Developing A Renewable Energy Awareness Scale
For Pre-service Chemistry Teachers

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ABSTRACT

In times when human beings used to live in a natural environment, their needs were also provided by natural resources. With the increases in population in time, human beings started to look for new resources willing to get "the more" and "the fastest". Just like the invention of steam, firstly, they increased the density of the resources and produced "more" energy. However, instead of working on the density of water, which spreads with the solar energy, they chose an easier way, which was fuel that produced more energy when burnt. Unfortunately, the damages these fuel products create in the atmosphere and environment shaded their benefits. It did not take so long for the earth to run out of energy resources and to threaten environmental and human health.

As a result of that, new energy resources were started to be sought and the studies enlightened the concepts of sustainable, renewable energy. Renewable energy is defined as "the energy source, which continues its existence for the following days within the evolution of nature". Educators pointed out a need in students for gaining consciousness on renewable energy resources. In the light of the importance of renewable and sustainable energy, a "Renewable Energy Awareness Scale" that questioned to what extent the individuals were aware of renewable energy was developed. The Renewable Energy Awareness Scale, which consisted of 50 items, was administered as a pilot study. The factor analysis concluded with a scale of 39 items with a reliability coefficient of 0.944 was developed.

Keywords: Renewable energy, Awareness scale, Factor analysis, Chemistry education.

INTRODUCTION

Consuming energy in various ways has been the basic element of development and civilization. One of the most important measures of development and welfare is the amount of energy consumed per person in societies. The produced and consumed types of energy are thermal energy, mechanical energy and electrical energy. In production of these types of energy, primary energy sources are fossil fuel, nuclear energy, wood, biomass, sun, water, wind, and underground hot or boiling water resources. By using different technologies with these resources, secondary energy sources, which are electrical energy, thermal energy and mechanical energy, are produced. In times when human beings used to live in a natural environment, their needs were also provided by natural resources. Drying and heating was provided by the sun; grain production was provided by the wind; and lighting was provided by candles. As the population increased and needs started to vary, human beings headed for new resources in order to reach the "the more" and "the fastest". First, "more energy" was produced through increasing the

density of the resources such as the invention of steam. However, instead of working on the density of water, which spreads with the solar energy, an easier way, which was the fuel that produced more energy when burnt, was chosen. Unfortunately, the damages these fuel products create in the atmosphere and environment shaded their benefits. In a very short period like 100 years, the harming effects of fossil fuel on nature and the health of living organisms appeared. While the resources that complete their formation in thousands of years die out such as coal, natural gas, and oil, air, water and soil has also started to get harmed because of their wastes. The disadvantages of using coal, oil and natural gas, which are fossil fuels, are not only limited to the environment but also have spread up to the atmosphere. In the end, this pollution has started to threaten the life on earth by causing changes in the climate.

These days, the negative effects of fossil fuels on human health are increasing rapidly. When fossil fuels are burnt, it causes six greenhouse gases to come out. The most significant ones among them are the carbon dioxide (CO_2) and methane. The others are sulfur, particle matter, azoth oxide, soot and ash. The reason why fossil fuels like coal, oil and natural gas cause changes in climate is the heat-keeping characteristic of the CO_2 and methane gasses that come out in burning. The Sun provides heat and light into the atmosphere from its rise to its setting. In the natural cycle, this heat needs to be retransferred to the space. However, the greenhouse gasses that comes out because of fossil fuels cause some of this heat to be kept within the atmosphere. Therefore the world gets warmer and the climate changes. Most countries in the world use oil, coal and natural gas to meet their energy needs. Fossil fuels are not renewable and they are limited resources that are slowly dying out. They become more and more expensive and harmful for the nature everyday. On the other hand, renewable energy resources are renewable and they never die out. Most of the renewable energy comes directly or indirectly from the sun. Sunlight or solar energy is used for many commercial and industrial purposes in heating, lighting and electricity production. Renewable energy has many advantages:

- ➢ **Environmental advantages: Renewable energy resources are clean energy resources. Their effects on nature are much less then traditional energy technologies.**
- ➢ **Energy for the grandchildren of our grandchildren: Renewable energy resources never die out. Other energy resources will die out one day.**
- ➢ **Business and economy: Renewable energy investments focus on producing material and work power in order to establish structure systems. Therefore the money spent does not go abroad and this provides new employment and income opportunities.**
- ➢ **Energy safety: As a result of the dying out fossil fuels, many countries have to import fossil fuels. However, since there is no risk for renewable energy to die out, it is always safe.**

Human beings, who have been trusting upon the fossil fuels such as oil, coal and gas in order to meet the energy needs for ages, are now face to face with the results. Global warming is a direct result of the CO2 and the other greenhouse gasses that come out when fossil fuels are burnt and this fact cannot be ignored. Greenpeace is looking for a national support in order to start a change towards solutions such as saving energy and clean sustainable energy resources in order to get rid of united polluters and fossil fuel users. By reducing consumption and producing clean energy with nature-friendly technologies could reduce our addiction to unacceptable energy resources. There are productive technologies and tools, which could be used economically. These will help in putting an end to the addiction to the fossil fuels. The aim of the renewable energy resource technologies is to look for and develop the ways of using solar, wind and water energy in order to create a clean energy that will never die out or cause global warming gasses.

By reducing the demands and increasing the stocks, it would be possible to make electricity sustainable in the next millennium. The research on natural energy resources against the fossil and nuclear fuels has brought forward the concepts of sustainable and renewable energy. For the existence of lifecycle, it is not enough for the resources to be sustainable. The resources also need to be renewable for the ecological balance. For something to be continuous does not mean for it to be sustainable. Sustainability is possible only if it is renewable in all aspects. Therefore, energy systems should be sustainable and energy resources should be renewable. Renewable energy is defined as the energy source that could exist for every next day in the own cycle of nature. The fossil fuels, which are widely used these days, are fuels that die out and cannot be renewed when burnt. Yet, natural resources such as hydroelectricity, solar, wind and geothermal are both renewable and clean. There are studies on producing 50% of electrical energy from the renewable resources in the year 2020. There are also studies on producing 10% of electrical energy from the wind in the year 2010. Apart from these, there are also other renewable energy resources, which are not widely used over the world. Waves, ebb tides, methane gas from the wastes and heating from the sever system are considered as energy resources for producing electricity.

As nature-friendly energy resources widespread, the research on new energy resources will also develop. Today, there are many studies at schools or in the society on renewable energy. Martin and O'Toole (2002) in their study, made presentations at schools with the help of the CD they had prepared. Grant and Littlejohn (2001) wrote a book at the primary and secondary level in order to help the teachers in teaching climate changes, in which they mentioned concepts such as greenhouse effect, climate and seasonal changes and energy. Newson (1997), held conferences and made field trips in their project where students gained information on renewable energy.

Nicholson (1996), in a study on using the Internet in the classroom, worked on the websites prepared by students on renewable energy resources. With this study, students were informed about both using the Internet in the classroom and renewable energy. Seutville and Reggle (1995) discussed recycling, organic agriculture, renewable energy and nature-friendly technologies in their study. Kroll (1992), made a curriculum proposal for little children that consisted of 7 chapters, each of which involved games, scientific experiments, ecosystem, habitat, solar energy and renewable energy. Desinger (1990) discussed the concept of sustainability in environmental education in his study. He worked on the definition of sustainability and its integration to the curriculum or interdisciplinary approaches. The educational program of New Mexico Solar Energy Institute aims to increase the abilities of teachers to teach renewable energy resources (Rowland, 1985). Hamilton (1983) planned studies in order to increase the motivation of the workers and improve their attitudes towards energy consumption by making a list of the reasons for the attention towards renewable energy. Although many research and informative studies were conducted on energy and renewable energy, there are not any on developing an awareness scale. This increases the importance of this study.

THE PURPOSE OF THE STUDY

In times when human beings used to live in a natural environment, their needs were also provided by natural resources. As the population increased in time, new energy resources were started to be needed in order to meet the needs. In a very short time, the energy resources not only died out but also started to threaten the human and environmental health. As a result of that, new energy resources were started to be sought and the studies enlightened the concepts of sustainable, renewable energy. Renewable energy is defined as "the energy source, which continues its existence for the following days within the evolution of nature". The fossil fuels, which are widely used these days, are fuels that die out and cannot be renewed when burnt. Yet, natural resources such as hydroelectricity, solar, wind and geothermal are both renewable and clean. Educators pointed out a need in students for gaining consciousness on renewable energy resources.

In the light of the importance of renewable and sustainable energy, developing a "Renewable Energy Awareness Scale" that questioned to what extent the individuals were aware of renewable energy was aimed.

METHODOLOGY

The subject

158 students attending to Hacettepe University, Faculty of Education, Department of Chemistry Education have participated in the study on the development of the Renewable Energy Awareness Scale.

The Renewable Energy Awareness Scale

Within the scope of this study, the following activities were carried out to develop the "Renewable Energy Awareness Scale" to measure renewable energy. The "Renewable Energy Awareness Scale" related to renewable energy awareness was developed by researchers. A total of 158 students were involved in the study while the scale was being developed. In order to develop a valid and dependable measurement tool to be used to measure the attitudes of students according to their knowledge on renewable energy awareness, a draft form consisting of 50 items of awareness was prepared first. The items in the form are given in Table: 1

Table: 1 The Pilot Renewable Energy Awareness Scale

Dear Student, In this scale, purpose is to determine pre-service chemistry teachers' awareness scale towards renewable energy. There is no right or wrong answers in this scale. Please, mark the blank that represent your stance toward each item in the scale. Thanks for your contribution.	I totally agree	I Agree	I am undecided	I don't agree	I disagree
1. Renewable energy resources should be effectively used in order to meet the rapid increase in energy demand.					
2. Public investments should be increased in order to make effective and rational use of renewable energy and renewable energy resources.					
3. It can not be useful that private sector investments direct to this area in order to make effective and rational use of renewable energy and renewable energy resources.					
4. I do not think that traditional energy production techniques destroy the environment.					

5. I believe that all countries should use nature-friendly renewable energy resources.					
6. Renewable energy and its resources is a subjects that I have no idea about.					
7. The slogan of this century should be using clean energy resources.					
8. I find using the sun and other unlimited clean energy resources unrealistic.					
9. I don't believe that the use of renewable energy resources, which are also named as clean energy resources, is more limited when compared to the use of traditional energy resources.					
10. I believe that the use of renewable energy resources, which are also named as clean energy resources, is more limited when compared to the use of traditional energy resources.					
11. The usage of enzymatic hydrolysis technologies does not increase the competition with gasoline.					
12. I do not believe that the capacity would increase in energy supply and usage with the usage of renewable energy resources					
13. Using renewable energy resources would not decrease the use of fossil fuels.					
14. I do not believe that renewable energy resources will be easier to use for me.					
15. I am not attracted to the renewable energy resources because they require more improved technology.					
16. I would not prefer renewable energy because I think it is not easy to use although it is needed for the environment.					

17. When we live in a natural environment, the supply of our energy needs from natural resources is more suitable.					
18. I use fossil fuel but I do not know anything about their disadvantages.					
19. The greenhouse gasses that come out because of fossil fuels cause some of the heat to stay within the atmosphere and parallel to this, global warming makes me happy.					
20. I do not believe that global warming would cause a very important problem.					
21. I believe that the sustainability of resources is not enough for the sustainability of life.					
22. I believe that resources should be renewable for the ecologic balance.					
23. I have no idea about renewable energy resources.					
24. The number of attempts on considering new renewable energy resources within a planned energy policy should be increased.					
25. I strongly support the use of renewable energy resources.					
26. I support the production of renewable energy resources.					
27. The expression of renewable energy makes me nervous because I am not used to it.					
28. Renewable energy resources are at the same time clean energy resources.					
29. I do not believe that the difference between renewable energy resources and non-renewable energy resources is very important.					
30. Wind energy is an important renewable energy resource.					

31. I do not believe in the idea of producing energy from the wastes.					
32. Producing energy from energy resources such as the Sun or the water is a utopia.					
33. In energy resources, electric energy is the most necessity					
34. I do not believe that using renewable energy resources would contribute to energy saving.					
35. I believe that education at schools on renewable and non-renewable energy resources is important.					
36. I am not interested in whether the energy resources are renewable or not.					
37. It is important in the globalization process for the individuals to become aware of consuming renewable energy resources.					
38. I do not see a relationship between the EU harmonization, globalization processes and using renewable energy resources.					
39. I believe that there is no enough improvement in a world related to the renewable energy usage					
40. It is important for the use of renewable energy resources to be listed among Environmental Protection activities.					
41. Using renewable energy resources would remove the negative effects of the greenhouse gasses.					
42. Turkey has quite positive conditions for renewable energy resources because of its position and climate characteristics.					
43. Renewable energy resources have a feature that					

increases environmental pollution.					
44. I believe that the conscious usage of energy resources is not important to be more quality of life in the world.					
45. The development of technology as an uncontrolled has caused to be harmful of unrenewable energy resources to environment.					
46. The purpose of the energy policies is to provide the sustainability of the energy systems and renewable energy resources					
47. I believe that there is not a difference between using renewable energy resources or non-renewable energy resources for energy saving.					
48. I believe that it is necessary to focus and create awareness on the importance of energy resources and energy saving within the in-service educational programs for teachers.					
49. I believe that media has a great responsibility in emphasizing the importance of using renewable energy resources.					
50. Fossil fuel is a type of renewable energy resource.					

When this form was being prepared, a group of students were asked to write compositions explaining their feelings and thoughts about Renewable Energy Awareness Scale. Upon the examination of these texts, sentences that can be used as items of awareness were selected and included in the draft form. These items accepted to indicate behaviors about Renewable Energy Awareness Scale were examined by measurement and evaluation experts and grammatically evaluated, and a draft form of 50 items was prepared after the required corrections. Whether the students agreed or disagreed with the affirmative and negative items of awareness was measured with a 5-level grading scale expressed as "I totally agree", "I agree", "I am undecided", "I don't agree", and "I disagree". In order to test the structural validity, in other words to test whether it measures a single structure (concept), the "fundamental components" analysis, which is a factor analysis technique, was applied. Structural validity is related to what the measured feature is. Factor analysis is the strongest method in examining structural validity and it enables the measurement to be made with much less number of factors by combining the variables that measure the same quality together (Kerlinger, 1973; Tabachnick, 1989). Therefore, with factor analysis, measurable concepts can be attained. Tabachnick and Fidel (2001) state that data from 200 subjects would be enough for factor

analysis. However, there are also studies with the number of subjects varying between 100 and 150. Therefore, the number of individuals reached (N=158) have been accepted sufficient for factor analysis.

FINDINGS

In this study, the decision to include an item in the scale was based on the principle that the load value in the first factor would be 0.40 and more.

Table: 2
Second Factor Analysis for Renewable Energy Awareness Scale
(Principle Components Analysis) Results

Item No	Factor-1 Load Value	Communality	Corrected Item Total Correlation
36	.728	.653	.704
27	.728	.721	.705
25	.715	.868	.676
49	.697	.706	.661
32	.699	.636	.661
40	.686	.629	.674
42	.682	.546	.643
23	.688	.703	.665
6	.679	.641	.657
16	.657	.558	.614
28	.643	.610	.610
8	.635	.601	.611
2	.626	.588	.589
41	.608	.585	.560
48	.596	.520	.559
31	.607	.677	.576
15	.587	.608	.548
26	.599	.795	.550
19	.584	.627	.565
14	.576	.641	.554
24	.584	.742	.533
7	.574	.710	.523
30	.572	.428	.543
10	.526	.579	.498
5	.527	.449	.487
13	.523	.556	.510
29	.514	.551	.501
4	.512	.535	.483
35	.499	.495	.456
1	.473	.654	.444
38	.457	.740	.440
47	.532	.623	.512
22	.472	.377	.436
46	.447	.627	.401
20	.403	.672	.396
18	.513	.655	.487
50	.454	.523	.432
34	.425	.496	.398
37	.479	.650	.450
α = 0.944			

The difference between the load value it takes in a factor needed to be 0.10 and more. Thus, it has been possible to prevent an item giving a high load value in the first factor to have a load value at this level and consequently, an increase in the amount of variance explained in a single factor in the end. On the data collected in the research study, first factor analysis and then item analysis were made in relation with the validity analysis of the scale.

When the data for "Total Variance Explained" and "Communalities" were examined, 11 items had a factor load value below 0.40 and therefore they were taken out of the scale. After the factor analysis, the items that had factor values less that 0.40 were removed from the scale and the results were displayed on Table: 2. The analysis results were examined and it was determined that the first factor loading values of all attitude items were 0.403 or higher. Moreover, none of the items were found to have a second factor loading value that was close to their first factor loading values. The alpha inner consistency coefficient that is calculated for the reliability of the "Renewable Energy Awareness Scale" was found to be 0,944. The differentiability and item reliability of the 39 attitude items in the scale were observed to have total item correlations between 0.396-0.705.

After the factor analysis, an important increase occurred in the amount explained by the first factor loading in total variance of the Renewable Energy Awareness Scale scores. The variance amount explained in a single factor increased from 28,4% in the scale of 50 items, to 34,2% in the scale of 39 items.

CONCLUSION

When the analysis results of the factor analysis for Renewable Energy Scale were evaluated, 39 items were decided to remain in the scale. The reliability coefficient of the scale is 0.944. Therefore it is a valid and reliable scale that assesses the awareness of students on renewable energy.

The final version of this scale is given in App-1. With the help of the "Renewable Energy Awareness Scale" the awareness levels could be determined as educators needed.

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