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RESEARCH ARTICLE

The Determination of Cognitive Structure of Candidate Teachers About Energy Centrals

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Abstract

Energy is the vital essence of every biotic and abiotic process. Energy is also in central position in human civilization. The famous energy centrals are the major way for production of energy with many diverse effects on environment. Therefore, the mitigation of these effects is extremely important and one of its way is education in this controversial issue. The aim of this study is to investigate the cognitive structure of these candidate teachers with various branches towards energy centrals or power plants in the road of the solution of the environmental problem. They were asked to fill the word association test containing four major concepts, nuclear, hydroelectric, thermal and wind centrals. In sum, the nuclear central and wind central are found to be the most and the least dangerous ones sequentially in cognitive structure.

Keywords: Candidate teacher; word association test; energy centrals; cognitive structure

Introduction

Energy is one of the most abstract concepts in science, education and daily life. It concerns many fields from academia to politics and science to media. It is simply defined as the ability to do work. It can be stored in material form and generally transmitted by electricity and radiation. The environmental pollution exerted meanwhile of these process is another issue. Energy conversions are possible, but the produced energy should be used immediately otherwise it is wasted as heat. The heat is the ultimate dead form of the energy which adds the global warming. Thus energy should be used efficiently before transforming into heat. The main topics are sustainable energy production, transportation and storage. The sustainability concept here bears also keeping delicate balance of the Earth. Environmental pollution with intrinsic and non-intrinsic hazardous material are prime issues. For example, carbon dioxide (CO_2) intrinsically nonhazardous compound but accumulation of it in the atmosphere nowadays is the major concern of global warming which can cause climate change. On the other, nitrogen oxides known as NO_x which are produced in every combustion process basically fossil fuels, are intrinsic hazardous material. The nitrogen oxides and sulfur oxides are responsible for acid rain which forms in the atmosphere with chemical reaction with water. The water when contaminated with toxic material becomes the basic material in the dissemination of toxicity. Also the nuclear energy embedded in the

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radioactive elements naturally starts to threaten the humanity and the world. Basically, when the uranium (^{235}U) enriched it can start to decay and produce energy, and the end results in residual dangerous waste. The other renewable and nonrenewable energy resources should also be evaluated carefully. Because, the energy resources which seems safe today may be found to be dangerous in the future.

The people of postmodern society had used to consume energy in easy and smart manner on time in luxury mode. We have to make choice whether we will continue to consume non renewable energy sources and/or find alternative and sustainable energy sources or we will change our habits and reduce energy consumption. Both of the conditions open exciting track to humanity. Anyway we have to try to find the solutions for every type energy problem. The discussion can be based on the interrelations of the subjects with energy, economy, sociology, ecology, citizenship and education.

The one of the main problem lies in the deficiency of communications between governmental organization and education system. All governments keep as secret of their energy demands and supply, because, they are strategic information and cannot be disseminated through public awareness and even in academia. If we are living in the same and one world, it cannot be monopolized by one authority whether it can be a group, a country or whatsoever.

The energy has started to play important role in the development of civilizations through its usage in steam engine with burning of fossil fuels in the last decades of 18th century in Europe (Küçükkalay, 1997; Griffin, 2011). Meanwhile, after the discovery of machine which produce electricity (by Michael Faraday in 1831), the pioneering primitive form of hydroelectric central resembling the today's one has started to be used in England after 50 years (Mallick, 2012). These conditions let the concepts of energy and electricity to become synonyms in public. From now on, the electricity unexceptionally becomes the autonomous power of science, technology and industry, and comfortable life. With the imagination of nonexistence of electricity, the humanity would have returned back to middle age. The increasing demand of energy due to increased population and technological devices triggers the consumption of fossil based energy resources (oil, coal, natural gas) which bring global warming and environmental pollution, probably resulting in climate change in future (Dinçer & Aslan, 2008; Keçebaş, Gedik & Kayfeci, 2010; MEB, 2012). Inevitably, these environmental issues take concern of public and none renewability of these resources towards the government alternative sources in last decades (Türkyılmaz, 2010). Nowadays, the specialists declare that oil, natural gas and coal will be depleted approximately in 40, 60 and 150 years respectively (Türkyılmaz, 2007; Aydın, Tonguz & Yılmaz, 2013). In these conditions, it is inevitable to use alternative sources in case availability. This differentiation starts in 19th century and fastens and takes priority meanwhile (Mallick, 2012).

Today, the sources energy centrals which generate electricity have been differentiated, and take the names of renewable and nonrenewable as distinct categories. In this context, while the renewable energy sources are flow potentials of water, solar radiation, biomass, wind, geothermal water, tides and waves, and hydrogen which have the potentials of existing tomorrow in natural cycle of mature with lesser hazardous to nature and human, the nonrenewable ones are fossil based fuels namely; oil, coal and natural gas along with uranium and thorium which have the higher potentials to damage them (Çakar, Başaran Filik & Kurban, 2009; Koç & Şenel, 2013; Yakıcı, Ayan & Papuçcu, 2013).

The popularity of renewable energy sources gaining acceleration due to lesser damaging effect of them to environment. However, the technologies related to them are newer and widespread usage is limited yet. Anyhow, some of the governments made formal legislation and politics towards them by 2009. Presently, the ratio of renewable

energy for supply of energies for OECD countries and world are 5.2 % and 2.1 % consequently. And, the investment in this sectors increases rapidly especially in developed countries (Kum, 2009).

Renewable energy centrals both have positive and negative effecting ways. For instance, hydroelectric centrals have low production cost of electricity after the construction of dam. And it adds economy like irrigation, fishery and tourism. However, since the electricity production depend on precipitation amount, the deterioration of the habitat near the water basin of the dam in order to collect water, and submerging of many historic and touristic places can be counted as main negative points of the hydroelectricity central. Wind centrals do not harm the environment during construction and it can be constructed in suitable places, but the storage cost is very high. The nuclear centrals have high construction cost, but the production cost of electricity is rather low. Normally, it does not harm environment other the problem of storage of nuclear waste. God forbid, in the case of accident, the destructive effect may continue decades apparently. Nuclear centrals do not cause air pollution and contribute a good and powerful image to country which can be counted as positive dimensions (URL 1 & URL 2). Fossil fuel plants low cost electricity due to the ample amount of the raw materials. However, it pollutes considerably water, earth and air (Goncaloğlu, Erturk & Ekdal, 2000). In a result, renewable or not all centrals have hazardous effects on environment (Ertürk, Akkoyunlu & Varınca, 2006; Ürker & Çobanoğlu, 2012).

Among these energy centrals, the deep debate is continuing on nuclear ones (Altın, 2004). The debate has started with Chernobyl and continue with Fukushima Daiichi (Stoutenborough, Sturgess & Vedlitz, 2013). Society does not have enough knowledge about energy centrals especially nuclear ones, and they prefer renewable sources rather than fossil fuels and nuclear based centrals (Lee, Hu & Chang, 1999; Aydın, Coşkun, Kaya & Erdönmez, 2011; Lee & Yang, 2013; Kim, 2013; De Groot, Steg & Poortinga, 2013; Kenar, 2013; Arikawa, Cao & Matsumoto, 2014; Haşıloğlu, 2014; Charisiou, Goula, 2014).

The transformation of knowledge into behavior about environmental issues is lacking back compared other areas of education in worldwide (Kuhlemeier & et al, 1999; Kibert 2000; Owens, 2000; Murphy, 2002; Pe'er, Goldman & Yavetz (2007); Purutçuoğlu, 2008; Erdoğan, 2009; Altınöz, 2010; Mcbeth & Volk, 2010; Esa, 2010; Timur, 2011). The people do not aware the incoming environmental dangers before occurring the inevitabilities. Also, the students growing in technologically developed post-cosmopolitan cities do not find chance to investigate natural and unnatural events like food chain and energy production plants. Environmental protection on the hand of insensitive people is difficult to achieve. Therefore, the determination of the cognitive structure of the people which results in attitude and behavior is important.

Nowadays, the word association test (WOT) has been started to be used in mapping cognitive structure of the concepts in human brain.

Kostava & Radoynovska (2008) have summarized the word association in contemporary way. Word association is a powerful research technique, introduced by Galton in 1880. Carl Jung theorized that people connect ideas, feelings, experiences and information by way of associations. According to him, ideas and experiences are linked, or grouped, in the unconscious in such a manner as to exert influence over the individual's behavior. A great work was ascribed to educators who can influence the human brain at very early stages that results in right connections and behavior is a test, consisting of a list of words, administered to the respondent, who has to answer to each word by means of the first word coming to his or her mind

By this way, a conceptual cognitive structure can be developed according to frequency table of the words cited by questioned people. This frequency table is quantized with numbers such as 10 etc. to obtain cognitive maps at various complexity and levels. The human brain has layered, divided and complex structure. The WOTs are promising in generalization of the cognitive structure.

In this structure, WOTs are one of the alternative measurement and evaluation technique. It is used to reveal the cognitive structure of the students where the concepts interconnected satisfactorily in long term-memory or not (Bahar, 2003). WOTS are not used only to determine cognitive structure of the students but also detection of the concept misconception and transformations of the concepts before and after execution of the training of the students (Işıklı & et al., 2011; Polat, 2013). This technique is used mainly for scientific concerns but also used for social issues (Deveci, Köse, & Bayır, 2014; Işıklı & et al., 2011; Bahar ve Kılıç, 2001).

The aim of this study is to outburst the disability of the candidate teachers in cognitive skills through energy centrals to reach satisfactory perceptions of energy centrals. This will supply many feedbacks. First of all, it will play a vital role in determination of the academic education affectivity of the candidate teachers in this controversial issue. Beside this, it will give some clues what they have learned and perceived about energy centrals (Han, Kim & Choi, 2014). The revelation of the cognitive structure of them can supply us how will probably teach these controversial subjects in the future. The revitalization of the individuals about energy issues has ultimate importance in terms of science, technology, society, and environment. One of the effective way to achieve this goal pass through education in schools.

Methodology

The Research Model

The survey model was used in this study. It is a descriptive statistical analysis to define the situation as exist (Karasar, 1999). By this way, the cognitive structure of candidate teachers has been tried to be revealed by word association test (WOT) about energy centrals.

Sample

The study has been executed by 78 candidate teachers with various branches (social, science and class teachers) in education faculty of Kastamonu University in 2014-2015 academic year in Turkey. These branch teachers are responsible in teaching about energy issues. The distribution of participants according to gender and branches were given in Table 1.

Table 1.

The distribution of participants according to gender and branches

Branches	Gender		Total
	Female	Male	
Elementary class teachers	19	7	26
Science teachers	19	7	26
Social science teachers	11	15	26
Total	49	29	78

Data Collection

WOT was used as data collection tool. The energy centrals which are the subject of this study are related with both science and social science. The nuclear, hydroelectric, thermal and wind energy centrals are chosen as key concepts for this study. All of these concepts were written covering the whole page separately as shown in the following.

Nuclear Central:.....

.....

Nuclear Central:.....

.....

Nuclear Central:.....

.....

Before the application of the WOT to students, they were informed about it and a sample application was done as pretreatment with another concept. Then, one minute is given to each concept for students to write out the words that they think about any relation with these key concepts.

Analysis of the Data

The frequency table showing the repetition frequency of the words that were produced by the candidate teachers about the concepts was given in App 1. By using this frequency table, concept networks were driven to depict cognitive structure of the students towards energy centrals by using cutting point techniques which is developed by Bahar et al. (1999). In this technique, a certain amount of number is subtracted from most cited words to determine the cutting point. The most cited word is energy in this study as 61 counts. Since there are a few words counted between 61 and 30 times, 30 is fixed as first cutting point. The concepts lying above this point were written on the first section of the concept network. Consequently, by counting down by tens from first cutting point till appearing new concepts, the process was continued on concept network (Bahar & Özatlı, 2003). The frequency of words which are cited less than 9 were not used in construction of concept network due to virtual difficulty, but given in frequency table.

Findings

If frequency table is examined, it is seen that total 165 words were used by candidate teachers in their response to WOT about the key concepts. The distribution of these words throughout the energy centrals was given in Table 2.

Table 2.

The # words produced by candidate teachers related with key concepts

Key Concepts	Positive word Counts	f	Negative word Counts	f	Total word Counts
Nuclear Central	59	331	50	302	109
Hydroelectric Central	49	511	6	24	55
Thermal Central	35	325	11	69	46
Wind Central	33	396	4	17	37

The key concept of nuclear central was associated with highest number of words (109) by candidate teachers, and least one is the wind centrals by 37 words. The number of words interrelated with hydroelectric and thermal centrals are 55 and 46 sequentially which are quite lower than the nuclear central one. This may be interpreted as the candidate teachers have developed cognitive structure on nuclear centrals. At the same time, they relate it with negative words at highest number (50) which is supported by highest frequency of these words (302). Even so, they have associated this nuclear central concept with science, technology, economy and politics which are rather positive words. In sum, they hesitate about it. Meanwhile, it is the wind central that was interrelated with least number of negative words (4)

The # of negative words about thermal central and their frequency is low and thermal, hydroelectric and wind central have similar values in table 2 in comparison with nuclear central. This can be a significant finding. They associate thermal central key concept with earthquake, fault line, thermal spring and hot water. This means that they probably confuse the thermal central and geothermal energy which may result in less number of negative associated words to thermal central which burns fossil fuels (coals and natural gas) which releases hazardous by products to environment. The term air pollution caused by thermal centrals only cited by 9 teacher candidate support this finding.

It has proven that hydroelectric centrals have many diverse effects to environment. Yet, the participants associated it lower number of negative words (6) which may show that they have weak cognitive structure toward it.

The concept networks prepared according to cutting points are in the following two figures; figure 1 and figure 2. The concept network belonging to the cutting point 30 and above is shown in figure 1.

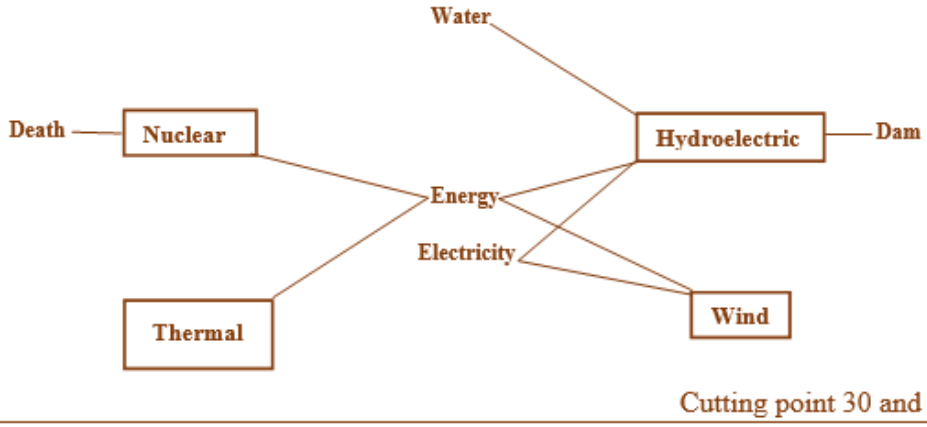

Figure 1. The concept network belonging to the cutting point 30 and above

As seen in Fig. 1, all the key concepts were outburst at cutting points 30 and above where all the key concepts were associated with energy word. Whereas the word electricity was only associated with hydroelectric and wind centrals. The association of the word death with nuclear central clearly shows the negative aspects of participants towards nuclear central in their cognitive structure. The association of hydroelectric central with such familiar words water and dam, and no association existence of thermal

and wind centrals with any words apparently show that their deficiency in their cognitive structure towards these three centrals.

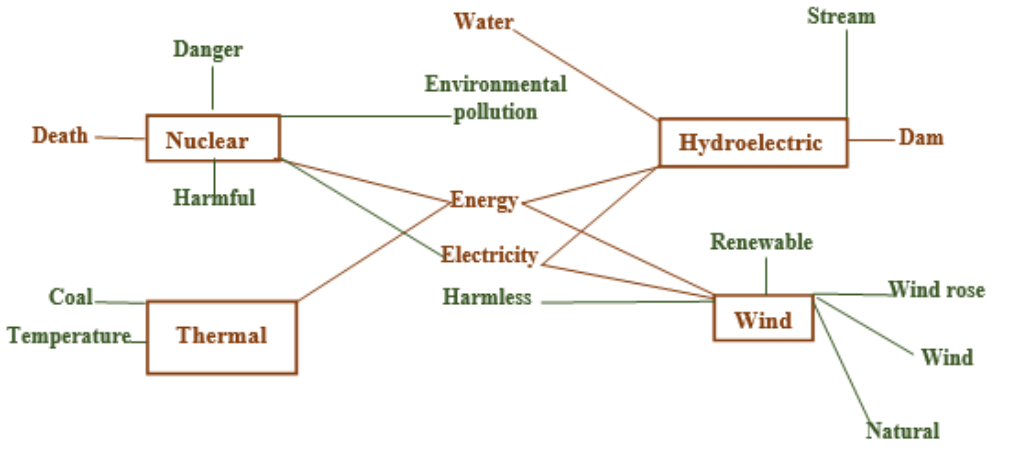

Figure 2. The concept network belonging to the cutting point 20 and above

It is seen that the # of associated words has increased with reduced cutting number (20). However, no words other than energy and electricity have appeared that was associated with four of the key concepts at this cutting point. The words associated with nuclear central are again negative ones such as dangerous, harmful and environmental pollution. Thermal central was only associated with the words coal and temperature. Wind central was associated by the word renewable 27 out of 78. Hydroelectric central was not related with the word renewable. Especially, it can be stated wind central is safe contrary to nuclear central in cognitive structure of the participants.

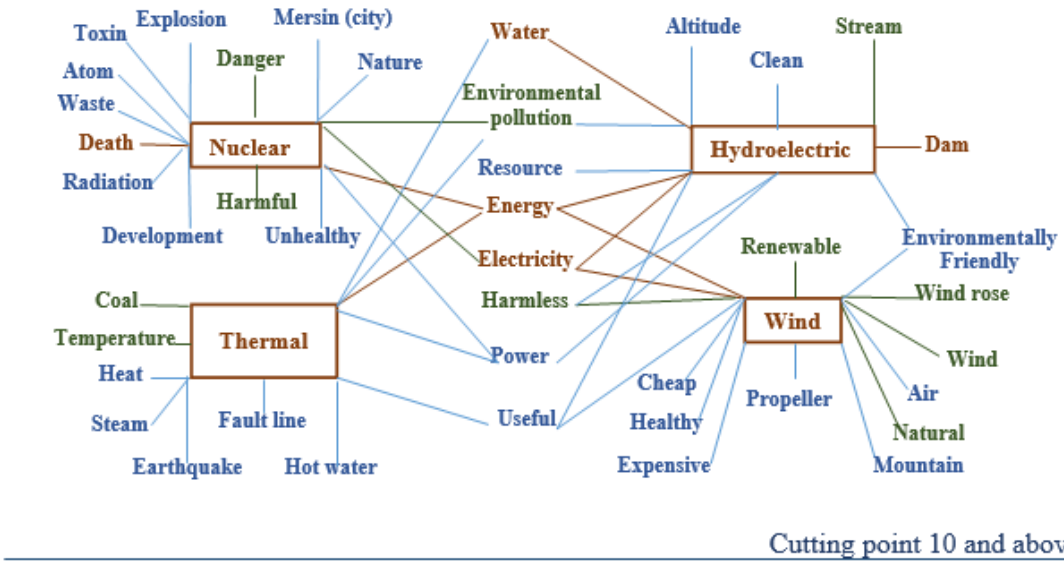

Figure 3. The concept network belonging to the cutting point 10 and above

Naturally, at cutting point 10 and above lots or words appeared that was associated with four key concepts. The association of environmental pollution with thermal and hydroelectric centrals only appeared at this stage which shows weak connections and cognitive structure of the candidate teachers towards these two centrals. They perceive the hydroelectric and wind centrals as harmless. At this point, new negative words appeared for nuclear central such as waste, explosion and unhealthy. And the association of thermal central with hot water, fault line, earthquake and hot spring imply that they have misconceptions about them.

Results and Discusiion

The energy production is the most important human dwelling which affects the nature and environment. The energy production scale should be determined according to needs of society and the resources and technologies of the country. Also, governments should consider the delicate balance between human and environment. The society directs the politics of the governments and people should be educated thoroughly and accordingly. The school or educational system is the basic arguments. The educational system, sustained by teachers can be effective in preserving the aforementioned balance consistent with the realities of locally and globally. This could be achieved by eco-centric perspective in energy education rather than anthropocentric approach. In this study, the positions of the energy centrals in cognitive structure of teacher candidates are quite different and unfortunately not satisfactory for efficient energy education.

The nuclear central which is absent yet but in construction stage in Turkey, was associated the highest amount of negative words. This may indicate negative situation in their cognitive structure. The extreme debate on nuclear central in media especially after catastrophic failure of Fukushima nuclear central in Japan may cause this result. It seems that candidate teachers are completely unaware about the technology of nuclear central. As they thought that nuclear central cause environmental pollution more than thermal central and this is contrary to reality under normal circumstances. In addition to this, they have related the words the asthma, air pollution and fume with nuclear centrals which show weakness of them. They also cite the words science, technology, economy and politics under key concept of nuclear central which show discrepancy in their cognitive structure (Lee, Hu & Chang, 1999; Özdemir, Kurt & Yapıcı, 2009; OECD, 2010; Aydın, Coşkun, Kaya & Erdönmez, 2011; Lee, &Yang, 2013; Kim, 2013; De Groot, Steg & Poortinga, 2013; Kenar, 2013; Charisiou & Goula, 2014; Özdemir, 2014; Arikawa, Cao & Matsumoto, 2014; Haşıloğlu, 2014).

The candidate teachers have associated energy centrals with rather simple words, and inadequate knowledge and misconceptions. This shows that they are deficient in teaching these subjects. They have associated electricity with only wind and hydroelectric central about at 30 cutting point and above. This shows their lacking in cognitive structure for nuclear and thermal central. Because the prime structure in their cognition was associated with diverse effects of accidents rather than production of electricity and their technology of nuclear centrals. Also, Ausebel (1963) has also defined the cognitive structure hierarchically where the general concepts take positions up and goes down with less generals (cited from Uçak & Güzeldere, 2006). The speculating the nuclear central accidents during teaching process would let students to attaining negative attitude toward it, consequently resulting in the opposing citizen to nuclear central. And this could affect the energy politics of government eventually.

Like nuclear central, the thermal central has also associated with electricity in lesser amount. Probably, they confused the thermal and geothermal adjectives and/or

concepts which were evoked by associating the words fault line, earthquake, hot water and thermal springs with thermal central. The expected words are air pollution, acid rains, global warming, asthma, heart attack etc. which were not cited; confirm their weakness of cognitive structure, similarly in Bozkurt & Koray (2002).

The wind and hydroelectric energy centrals take the position as the least harmful and environmentally friendly ones in their cognitive structure. Also, at cutting points 10 and above, these centrals were not associated with negative words other than the association hydroelectric central with environmental pollution. In addition to these, just 27 and 7 candidate teachers sequentially have associated these centrals with renewable energy which indicate the weak relations of electricity with these resources in cognitive structure. These show that the candidate teachers are unaware about the diverse effects of especially hydroelectric centrals such as extinction of species, perturbation of natural life and deterioration of socioeconomic structure etc. (Akkaya et al., 2009). Beside these, science education candidate teachers have associated hydroelectric central with decrease in biodiversity, and social science education candidate teachers have related it with immigration, history and erosion of cultural heredity which show again their adequacy in their teaching of these subjects. This means that even their approach is affirmative towards these two energy centrals, they have limited knowledge and also misconceptions, similarly in (Bilen, Özel & Sürücü, 2013; Saraç & Bedir, 2014).

In sum, civic people should be cultivated handling the environmental and energy issues in holistic manner. And this only can be achieved by multidisciplinary and interdisciplinary education perspectives which rely on not only economic constraints but also ecological, sociological, biological, political and geographical issues which compromise both scientific sociological developments. By do way, society will be cleared by a chicken and egg situation even it does not produce alternative solution to problems, but shades the brilliant ideas.

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References

Akkaya, U., Gültekin, A.B., Dikmen, Ç.B. & Durmuş, G. (13-15 Mayıs, 2009). Baraj ve hidroelektrik santrallerin (HES) çevresel etkilerinin analizi: ılısu barajı örneği, *5. Uluslararası İleri Teknolojiler Sempozyumu,(IATS'09),* Karabük Üniversitesi, Türkiye.

Altın, V. (2004). Yeni ufuklara nükleer enerji. *Bilim ve Teknik*. TÜBİTAK.

Altınöz, N. (2010). F*en bilgisi öğretmen adaylarının çevre okuryazarlık düzeyleri,* Yayımlanmamış Yüksek Lisans Tezi, Sakarya Üniversitesi Fen Bilimleri Enstitüsü, Sakarya.

Arikawa, H., Cao, Y.& Matsumoto S. (2014). Attitudes toward nuclear power and energy-saving behavior among japanese households. *Energy Research & Social Sci*ence, *2,* 12-20.

Aydın, D.S. Tonguz, A. & Yılmaz, Ö.M. (2013). Nükleer enerji 2023 yılında dünyanın en büyük ilk 10 ekonomisi arasında yer almayı hedefleyen Türkiye Cumhuriyeti'nin enerji ihtiyacına çare olabilir mi?

http://tedprints.tedankara.k12.tr/429/1/Damla_Su_Aydin-Omer_Mert_Yilmaz.pdf (08.06.2015 tarihinde edinilmiştir).

Aydın, F., Coskun, M., Kaya, H. & Erdönmez, İ. (2011). Gifted students' attitudes towards environment: a case study from Turkey. *African Journal of Agricultural Research, 6* (7), 1876-1883.

Bahar, M. (2003). Biyoloji eğitiminde kavram yanılgıları ve kavram değişim stratejileri. *Kuram ve Uygulamada Eğitim Bilimleri / Educational Sciences: Theory & Practice, 3* (1), 27-64.

Bahar, M., Johnstone, A.H. & Sutcliffe, R.G. (1999). Investigation of students' cognitive structure in elementary genetics through word association tests. *Journal of Biological Education*, 33, 134-141.

Bahar, M. & Kılıç, F. (Haziran, 2001). Kelime iletişim testi yöntemi ile Atatürk ilkeleri arasındaki kavramsal bağların araştırılması. *IX. Eğitim Bilimleri Kongresi,* Abant İzzet Baysal Üniversitesi, Bolu.

Bahar, M. & Özatlı, N.S. (2003). Kelime iletişim test yöntemi ile lise 1. sınıf öğrencilerinin canlıların temel bileşenleri konusundaki bilişsel yapılarının araştırılması. *BAÜ Fen Bilimleri Enstitüsü. Dergisi 5* (2), 75-85.

Bilen, K., Özel, M. & Sürücü, A. (2013). Fen bilgisi öğretmen adaylarının yenilenebilir enerjiye yönelik tutumları. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*,
(36), 101-112

Bozkurt, O. & Koray, Ö, C. (2002). "İlköğretim öğrencilerinin çevre eğitiminde sera etkisi ile ilgili kavram yanılgıları". *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, (23), 67-73.

Charısıou N.D. & Goula M.A. (2014). Attitudes of Greek university students towards energy and the environment. *Global Nest Journal, 16* (5), 856-865.

Çakar, M.C., Başaran Filik, Ü. & Kurban, M. (2009). Yenilenebilir enerji kaynaklari ve ulaşim sistemlerinde kullanim uygulamasi. *V. Yenilenebilir Enerji Kaynakları Sempozyumu*, Diyarbakır.

De Groot, J.M., Steg, L. & Poortinga, W. (2013). Values, perceived risks and benefits and acceptability of nuclear energy; *Risk Analysis, 33* (2), 307-317.

Deveci, H., Köse-Çengelci, T. & Bayır-Gürdoğan, Ö. (2014). Öğretmen adaylarinin sosyal bilimler ve sosyal bilgiler kavramlarina ilişkin bilişsel yapilari: kelime ilişkilendirme testi uygulamasi. *Adıyaman Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 7* (16), 101-124.

Dinçer, M.Z. & Aslan, Ö. (2008). *Sürdürülebilir kalkinma, yenilenebilir enerji kaynaklari ve hidrojen enerjisi: Türkiye değerlendirmesi*. İTO. Yayın No: 2009-51.

Ertürk, F., Akkoyunlu A. & Varınca, K.B. (2006). Enerji üretimi ve çevresel etkileri fosil hidrolik yenilenebilir nükleer. *TASAM Stratejik Rapor.* No: 14.

Erdoğan, M. (2009). Fifth grade students' environmental literacy and the factors affecting students' environmentally responsible behaviors, Unpublished Doctoral Dissertation, The Graduate School of Social Sciences Middle East Technical University.

Esa, N. (2010). Environmental Knowledge, Attitude and practices of student teachers. *International Research in Geographical and Environmental Education*, *19* (1), 39-50.

Goncaloğlu, B.İ., Ertürk, F. & Ekdal, A. (2000). Termik santrallerle nükleer santrallerin çevresel etki değerlendirmesi açısından karşılaştırılması. *Ekoloji Çevre Dergisi*. 9 (34) 9-14.

Griffin, E. (2011). The mechanical age: technology, innovation and industrialization https://www.academia.edu/991318/A_Short_History_of_the_British_Industrial_Revolution_Palgrave_2011_ (accessed 08.06.2015)

Han, E.O., Kim, J.R.,& Choi, Y.S. (2014). Korean students' behavioral change toward nuclear power generation through education. *Nuclear Engineering and Technology, 46* (5), 707-718.

Haşıloğlu, M.A. (2014). The examining of prospective teachers' views about renewable and non-renewable energy sources: a case study of Turkey. *Academic Journals. 9* (13) 411-416.

Işıklı, M., Taşdere, A. & Göz, N. L. (2011). Kelime ilişkilendirme testi aracılığıyla öğretmen adaylarının Atatürk İlkelerine yönelik bilişsel yapılarının incelenmesi. *Uşak Üniversitesi Sosyal Bilimler Dergisi, 4* (1), 50-72.

Karasar, N. (1999). *Bilimsel araştırma yöntemi*, Ankara: Nobel Yayınları.

Keçebaş, A., Gedik, E. & Kayfeci, M (2010). Fosil yakıtların kullanımından kaynaklanan hava kirliliği üzerine jeotermal enerji ve doğalgaz kullanımının etkisi: Afyon örneği, *Makine Teknolojileri Elektronik Dergisi*, *7* (3), 23-30.

Kenar, İ. (2013), Nuclear energy reality in Turkey and the attitude of the science teachers towards the issue. *Kamla-Raj. Anthropologist, 16* (1-2), 153-165.

Kibert, C. N. (2000). *An Analysis of the correlations between the attitude, behavior, and knowledge components of environmental literacy in undergraduate university* students. Unpublished Master Dissertation, The Graduate School of the Unıversity of Florida, USA.

Kim, M. (2013). Risk communication about nuclear power in Korea: one-year descriptive analysis on twitter. *Science Education International, 24* (3), 324-343.

Koç, E. & Şenel, M. C. (2013). Dünyada ve Türkiye'de enerji durumu - genel değerlendirme. *Mühendis ve Makina*, *54*(639), 32-44.

Kostova, Z. & Radoynovska, B. (2008). Word association test for studying conceptual structures of teachers and students. *Bulgarian Journal of Science and Education Policy (BJSEP) 2*(2), 209-231.

Kuhlemeier, H., Bergh, V.D. H. & Lagerweij, N. (1999). Environmental knowledge, attitudes, and behavior in Dutch secondary education. *The Journal of Environmental Education, 30* (2), 4-14.

Kum, H. (2009). Yenilenebilir enerji kaynakları: dünya piyasalarındaki son gelişmeler ve politikalar*, Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* (33), 207-223.

Küçükkalay, A. M. (1997). Endüstri devrimi ve ekonomik sonuçlarının analizi. *Süleyman Demirel Üniversitesi İktisadi İdari Bilimler Fakültesi Dergisi*, (2), 51-68.

Lee, C., Hu, S., & Chang, W. P. (1999). *A study on risk perception toward nuclear power operation in Taiwan*. Institute of Public Health, and Institute of Environmental Health Sciences, National Yang-ming University, Taiwan

Lee, L., Yang, H. (2013). Technology teachers' attitudes toward nuclear energy and their implications for technology education. Online Submission, http://files.eric.ed.gov/fulltext/ED545402.pdf. (accessed 06.05.2015).

Mcbeth, W. & Volk, T. (2010). The national environmental literacy project: a baseline study of middle grade students in the United States, *The Journal of Environmental Education, 41* (1), 55-67.

Mallick, A, (2012). History and Present Technological development in electrical energy sector, *Steam Boiler*, *6* (7), 25-27.

MEB. (2012*). Hava kirliliğine etki eden kaynaklar. Aile ve tüketici hizmetleri,* Ankara: http://megep.meb.gov.tr/mte_program_modul/moduller_pdf/%C3%87evre%20Hizmetleri.pdf. (accessed 06.05.2015).

Murphy, T.P. (2002). *The Minnesota report card on environmental literacy.* Hamline University, Center for Global Environmental Education. (ERIC Reproduction Service No. ED 474505)

OECD. (2010). Public attitudes to nuclear power, nuclear energy agency organisation for economic co-operation and development. https://www.oecd-nea.org/ndd/reports/2010/nea6859-public-attitudes.pdf. (accessed 07.06.2015).

Owens, M.A. (2000). *The environmental literacy of urban middle school teachers*. Unpublished Doctoral Dissertation, Faculty of the Graduate School of Emory University, USA.

Özdemir, N. (2014). Sosyo bilimsel esaslar çerçevesinde sosyo bilimsel konulari tartişmak tutumlari nasil etkiler? nükleer santraller. *Turkish Studies - International Periodical for The Languages, Literature and History of Turkish or Turkic, 9* (2), 1197-1214.

Özdemir, Ö.Ö., Kurt, A.Ö.& Yapıcı, G. (2009). Mersin ilinde görev yapan hekimlerin sağlik ve çevre boyutuyla nükleer enerjiye bakış açılarının değerlendirilmesi. http://www.phd.org.tr/14kongresunum/bildiri/2.ppt. (accessed 08.06.2015).

Pe'er, S., Goldman, D. & Yavetz B. (2007). Environmental literacy in teacher training: attitudes, knowledge, and environmental behavior of beginning students, *The Journal of Envıronmental Educatıon*, *39* (1), 45-59.

Polat, G. (2013). 9. sınıf öğrencilerinin çevreye ilişkin bilişsel yapılarının kelime ilişkilendirme test tekniği ile tespiti. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi (EFMED*) *7* (1), 97-120.

Purutçuoğlu, E. (2008). Üniversite öğrencilerinin demografik özellikleri ve materyalist eğilimleri ile çevreye yönelik tutum ve davranışları arasındaki ilişkinin incelenmesi, Yayımlanmamış Doktora Tezi, Ankara Üniversitesi Fen Bilimleri Enstitüsü, Ankara.

Saraç, E. Bedir, H. (2014). Sınıf öğretmenlerinin yenilenebilir enerji kaynakları ile ilgili algılamaları üzerine nitel bir çalışma. *KHO Bilim Dergisi, 24* (1), 19-45.

Stoutenborough, J.W., Sturgess S.G. & Vedlitz, A. (2013). Knowledge, Risk, and Policy Support: Public Perceptions of Nuclear Power. *Energy Policy*, 62, 176–184.

Timur, S. (2011). *Fen bilgisi öğretmen adaylarının çevre okuryazarlık düzeylerinin belirlenmesi,* Yayımlanmamış Doktora Tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Türkyılmaz, O. (2007). Dünyada ve Türkiye'de enerji sektörünün durumu. *Mühendis ve Makine, 48* (569), 69-77.

Türkyılmaz, O. (2010). Türkiye'nin ve Dünyanın enerji profili http://www.yildiz.edu.tr/~okincay/dersnotu/EnerjiProfili.pdf (accessed 08.05,2015)

Uçak, N.Ö. & Güzeldere, Ş.O. (2006). Bilişsel yapının ve işlemlerin bilgi arama davranışı üzerine etkisi, *Türk Kütüphaneciliği, 20* (1), 7-28.

Ürker, O. & Çobanoğlu, N. (2012).Türkiye'de hidroelektrik santrallerin durumu (hes'ler) ve çevre politikalari bağlaminda değerlendirilmesi. *Ankyra: Ankara Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *3*(2), 65-88.

Yakıcı Ayan, T. & Pabuçcu, H. (2013). Yenilenebilir enerji kaynakları yatırım projelerinin analitik hiyerarşi süreci yöntemi ile değerlendirilmesi. *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 18.*(3), 89-110.

URL 1. http://www.epa.gov/cleanenergy/energy-and-you/affect/nuclear.html. (accessed 15.06.2015).

URL 2. http://www.physics.isu.edu/radinf/np-risk.htm. (accessed 18.06.2015).

Appendix

The Frequency Table of the Words Associated with Energy Centrals by Candidate teachers.

Word Counts	Words	Energy Central				Word Counts	Words	Energy Central			
		Nuclear	Hydroelectric	Fossil Fuel	Wind			Nuclear	Hydroelectric	Fossil Fuel	Wind
1	Aegean region			8		49	England	1			
2	Agriculture		4			50	Environmental Damage	2		1	
3	Air	3			16	51	Environmental pollution	29	10	13	
4	Air pollution	8		9		52	Environmentally friendly		8		15
5	Airlessness	2				53	Expensive	1	5		10
6	Alaçatı				8	54	Explosion	12			
7	Altitude		14		7	55	Factory	8	2	6	
8	Asthma	4				56	Fault line			12	
9	Atatürk dam		4			57	Filter			1	
10	Atom	10				58	Fire	1			
11	Atomic bomb	4				59	Flow		9		
12	Balıkesir				2	60	Flow rate		6		
13	Black Sea	2				61	Forest	1			
14	Bomb	5				62	Fossil fuel			1	
15	Brown coal			5		63	France	1			
16	Cancer	10				64	Fuel	1			
17	Cheap		7	3	16	65	Fume	4		5	
18	Chemicals	6				66	Garbage	1			
19	Chemistry	1				67	Geology	1			
20	Chernobly	8				68	Geopolitics	2			
21	Child	3				69	Harmful	21	5	6	
22	China	1				70	Harmful substance	1			
23	Clean		13	5		71	Harmless		10	6	27
24	Climate		3			72	Hazardous radiation	2			
25	Coal	3		21		73	Healthy		9	6	10
26	Consumption	2				74	Heat	5		16	
27	Controversial	2				75	Hot water			18	
28	Cripple	3				76	Human	6	3		
29	Çanakkale				3	77	Industry	6	2	4	
30	Dam	5	40			78	Iron	1			
31	Danger	27		1		79	İncome	4	5		
32	Death	33				80	İrrigation		4		
33	Deficient				4	81	Japan	12			
34	Deforestation		2			82	Kazım Koyuncu	1			
35	Developed country	6				83	Lake		4		
36	Development	18	7	2		84	lasting				3
37	Disabled	1				85	Life		6		
38	Disaster	7				86	Manufacture	5	13	9	8
39	Disease	7		3		87	Mersin	9			
40	Distribution		3			88	Metal	1			
41	Earthquake	1		13		89	Mineral	2		4	
42	East Blacksea		5			90	Money	7		5	3
43	Eastarnian region		7			91	Mountain		4		12
44	Economical	1	3	1		92	Mutation	3			
45	Economy	5	7	5	6	93	Natural		9	6	20
46	Electricity	25	56	23	36	94	Natural gas			2	
47	Employment	9				95	Natural resource	1			
48	Energy	61	58	61	54	96	Nature	12	6	5	7

Word Counts	Words	Energy Central				Word Counts	Words	Energy Central			
		Nuclear	Hydroelectric	Fossil Fuel	Wind			Nuclear	Hydroelectric	Fossil Fuel	Wind
97	Necessary	1				148	U.S.A	3			
98	Nederland				3	149	Underground resource			8	
99	Need	7	3			150	Unhealthy	10	1	1	
100	Negation	1				151	Unrenewable	2		5	2
101	Noise	1			1	152	Uranium	6			
102	Physics	4				153	Useful		13	13	15
103	Politics	1				154	War	4			
104	Pollution	9				155	Waste	10			
105	Poor soil	2				156	Water	12	57	11	
106	Power	11	10	10	5	157	Water pollution	1	1		
107	Powerfull	1				158	Water power		8		
108	Pressure				2	159	Weapon	1			
109	Profit	1				160	Wind				28
110	Propeller				12	161	Wind rose				24
111	Protest	6				162	Wind turbines				3
112	Radiation	18				163	Windmill				8
113	Radioactive substance	2				164	Worry	5			
114	Rainfall		7			165	Zonguldak			4	
115	Ray	1					**Total**	**109**	**55**	**46**	**37**
116	Reactor	1									
117	Regime		2								
118	Renewable		7	5	27						
119	Resource	3	11	9	3						
120	Risk	1									
121	Roid food	1									
122	Roughness		6								
123	Russia	4									
124	Safe	1			2						
125	Saving	4	9	4	7						
126	Science	6									
127	Sea	4	3								
128	Security	4									
129	Sinop	8									
130	Soil pollution	2									
131	Southestarnian region		3								
132	Speciality	1									
133	Speed		4								
134	Steam			10							
135	Steep terrain		6								
136	Stone	1									
137	Strategic	1									
138	Stream		25								
139	Tea	2									
140	Technology	9	4		2						
141	Temperature			21							
142	Thermal springs			7							
143	Tourism		2								
144	Toxin	11									
145	Trade	1									
146	Trouble	1									
147	Turbine				2						

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RESEARCH ARTICLE

Öğretmen Adaylarının Enerji Santralleri Hakkındaki Bilişsel Yapılarının Belirlenmesi

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Özet

Her türlü işlemin olmazsa olmaz bileşeni olan enerji, insan medeniyetinde başroldedir. Meşhur enerji santralleri de çevreye zıt etkileriyle beraber enerji üretiminin başlıca yoludur. Çok tartışılan bu konuda, zararlı etkilerin hafifletilmesi ve ılımlaştırılması çok önem arz etmektedir ve bunun bir yolu da eğitimden geçmektedir. Bu çalışma kapsamında, çevresel problemlerin çözümüne giden yolda, farklı branşta öğretmen adaylarının enerji santralleri üzerine zihin yapıları incelenmiştir. Adaylardan, dört ana kavram olan nükleer, hidroelektrik, termik ve rüzgâr santralleri ilgili kelime ilişkilendirme testini doldurmaları istenmiştir. Sonuç olarak zihin yapılarında, nükleer santral en tehlikeli ve rüzgâr santrali en az tehlikeli olarak bulunmuştur

Anahtar Kelimeler: Öğretmen adayı, kelime ilişkilendirme testi, enerji santralleri, bilişsel yapı.

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