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AN INVESTIGATION OF FACTORS AFFECTING PRE-SERVICE SCIENCE TEACHERS AWARENESS IN RENEWABLE ENERGY SOURCES

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ABSTRACT: Due to increasing energy demands and environmental problems in burning fossil fuels (coal, oil, and gas), interest on renewable energy sources has been increased. Scientists try to find new and more effective ways to replace fossil fuels with renewable energy resources. Science teachers' knowledge, attitude and awareness plays an important role for the future. Because, they will be bringing up future generations of school children so that energy can be utilized efficiently. Few studies have explored teachers' awareness level about renewable energy resources, but there is no available instrument that assesses all science teachers' (physics, chemistry and biology) renewable energy awareness. Pre-service science teachers were asked to write a composition about their feelings, opinions, and attitudes towards renewable energy and explorative literature study was conducted to gather an initial pool of items. Item selection took place using qualitative and quantitative methods. Expert-analysis was used for screening the relevance. Exploratory factor analysis with promax rotation was used to determine construct validity and Cronbach's coefficient alpha determined the scale's internal consistency reliability. The instrument demonstrated high internal consistency (alpha 0.90). Exploratory factor analysis yielded a five-component structure termed Expectations from authorities, Relationship between renewable energy and environment, Comparison of renewable energy resources with fossil fuels, environmental awareness and Suitability of country for renewable energy; each sub-scale demonstrated satisfactory consistency: 0.85; 0.82; 0.71; 0.76; 0.82 respectively. The 32-item scale is easy to complete and to administer. This study has also investigated effect of gender and subject of pre-service science teachers on the awareness scale, and the relationship between effect of teachers' subject and awareness of pre-service science teachers. The development of a new and reliable awareness scale to identify pre-service science teachers' attitudes towards renewable energy resources will enable researchers to explore the relationships between science teachers' attitudes and their demographic and education-related characteristics.

Key words: Renewable energy education, awareness, energy literacy, preservice science teachers

INTRODUCTION

Since Renewable energy has become highly popular in educational institutions, throughout this process, there has been and will continue to be a need for faculty and students to re-examine preservice teachers' awareness and to re-develop a more comprehensive measure of teachers' awareness. By undertaking this task, it can be designed better courses and guide students and teachers toward successful and fruitful learning experiences.

Renewable energy sources such as solar, geothermal, wind, and biomass are receiving increased attention not just in Turkey but also in the world. The depleting nature and the accelerated demand of commercial energy have forced planners and policy makers to look for alternative sources. It is now generally accepted that renewable energy sources will have to play a major role in the future (Arif Hepbasli, Aydogan Ozdamar, 2001).

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Renewable Energy at a Glance

The literature provides several definitions of Renewable Energy supplies. For example: Twidell and Weir (2006, p. 3) define Renewable energy as ‘‘energy obtained from the continuing or repetitive currents of energy occurring in the natural environment’’. The Dictionary of Energy edited by Cleveland and Morris (2006, p. 371) says renewable energy is ‘‘any energy source that is naturally regenerated over a short time scale and either derived directly from solar energy (solar thermal, photochemical, and photo-electric), indirectly from the sun (wind, hydropower, and photo-synthetic energy stored in biomass), or from other natural energy flows (geothermal, tidal, wave, and current energy).’’ (Verbruggen vd., 2010)

Renewable energy supply in Turkey is dominated by hydropower and biomass, but environmental and scarcity-of-supply concerns have led to a decline in biomass use, mainly for residential heating. Total renewable energy supply declined from 1990 to 2004, due to a decrease in biomass supply. As a result, the composition of renewable energy supply has changed and wind power is beginning to claim market share. As a contributor of air pollution and deforestation, the share of biomass in the renewable energy share is expected to decrease with the expansion of other renewable energy sources (Bilgen, Keleş, Kaygusuz, Sarı, & Kaygusuz, 2008).

Solar Energy

The most important component of solar thermal technology is the solar thermal collector. A solar thermal collector is designed to collect heat by absorbing sunlight. (Sopian vd., 2011) Solar energy could eventually replace fossil fuels in most applications. Recently, several different types such as photovoltaic, solar thermal energy, and low temperature solar heat have become more cost-effective (Jager-Waldau 2007). Building-integrated and rooftop photovoltaic are now important aspects of building design. Solar domestic hot water systems are also widely available and cost-effective in many situations. (Taleghani, Ansari, & Jennings, 2010)

Although solar energy is the most important renewable energy source, it has not yet become widely commercial, even in nations with high solar potential such as Turkey. There are limited applications, and most of them are inefficient, both in terms of energy use and economical benefits. The economical feasibility of a solar energy system is mainly determined by its initial cost and long-term efficiency (Kaygusuz & Sari, 2003). The photovoltaic sector in Turkey is still fairly small, providing work for only a small number of employees. The main actors consist of several companies and a number of research institutes (Yuksel & Kaygusuz, 2011).

Wind Energy

This is likely to generate 10% of the world’s electricity by 2020 and is now regarded as a conventional energy source. The available wind energy estimates range from 300 to 870 TW (Jefferson 2005). Using the lower estimate, just 5% of the available wind energy would supply the current worldwide energy needs. Most of this wind energy is available over the open ocean and large-scale offshore wind farms are being constructed in many countries. Small-scale, building-integrated wind turbines are becoming available and may be integrated into houses and commercial buildings to provide free energy from the wind (Taleghani vd., 2010).

Biomass

Biomass energy includes fuel wood, agricultural residues, animal wastes, charcoal and other fuels derived from biological sources. It is used by approximately half of the world’s population as cooking and/or heating fuel, and it currently accounts for about 14% of world energy consumption. Biomass is the main source of the energy for many developing countries, providing more than 90% of the energy supply in some developing countries. Fuel wood and other biomass fuels are handled and combusted primarily by women, who are largely responsible for repetitive chores, such as cooking, and are often involved in any household industries (Kaygusuz & Sari, 2003).

Wave and Tidal Energy

Wave energy generates electricity, heat or mechanical energy from ocean wave. Some other applications beside electricity generation include desalination, pumping of seawater for marine cultures are potentially viable.(Sopian vd., 2011)

Geothermal Energy

It is expected that the worldwide use of fossil fuels is going to decline in this century, and that geothermal energy will contribute in the replacement of those fossil fuels. Even now, the recent rise of oil and gas prices has made the development of the geothermal resources of Turkey more feasible. In the recent years, among the renewable

energy alternatives, geothermal energy in world and our country has become very attractive. The reason for this interest is features of geothermal energy in direct and indirect use (Yuksel & Kaygusuz, 2011).

Social acceptance is recognized as an important issue shaping the widespread implementation of renewable energy technologies and the achievement of energy policy targets. Furthermore, it is commonly assumed that 'social attitudes' need to change to make more radical scenarios about the implementation of renewable energy technologies feasible (E. Moula vd., 2013).
The purposes of this study are to re-examine the concept and the underlying dimensions of science (physics, chemistry and biology) teachers' awareness for renewable energy, and to construct and validate an instrument the Renewable Energy Awareness Scale (REAS). Because this study's REAS framework is a hypothetical model serving to explain physics, chemistry and biology teachers' awareness toward renewable energy, the construct should be validated. Therefore, the present study has used a traditional exploratory factor analysis (EFA) to establish the construct validity of the REAS model. This study will explore the following research questions:

- What is pre-service science (physics, chemistry and biology) teachers' awareness for renewable energy?
- Does the gender of teachers make any difference in their awareness for renewable energy?
- Does the subject they teach (i.e., physics, chemistry and biology) of teachers make any difference in their renewable energy awareness?
- Does renewable energy education given at the undergraduate level make any difference in renewable energy awareness?

METHODS

First of all, a literature review was done, after that, 30 pre-service science teachers from different areas (physics, chemistry and biology) were asked to write a composition about their feelings, opinions, and attitudes towards renewable energy. An item pool was constructed from literature and compositions written by participants. Then, item selection took place using qualitative and quantitative methods: Expert-analysis was used for screening the relevance. 63 items were extracted from the item pool. Approximately half of items in are written in the form of positive statements and the other half in the form of negative statements. Teachers were asked to describe themselves in reference to a 5-point Likert-type scale, with anchors ranging from 1 (strongly disagree) to 5 (strongly agree). The Brief instructions for the completion of this scale are included to ensure that the scale can be self-administered. Participants also completed a demographic questionnaire, which included items on their age, gender and so on.

The REAS was administered to 161 pre-service physics, chemistry and biology teachers taking pedagogical training class at different universities. Exploratory factor analysis with principle component analysis was employed to empirically reveal and demonstrate the hypothesized, underlying structure of renewable energy awareness scale. Before conducting an exploratory factor analysis, the results of the KMO measure of sampling adequacy and the Bartlett's test of sphericity were examined to determine appropriateness of factor analysis. Bartlett's test was significant (BTS value= 2024,61, $p<0.001$), showing that the correlation matrix was significantly different from an identity matrix. Similarly, the KMO Measure of Sampling Adequacy of 0.85 was substantial. Both revealed that it was appropriate to perform a factor analysis (Tabachnick & Fidell, 2007).

Correlation Matrix

The next step was to examine the correlation matrix of the scale for items with high (greater than 0.9) or low (less than 0.4) correlations. A high correlation coefficient between two items suggests that the items are too similar or too redundant and should be removed or rephrased. (Field, 2005). Examination of the correlation matrix of the Renewable energy awareness scale, items that had coefficients less than 0.4 (redundant) were subsequently removed. Sometimes dropping problematic items (ones that are low-loading, cross loading or freestanding) and rerunning the analysis can solve the problem, but the researcher has to consider if doing so compromises the integrity of the data.(Costello & Osborne, 1994). So We have dropped problematic items.

Exploratory Factor Analysis

Exploratory factor analysis EFA (principle component analysis) with promax rotation was conducted as to determine construct validity and Cronbach's coefficient alpha determined the scale's internal consistency reliability. Factor analysis allows for the grouping of related items in a scale into a smaller number of factors or categories (Levett-Jones vd., 2011). The goal of rotation is to simplify and clarify the data structure. Rotation cannot improve the basic aspects of the analysis, such as the amount of variance extracted from the items. As with extraction method, there are a variety of choices. Varimax rotation is by far the most common choice (Costello & Osborne, 1994). There are some techniques used to assist in the decision concerning the number of factors to retain such as Kaiser's criterion; scree test; and parallel analysis. A popularity gaining technique is

parallel analysis that involves comparing the size of the eigenvalues with those obtained from a randomly generated data set of the same size. Only those eigenvalues that exceed the corresponding values from the random data set are retained (Pallant, 2013). The remaining 32 items on the scale were checked by language experts to control the intelligibility and grammar.

RESULTS and FINDINGS

Five factors were found in teachers' renewable energy scale. The total variance obtained by five factors was estimated as 50.23%. According to literature, the higher the variation in the results of factor analysis got, the stronger the factor structure of the scale was considered (Dunteman, 1989). Because it is difficult to reach higher values in social sciences, the variance percentage over 40–60 is considered acceptable in various resources (Namlu & Odabasi, 2007). Therefore, in this study, variance percentage was approximately 50%, which is at the acceptable border. The estimated factor load was between 0.45 and 0.82 values. Table 1 represents the items included in the factors.

Table 1. Rotated Factor Loadings for The 32-Item Renewable Energy Awareness Scale

Item No	Original Item No	Political support expectations for the future	Contribution for environment and country	Comparison with Other Energy Sources	Environmental protection and knowledge	Suitability of country for renewable energy
1	47	0,76				
2	50	0,75				
3	45	0,68				
4	44	0,64				
5	46	0,63				
6	53	0,60				
7	59	0,55				
8	4		0,68			
9	12		0,67			
10	31		0,66			
11	30		0,65			
12	11		0,63			
13	3		0,59			
14	54		0,54			
15	7		0,50			
16	43		0,45			
17	36			0,86		
18	51			0,57		
19	35			0,53		
20	56			0,53		
21	55			0,50		
22	37			0,45		
23	41			0,45		
24	2				0,68	
25	8				0,67	
26	1				0,63	
27	9				0,51	
28	17				0,50	
29	13				0,48	
30	24					0,82
31	23					0,81
32	22					0,78

Reliability revisited the alpha values were for the new Scale and subscales were satisfactory after removal of the poorly fitting items (refer to Table 2)

Table 2. Total Variance Explained by Factors with Eigenvalues

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	8,59	26,85	26,85
2	2,28	7,14	33,99
3	1,88	5,88	39,87

4	1,76	5,50	45,37
5	1,56	4,86	50,23

CONCLUSION

In this study, mean awareness score of all preservice teachers was found 3.97 (0,50). On average, male participants had greater average (M = 4,06, SE = 0,54) than to female participants (M = 3,99, SE = 0,50). But this difference was not significant $t(124) = -0.705$, $p > 0.05$; it represents an effect of $r = 0.003$. The average renewable energy awareness of pre-service science teachers was found as 3.93 out of 5.00 for teachers who did not get any course and 4.13 for teachers who got a course about renewable energy, respectively. $t_{(156)}=2,23$, $p<0,05]$. it represents an effect of $r = 0.03$.

We conducted a multivariate, repeated one-way ANOVA to compare the mean awareness score of the teachers, according to the subject they teach (i.e., physics, chemistry and biology). Any effect of teachers' subject (physics, chemistry and biology) on renewable energy awareness was not observed.

Despite some methodological limitations in our study, this new scale does appear to be a consistent and stable measure of pre-service science teachers' awareness of renewable. Further research is necessary with larger groups of students to confirm these study findings and to evaluate the validity of this scale.

RECOMMENDATIONS

The REAS is a practical measurement instrument that yields reliable data about the renewable energy of pre-service science teachers (physics, chemistry and biology) at individual and group level. The REAS is a one-dimensional scale with five relevant aspects of that dimension: Expectations from authorities, Suitability of country for renewable energy, Relationship between renewable energy and environment, economic effect of renewable energy source, environmental awareness, and comparison of renewable energy. The 32 items on a 5-point Likert scale are easy to complete, resulting in a one-REAS score. Scores can be calculated without time-consuming coding procedures.

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APPENDIX

REAS dimensions and items

Item No:	Dimension/items
Political support expectations for the future	
PSEFF1	Public investments should be increased in order to make effective and rational use of renewable energy and renewable energy resources.
PSEFF2	Instead of fossil fuels that running out day by day, renewable energy resources should be used in the next years.
PSEFF3	I believe that advertisements are one of the most effective way to raise awareness about renewable energy.
PSEFF4	Renewable energy projects to be realized in the region, will contribute to the awareness of renewable energy.
PSEFF5	Necessary arrangements and facilities for renewable energy resources should be made in order to meet the rapid increase in energy demand.
PSEFF6	Replacing fossil fuels that will be exhausted in the future with renewable energy resources makes sense.
PSEFF7	I believe that all countries should use nature-friendly renewable energy resources.
Contribution for environment and country	
CFEC1	Bioenergy is not the energy produced from biological resources.
CFEC2	The use of renewable energy sources instead of fossil fuels does not create a significant difference to stop global warming.
CFEC3	Generating electricity and heat from renewable energy sources, there is no effect in reducing the country's dependence on foreign energy sources.
CFEC4	I do not think, generating electricity and heat from renewable energy resources will contribute to the national economy.
CFEC5	There is no need to use environmentally friendly renewable energy sources instead of fossil fuels for a healthier planet and a safer world.
CFEC6	Geothermal energy is not the earth's internal heat.
CFEC7	I do not believe that it is possible to generate energy from renewable resources which are naturally replenished.
CFEC8	Using renewable energy resources does not mean protecting nature.
CFEC9	Turkey does not have quite positive conditions for renewable energy resources because of its position and climate characteristics.
Comparison with Other Energy Sources	
CWOES1	I think, nuclear energy should be banned while there are renewable energy resources.
CWOES2	We should use renewable energy resources instead of fossil fuels to get rid of climate change which is a major threat for our civilization
CWOES3	When compared with renewable energy resources, nuclear power plants are dangerous, therefore they not accepted by society.
CWOES4	I think, We are not good enough as a society about the use of solar energy efficiently.
CWOES5	I can pay more for electricity generated from renewable resources.
CWOES6	Generating electricity and heat from renewable energy resources reduces the need for nuclear energy.
CWOES7	In our country, the use of renewable energy resources is less than the developed countries.
Environmental protection and knowledge	
EPAK1	Wind turbines are utilized to produce electricity.
EPAK2	Renewable energy resources are more environmentally friendly than fossil fuels.
EPAK3	Sunshine can be utilized to produce electricity .
EPAK4	Generation of electriciy and heat from renewable energy resources have no harmfull effects on the environment.
EPAK5	Renewable energy sources are environmentally friendly that do not ruin the balance of nature, relative to other sources.
EPAK6	It is necessary for the use of renewable energy resources to be listed among environmental protection activities.
Suitability of country for renewable energy	
SOCFRE1	Solar water heating systems is one of most convenient sources of energy for Turkey.
SOCFRE2	Wind energy is One of the most useful renewable energy resources for Turkey.
SOCFRE3	Generating electricity with solar panels is one of the most useful ways for Turkey.