpha α	Skewness	Kurtosis
Application Request (AR)	att4	3.62	1.25	.59	.65	-.76	-41
	att6	3.68	.93	.53		-.55	.19
	att10	3.98	.83	.64		-.92	1.34
	att14	4.08	.86	.55		-1.24	2.28
	att17	4.03	.81	.49		-1.14	2.28
	att19	3.84	.95	.44		-.77	.34
	att21	3.86	1.12	.54		-1.00	.35
Importance of Education (IoE)	att1	4.48	.72	.68	.66	-2.11	2.64
	att8	3.34	1.00	.48		-.36	-.12
	att11	4.04	.87	.61		-1.14	1.81
	att20	3.97	.87	.59		-1.01	1.54
	att23	4.22	.96	.62		-1.55	2.35
	att24	4.09	1.14	.55		-1.39	1.11
	att25	4.33	.79	.40		-1.66	2.96
Country Interest (CI)	att2	3.90	1.14	.40	.71	-1.03	.34
	att5	3.71	1.15	.52		-.77	-.21
	att13	4.09	1.03	.57		-1.34	1.45
	att18	3.85	1.22	.59		-.98	-.04
	att22	4.21	.99	.60		-1.58	2.42
	att26	4.29	.95	.58		-1.62	2.44
Environmental Awareness and Investments (EAI)	att3	3.97	.98	.47	.70	-.89	.43
	att7	4.00	.96	.55		-1.02	.92
	att9	3.80	1.35	.53		-.92	-.46
	att12	3.78	.98	.40		-.55	.01
	att15	3.99	.92	.53		-.80	.50
	att16	4.01	.99	.55		-1.04	.79

After examining the explanatory factor analysis results, it was decided that all the items used in the scales were suitable to be included and tested in the structural model. However, in model studies to be made using latent variables, it is necessary to test each measurement tool separately before starting the analysis. The measurement tool testing should be similar to a confirmatory factor analysis and no unconfirmed measurement model should be included in the structural model. Therefore, each sub-dimension (latent variable) used in a research must be tested separately and its suitability for the structural model must be proven. The goodness of fit values obtained with the aid of LISREL for each factor are shown in Table 4.

Table 4. Goodness of fit values for variables to be included in model.

Factors	AGFI	GFI	NFI	CFI	RMSEA	SRMR
REK	0.86	0.90	0.86	0.88	0.093	0.070
WA	0.95	0.97	0.96	0.96	0.078	0.038
IoE	0.78	0.89	0.81	0.82	0.073	0.030
NI	0.96	0.98	0.96	0.97	0.073	0.037
EAI	0.88	0.95	0.95	0.95	0.059	0.071

Examining Table 4, it is seen that the goodness of fit values of the variables considered for inclusion in the model were within the fit limits according to the measures included in Table 1. Therefore, it was decided that the data sets for all the variables were suitable for SEM analysis and could be included in the model.

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Results of the Measurement Model Testing

In the second stage of the research, the structural model defined for revealing the correlations between renewable energy knowledge and the components of attitudes towards renewable energy were tested. As a result of the tests, χ^2=1811.34, *df*=775 and *p*= .001 found and the goodness of fit values are given in Table 5.

Table 5. Goodness of fit values for measurement model.

AGFI	GFI	NFI	CFI	RMSEA	SRMR
0.88	0.90	0.92	0.94	0.075	0.080

Examining Table 5, it is seen that these obtained values were within acceptable intervals for the goodness of fit measures (Table 1), and that therefore the structural model had an acceptable level of fit and the established model was valid for all data sets. Moreover, the χ^2/df value was found to be 2.33. The fact that this value is between 2-3 also shows that the model had an acceptable fit. The t values for the structural model of the research are given in Figure 2.

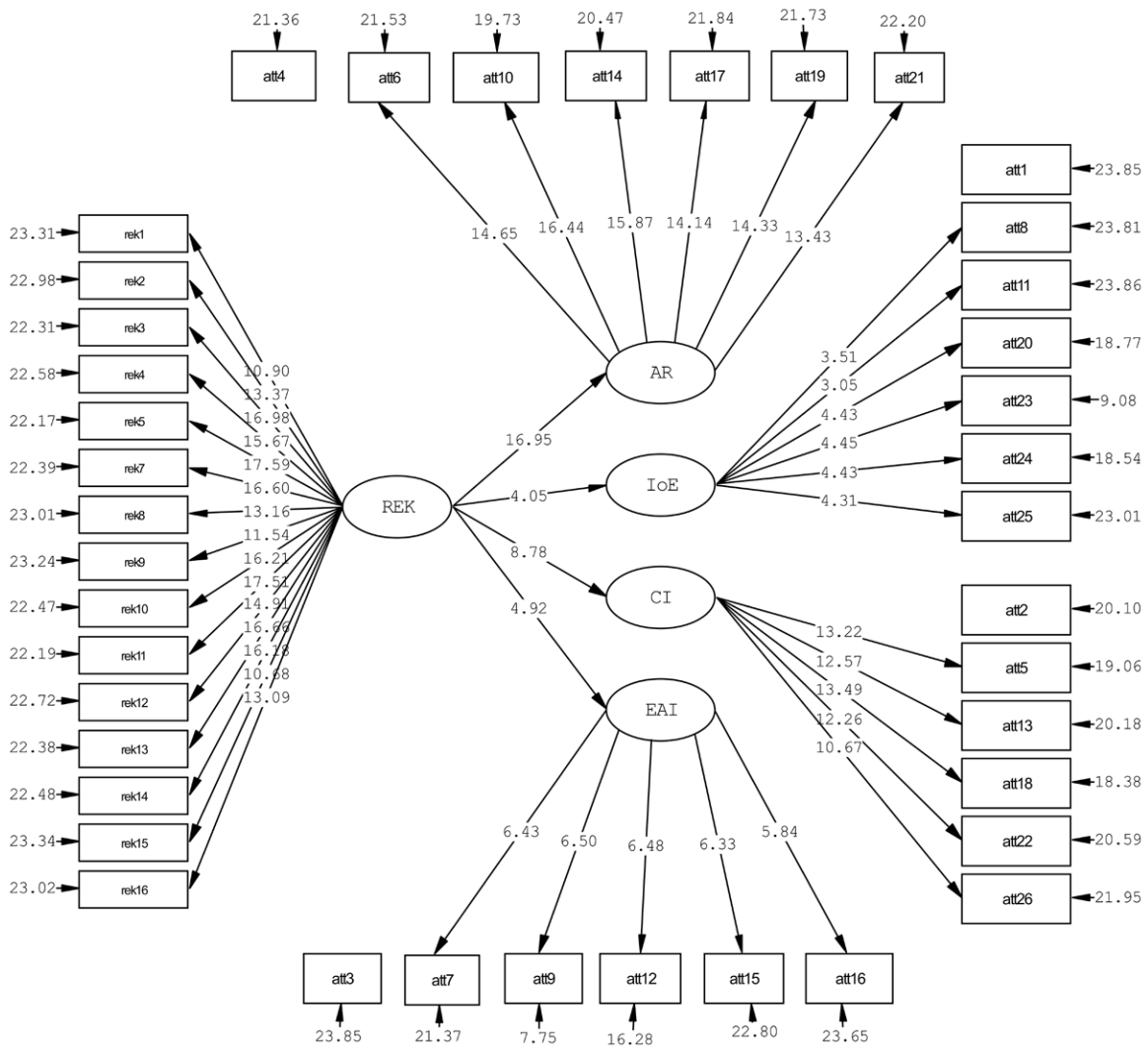

Figure 2. ***t*** **values for structural model adopted in research**

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Examining Figure 2, it can be seen that all *t* values are significant at a level of .1. The standardised values for the structural model of the research are given in Figure 3.

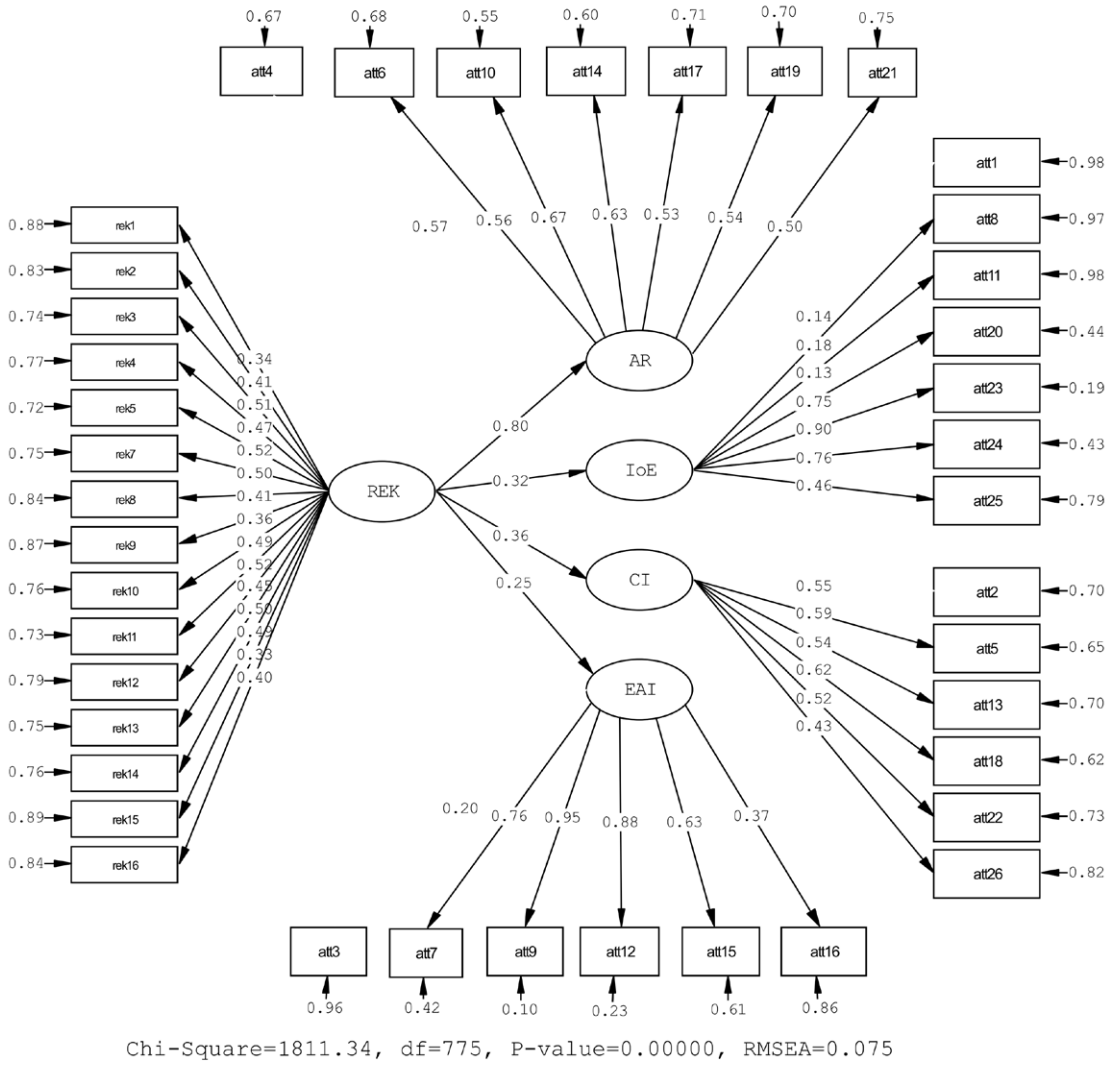

Figure 3. Structural model showing correlation between renewable energy knowledge and components of attitudes towards renewable energy.

According to Figure 3, correlation coefficients showed that renewable energy knowledge has positive effects on renewable energy attitude and its sub-dimensions.

Discussion

This research was carried out with structural equation modelling (SEM) with the aim of analysing how and to what extent preservice teachers' knowledge of renewable energy sources affected their attitudes towards renewable energy.

The research findings reveal a correlation between the teacher candidates' knowledge of RE sources and their attitudes towards them. Studies exist in different fields which state that when there is positive correlation between knowledge and attitude, they have effects on each other (Abu Bakara et al., 2010; Bradley, Waliczek, & Zajicek, 1999; Brossard, Lewenstein, & Bonney, 2005; Prokop, Tuncer, & Kvasničák, 2007).

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While there are a number of studies on attitudes towards renewable energy sources in the literature (Gökmen, Atik, Ekici, Çimen, & Altunsoy, 2010; Halder, Pietarinen, Nuutinen, & Pelkonen, 2010; Halder et al., 2012; Kılınç, Stanisstreet, & Boyes, 2009; Yuenyong, Jones, & Yutakom, 2008; Zyadin, Puhakka, Ahponen, Cronberg, & Pelkonen, 2012), only a limited number of studies can be found that examine attitudes of preservice teachers towards renewable energy sources. Although studies have examined attitudes towards renewable energy sources according to different variables (settlement area, environmental education received, parents' educational status, class level, etc.), there is a need for further studies examining different variables such as attitudes, knowledge and awareness about this type of energy especially in the teachers and preservice teachers who will shape the future. At the same time, there is a need for studies like the one conducted in Greece by Kaldellis, Kapsali and Katsanou (2012) which showed that as public knowledge about renewable energy increases, they have more positive attitudes about this issue.

Some studies made about attitude have reached different conclusions related to the effect on attitude of gender in particular. For example, in their research, Fırat et al. (2012) stated that male students' knowledge and attitudes were better than those of female students. However, as a result of the research, they stated that in general, students' attitudes towards renewable energy were positive. In contrast to this finding, in a research by Karatepe et al. (2012) conducted with engineering students, it was stated that no significant difference was found between attitudes of male and female teacher candidates towards renewable energy, whereas it was determined that female students' knowledge and awareness of the subject of renewable energy were higher than those of male students. Similarly, in Akçöltekin and Doğan's (2013) research, it was stated that there was no significant difference in attitudes of male and female teachers towards renewable energy.

In a research made by Bilen, Özel and Sürücü (2013), it was revealed that preservice science teachers had positive attitudes towards renewable energy. The obtained results revealed that gender and place of residence did not make a difference to the preservice teachers' attitudes, while it was seen that the grade level variable produced a significant difference. A significant difference was found between first and fourth grades.

Studies can be found which state that attitudes towards renewable energy vary according to the programme in which education is received. In their research, Fırat, Sepetcioğlu and Kiraz (2012) reported that preservice teachers' attitudes towards renewable energy differed on the basis of department, gender, grade and environmental education received at university. They stated that there were significant differences among departments in attitude scores related to renewable energy sources and that students in the geography teaching department had higher scores. Similarly, Çelikler and Kara (2011), in their research examining attitudes of preservice elementary mathematics and social science teachers towards renewable energy, revealed that the attitudes of the preservice social science teachers were more positive.

When attitude scores according to the period of receiving education are compared, Fırat et al. (2012) observed in their research that attitudes of preservice teachers studying in the first grade towards renewable energy were lower than those of preservice teachers studying in higher grades. This finding does not correspond to the findings in a research conducted by Zarnikau (2003). They state that this difference is because preservice teachers in the final year in particular had knowledge about renewable energy due to the lessons related to the environment that they had taken and that for this reason they were deduced to have positive attitudes.

It is known that for recognition, knowledge and development of positive attitudes regarding renewable energy sources, education is an important factor. It is stated that students do not have adequate knowledge of renewable energy (Yıldırım, Tanık-Önal, & Büyük, 2019). If teachers and preservice teachers have more knowledge related to renewable energy sources, this will also help students to acquire adequate knowledge, estimation and behaviour with regard to these energy sources. Teachers who have sufficient knowledge of renewable energy sources can serve as guides for their students in gaining suitable qualifications to be able to use these resources in their daily lives (Liarakou, Gavrilakis, & Flouri, 2009). The attitudes, awareness, perceptions and behaviours, especially of classroom and science teachers, towards renewable energy sources will also affect the perceptions, awareness, attitudes and behaviours about this subject in the students that they teach. It is suggested that especially in these subjects, environmental education (Genç, 2015) and education about renewable energy types (Çelikler & Aksan, 2016; Çolak, Kaymakçı, & Akpınar, 2015; Keramitsoglou, 2016) are important.

On the other hand, in the research carried out by Zyadin et al. (2012), it was stated that students did not have sufficient levels of knowledge about renewable energy sources, whereas 87% of students regarded renewable energy as one of the energy choices for the future and they generally had a positive attitude regarding adopting renewable energy despite its high costs. They reported that in general, young women became informed about

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renewable energy at an earlier period than young men did. In their research, Güven and Sülün stated that there were differences among departments in knowledge levels related to renewable energy. Similarly, in the research by Çolak, Kaymakcı, and Akpınar (2015), it was revealed that preservice teachers did not have sufficient knowledge levels with regard to renewable energy sources. In Cırıt's (2017) research, it was stated that preservice teachers did not have adequate knowledge about renewable energy sources.

According to the findings of the research by Zyadin et al. (2014), it was revealed that teachers had limited levels of knowledge about renewable energy. It was determined that they had neutral perceptions related to renewable energy use. On the other hand, it was seen that the teachers had open positive attitudes towards renewable energy development. It was determined that in general, while male teachers had slightly higher knowledge levels with regard to renewable energy, female teachers had more positive attitudes towards it. It was stated that a number of sociodemographic factors and factors related to work areas affected the teachers' knowledge and attitudes about renewable energy. It was stressed that teachers needed personal training in the subject of renewable energy before they began their professional lives.

Besides these, studies are seen which examine knowledge and attitudes about renewable energy together. However, in these studies, knowledge and attitude are examined only according to different variables without considering the correlation between them. For example, in a research conducted by Németh, Jakopánecz, and Törõcsik (2013), it was stated that there were differences between knowledge and attitudes related to renewable energy in males and females. It was determined that males had more knowledge about renewable energy sources, and that they had developed more attitudes towards these resources. It was also determined that economic reasons hindered women with regard to further modernisation, that they were more inclined towards saving money, that they were more sensitive towards the environment, that they went into action in a shorter time, that they were more optimistic, and that they were more affected by the activities of companies.

In their research, Çelikler, Yılmaz, and Aksan (2016) examined the knowledge and attitudes about renewable energy sources of students in different schools in a province. The research results showed that according to different variables, attitudes towards renewable energy sources were at a significantly different level among science high school students. The research results revealed that although the participating students generally displayed a positive attitude towards renewable energy sources and the power stations that use them, their knowledge of renewable energy sources was lacking in various respects. It was found that this lack of knowledge caused groundless anxieties among the students with regard to these energy sources.

In a research by Us, Florkowski, and Klepacka (2015), the factors affecting knowledge about renewable energy types among 200 inhabitants of 13 villages in a province, and their attitudes towards renewable sources, were investigated. The findings showed that among five types of energy, the participants were best informed about wind energy and that they were least well-informed about biofuels. It was also stated that their attitudes were at medium levels.

In a research carried out by Liarakou, Gavrilakis, and Flouri (2009), it was revealed that although teachers were informed about renewable energy sources, their knowledge about various subjects related to wind and solar energy technologies and farms was lacking. It is seen that since subjects such as these are not included in teaching programmes, it is difficult for them to be taught. This shows that teachers cannot develop their students' views about renewable energy systems. Therefore, it is recommended that authorities make more investment in teacher training related to environmental education. It is stated that older teachers have developed more attitudes towards renewable energy than younger teachers. It is also determined that males look more favourably upon nuclear energy than females do. In Cebesoy and Karışan's (2017) research, it was observed that the knowledge levels of preservice teachers towards renewable energy sources were insufficient, whereas their attitudes were shaped according to various variables.

The above studies show that while various studies have been conducted related to knowledge and attitudes about renewable energy, the correlation between the two variables has not been examined. When cognitive levels of individuals receiving education change, these affective factors are also affected. Therefore, importance must be given to increasing students' knowledge levels. Education programmes should be implemented in a more effective and meaningful way. Moreover, more comprehensive information related to renewable energy subjects must be included in teacher education. In this way, students can be provided with education on these subjects from an early period onwards. As stated in the research by Zyadin et al. (2012), the importance of implementing renewable energy education as soon as possible is emphasised in order to encourage the renewable energy development required for minimising the risks arising from environmental problems related to fossil fuels.

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The greatest barrier facing individuals in society towards adopting and internalising the subject of renewable energy is the level of their attitudes and knowledge about it. The more that knowledge and attitudes about the subject of renewable energy can be developed, the more individuals will be able to acquire positive attitudes and behaviours about this issue, and in this way, the effective and efficient use of renewable energy types can be realised.

Conclusions

According to the results of the research, it is determined that there is a relationship between the knowledge and attitudes of the preservice teachers about renewable energy sources. It is important that Renewable Energy is known, accepted and supported in order to meet the needs of today. Different factors for renewable energy are effective and it is important to determine the effects of these factors. However, there is no study showing the relationship between these variables. The relationship between knowledge and attitude was determined with this study. In this way, the importance of better knowledge of renewable energy and developing a positive attitude towards it has emerged. The more knowledge and attitudes about renewable energy can be improved, the more positive attitudes and behaviors will be provided to individuals and the efficient and efficient use of renewable energy types will be realized.

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