

## Research Article

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**To cite this article:** Kaya, B.; Aladağ, C. (2018). Determining the Cognitive Structures of Candidate of Geography Teachers about Some Conceptions Related to Energy Resources, *Review of International Geographical Education Online (RIGEO)*, 8(2), 350-370. Retrieved from <http://www.rigeo.org/vol8no2/Number2Summer/RIGEO-V8-N2-9.pdf>

Submitted: May 30, 2018

Revised: July 11, 2018

Accepted: August 06, 2018

## Determining the Cognitive Structures of Geography Teacher Candidates Related to Energy Resources

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### Abstract

This study aims to determine the cognitive structures of the geography teacher candidates studying at the 4th grade of the department of teaching geography related to the energy resources using Word Association Test (WAT). The universe of the study is the last grade students of the geography teaching department at 2016-2017 academic year and the sample of the study constitutes 36 last grade students studying in a geography teaching department at a university. It played an effective role in selecting the sample if students took lessons about energy resources. In the research, words such as fossil fuels, nuclear energy, wind energy, geothermal energy and solar energy were chosen as key concepts. A survey model was used to identify the current situation of the study. The analysis of the data was carried out by using the frequency count, which is one of the descriptive analysis techniques. Each of the key concepts was written on a different paper and they were written 10 times as one is written under the other. Before the study was carried out, the word association test was introduced to the students and some sample works were carried out. Then it is required from teacher candidates to write the words that these key concepts evoke in their minds within 30 seconds. A frequency table was created by evaluating the obtained data. Concept words were examined in detail and concept networks were formed in the direction of the cut-off points. The relevant sample sentences of the teacher candidates were examined and classified according to their characteristics.

### Keywords

Cognitive Structure, Word Association Test, Energy Sources, Geography Teacher Candidates, Turkey

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Teaching a subject does not mean that it is always learned thoroughly. In this respect, it is important to determine how the students have constructed the knowledge that they have learned during their education process in their minds. Sometimes it is observed that students have confusions between the information that they learn during their education process and the information that they learn from their daily lives. In this respect, the evaluation of cognitive structures has a particular importance. One of these issues is the cognitive structures of students about the energy sources that they frequently hear about in their daily lives. Especially when the information that geography students have learned before is taken into consideration, it is important to know how they have constructed their cognitive structures.

Geographical knowledge can provide valuable assistance to young people in managing and guiding future developments at a local, national or global level and in transferring knowledge from the educational and theoretical into the practical fields of life. Modern geography is not just a science that examines natural and socio-economic elements and phenomena and their interaction in a specific geographical area, it is also closely linked with information from everyday life. Regardless of the mechanisms of different school systems, geography should retain a key role in the overall education of children and youth (Planinc, 2011, p. 41-42).

We use energy in almost every moment of our daily life. Energy is an indispensable element in preparing our food, obtaining light and temperature, using all the tools and sustaining the industrial activities (Karabulut, 2003, p. 7). The rapid increase in world population brings many problems. One of these problems is the inadequacy of available energy resources. Countries have to turn to alternative energy sources to solve this problem. Despite meeting the needs of people, these resources also create many environmental problems. For this reason, while determining energy policies, countries should aim to use energy types that can meet their energy needs at the best possible level and that give the least harm to the environment or do not cause any harm to the environment (renewable) (Geçit & Yangın, 2012, p. 30). Although energy resources can be classified in different forms, there are mainly two major groups; fossil energy sources and renewable energy sources. Coal, oil and natural gas are the examples of the main sources of fossil energy. Fossil energy sources come into being in different geological ages due to a metamorphosis of some vegetable and animal origin materials in suitable places and under suitable conditions. Sun, wood, wind, stream, wave, current, thermal amplitude in the seas, geothermal, various plant and animal origin materials can be mentioned as sources of renewable energy (Akova, 2016, p. 6).

Energy use, caused by economic activities such as production and consumption, affects the environment negatively by causing water pollution, air pollution, CO<sub>2</sub> emission the reason of global warming- and exhaustion of energy resources. In addition, the energy obtained from consumable sources may lead to energy stresses in the future (Chow, 2008, p. 57). Today, the need for energy is increasing everywhere and fossil fuels will be consumed in the near future, so this makes it necessary to turn to renewable energy sources. In this context, it is necessary for the societies to be

conscious of a clean and liveable environment and to provide the permanence of the education given in this subject and to convert this education into behaviour.

Increasing world population, increasing use of technology and using more energy for a comfortable life have increased the need for energy day by day, and the energy problem has become a global problem now. The quality of education for the correct and effective use of energy resources, which will become a bigger problem day by day, has a great importance (Güneş, Alat & Gözüm, 2013, p. 270). In order to achieve this, the individuals who form the society must be trained to have responsibility. The education given to individuals should let them know how to be environmentally responsible, to have environmental awareness, to have the knowledge and skills to produce solutions against environmental problems.

What is aimed with environmental awareness is to develop environmental knowledge, attitudes and beneficial behaviours towards the environment. Along with the formation of environmental awareness, efforts to find solutions to these problems give rise to environmental sensitivity as a result of individuals not being silent against environmental problems and indicating their discomfort (Yılmaz, Çelik & Arslan, 2010, p. 325). Environmental awareness can only be achieved through the continuous environmental education at all levels of education. Environmental education can be achieved if it is taught by using methods and techniques that facilitate the learning, make it permanent, and can be easily remembered. It may be possible not only by theoretical education but also by seeing and living, in other words by adopting an understanding of applied education. In order for students to have a certain environmental awareness and to make their cognitive structures permanent, conceptual learning should be provided and concepts should be kept in their minds correctly.

The question of how to determine a student's prior knowledge has always been a topic of discussion in education. In response to this question, Vance, Miller & Hand (1995), indicated that there are some ways to determine the learners' prior knowledge. These are; topic planning, free writing and class discussions. In addition, some strategies have been developed that measure and provide a conceptual framework and conceptual change. Bahar (2003) lists these strategies as follows; word association, structured grid, branched tree, concept maps, conceptual change texts, analogy, prediction-observation and explanation.

Knowing what concepts constitute the basic building blocks of the individual's cognitive structure and which are at the core of all thinking skills is important in terms of realizing a meaningful and lasting learning (Malatyali & Yılmaz, 2010, p. 321). Polat (2013, p. 103) expresses that researchers use the WAT (Word Association Test) technique mostly to identify cognitive structures of the students before and after the training and they also use it with the aim of revealing the change that has occurred in students' cognitive structures through teaching.

The word association test method can be applied in various forms: Grouping method; a list of the words related to the topic is given to the students and they are asked to group them. Controlled word association method; students are asked to write the words

that have the closest relation to the stimulus word given at the top of every page according to the order of closeness. And there is a free word association test (Preece, 1976; Tsai & Huang 2002; White & Gunstone, 1992). In this study, free word association has been used. In the free word association, there is a stimulus word on each page and the stimulant word is written several times on the left side of the page while blanks are left for writing the words associated by the students on the right side of the page (as cited in: Köseoğlu & Bayır, 2011).

### **Purpose of the Research**

The purpose of this study is to find out the cognitive structures of the 4<sup>th</sup> grade geography students about "energy resources" by using the word association test. In other words, it is to determine what geography students think about energy resources, whether meaningful learning has taken place or if there are misconceptions in their minds.

## **Method**

### **Research Design**

In this study, relational survey model was used to determine the current situation. Survey model is a research model that aims to identify the past or present situation as the way it exists. The event, individual or object which are the subjects of the investigation are attempted to be defined as they are or as they are in their own circumstances. No attempt is made to alter or influence them in any way. There is something wanted to be known and it is there. The important thing is to be able to observe and document it appropriately (Karasar, 2016, p. 109).

### **Universe and Sample of the Research**

The universe of the study is the last grade students of the geography departments at 2016-2017 academic year and the sample of the study constitutes 36 last grade students studying in the department of Geography Teaching of Necmettin Erbakan University, Ahmet Keleşoğlu Faculty of Education at the same academic year. While selecting the purposeful sample, it was taken into consideration if students have taken lessons on energy resources. According to Yıldırım & Şimşek; (2016, p. 118), purpose sampling provides an in-depth study for the situations that are thought to have rich knowledge.

### **Data Collection Tool**

Word association test was used in obtaining the data of this study. The word association test is a common method within psychology which has been used to reveal the private world of an individual. In its simplest form a series of disconnected words (stimulus words) are projected orally or in writing to the respondents who must respond with the first word which comes to mind (response words) (Nielsen & Ingwersen, 1999, p. 17). Word association tests typically present participants with a test bed of single-concept terms ("Stimulus terms") from one subject domain; for each stimulus term, the participants are asked to write down as many words ("response terms") that they think are related to the term (Spiteri, 2002, p. 24). There are different variations of word

association tests but the underlying principle remains the same: stimulus words are presented to the subject (either verbally or in written form) who is asked to respond with the first word or words that come to mind. The resulting word association is thought to mirror the way the words are stored and linked to the mental lexicon (Peppard, 2007). Five key concepts related to energy resources were chosen to form the test. While selecting the key concepts, expert opinion was applied. These key concepts are; fossil fuels, nuclear energy, wind energy, geothermal energy and solar energy. A measurement tool was prepared by writing each key concept 10 times as one is written under the other and all the key concepts were written on a single page independently. Bahar and Özatlı (2003, p. 77) explained the reason of writing the key concept one under the other as to prevent the chained response risk. Because if a student does not turn back to key concepts while writing each concept, s/he will write the words that the concept he writes as a response brings to his mind instead of writing the words that key concept brings to his mind.

A page of the measuring tool is shown below as an example.

Fossil Fuels.....

Fossil Fuels.....

Fossil Fuels.....

Fossil Fuels.....

.

.

Related

sentence: \_\_\_\_\_

Students are required to write the words that come to their minds about the key concept during the period of 30 seconds given for each key concept. At the end of the 30-second period, the students were asked to pass the other key concept and by this way each key concept was applied to the students simultaneously. Since the university students are the sample group of this study, it was thought that thirty seconds would be appropriate for each key concept.

In addition, participants were asked to write sentences about key concepts and each sentence was examined one by one during the analysis phase of the data. Işıklı, Taşdere & Göz (2011, p. 65), stated that information at a more meaningful and conceptual level can be obtained through these relevant sentences.

### **Data Analysis**

The evaluation of the data obtained by the word association test was carried out by using frequency analysis from descriptive analysis techniques. A frequency table was created for each key concept showing the type of answer words and how many answer words were repeated for each key concept (Table 1). Concept networks were created by

evaluating the data in the frequency table and by using the cut-off point (CP) technique was formed (Bahar, Nartgün, Durmuş & Bıçak, 2010: 72.)

In this technique, there was between 5 and 3 points below of the most repeated answer words in the frequency table given for any key concept in the word association test is used as the cut-off point and the answers above this response frequency are written in the first division of the map. Then the cut-off point is pulled down at regularly and the process continues until all the keywords have appeared. A conceptual map created by this way reveals how learners see relations between concepts and leads to the establishing new relationships. Teachers can also look over their teaching methodologies by taking this conceptual network map into account, or they can focus on conceptual links that are missing in the map (Bahar et al., 2010).

In the concept networks in each cut-off point range, key concepts and answer words related to key concepts were given. When concept nets were being formed, the same colour was used to make the relationship between the concepts and the answer words at the same cut-off point clear. Sentences written under key concepts were also categorized and tabulated as 'sentences containing scientific information, sentences containing non-scientific or superficial information and sentences containing misconceptions' (Table 3). In addition, a scientific content table was created by calculating the frequencies of these sentences in each category separately for each key concept (Table 2). The number and types of words written in response to the key concept were evaluated. The words were categorized according to semantic relations and the frequency table was created by calculating the frequency of the words in each category.

### **Validity and Reliability**

According to Yıldırım and Şimşek (2011), expert examination is required to ensure the validity of the research. In order to confirm whether concepts obtained from the research data and the codes given under categories represent the conceptual categories, two researchers' codes and categories related to codes were compared. The reliability of the data analysis conducted in this manner were calculated by using the formula of  $[\text{Consensus}/(\text{Consensus} + \text{Dissensus}) \times 100]$  (Miles & Huberman, 1994). Average reliability between coders was calculated as 92%.

### **Findings**

Teacher candidates produced 58 answer words for the key concepts related to energy resources. The total frequency of these words was calculated as 933. From these answer words, the fossil fuel has 215, nuclear energy has 199, wind energy has 187, geothermal energy has 192 and solar energy has 140 frequencies. The key concept with the highest frequency is fossil fuels and with the lowest frequency is solar energy. The number of answer words given for each key concept is shown in detail in the frequency table. The answer words produced by the teacher candidates in WAT were examined one by one and the number of repetitions of the answer words related to the key concepts was calculated and written in Table 1.

Table 1

*Frequency table of key concepts and answer words related to nuclear energy.*

	<b>Fossil Fuels</b>	<b>Nuclear Energy</b>	<b>Wind Energy</b>	<b>Geothermal Energy</b>	<b>Solar Energy</b>
USA	*	9	1	*	1
Mediterranean	*	*	*	*	9
Akkuyu	*	18	*	*	*
Anthracite	8	*	*	*	*
Plant residues	17	*	*	*	*
Steam	*	*	*	8	*
Live event	14	1	*	*	*
Çanakkale	*	*	12	*	*
Chernobyl facility	*	27	*	*	*
Environmental pollution	8	*	1	*	*
Eco friendly	*	*	11	1	5
Tectonics	*	*	*	10	*
Natural energy	*	*	7	2	7
Natural gas	24	*	*	*	*
Aegean Region	*	*	*	12	*
Equatorial Region	*	*	*	*	7
Electricity	*	2	9	2	7
Energy	12	5	5	3	3
Fission	*	10	*	*	*
Fusion	*	10	*	*	*
Development	*	8	3	*	1
Sunbathing time	*	*	*	*	10
Southeastern Anatolia	*	*	*	*	12
Noise pollution	*	*	15	*	*
Cancer	*	9	*	*	*
Air pollution	7	*	*	*	*
Spa	*	*	*	14	*
Heating	11	*	*	5	4
Alaçatı (İzmir)	*	*	14	*	*
Japan	*	11	*	*	*
Spa	*	*	*	22	*
Carbon	7	*	*	*	*
Fault line	*	*	*	35	*
Coal	28	*	*	*	*
Lignite	18	1	*	*	*
Akkuyu (Mersin)	*	18	*	*	*
Mineral-rich water	*	*	*	7	*
Solar panel	*	*	5	*	21
Oil	34	*	*	*	*
Radiation	*	12	*	*	3
Reactor	*	13	*	*	*
Wind farm	*	*	8	*	*
Wind rose	*	*	23	*	*
Wind turbines	*	*	16	*	*
Health	*	*	*	15	1

Power plants	2	7	3	*	1
Sarayköy (Denizli)	*	*	16	16	*
Hot water	*	*	*	15	7
Hot	*	*	*	12	8
Sinop	*	7	*	*	*
Sustainable	*	*	28	10	23
Coal	8	1	*	*	*
Clean energy	*	1	19	4	6
Thorium	*	20	*	*	*
Peat	7	*	*	*	*
Tourism	*	*	*	12	3
Uranium	*	26	*	*	*
Nonrenewable	10	1	*	*	*
Underground	*	*	*	8	*
High areas	*	*	10	1	1

When the sentences produced for the keywords are examined, it is seen that the sentences containing scientific information are mostly written for wind energy and the number of the sentences is 98. This is followed by solar energy with 91 sentences, geothermal energy with 78 sentences, nuclear energy with 65 sentences and fossil fuels with 63 sentences (Table 2). The number of sentences of wind energy and solar energy is close to each other. These two concepts are desired results as clean energy sources. When sentence samples containing non-scientific and superficial information are examined, nuclear energy with 58 sentences and fossil fuels with 47 sentences are listed in the first places. This result shows that students are in doubt about these two concepts and this result shows that students use the information they have heard in everyday life rather than academic thought. The other three key concepts have less number of sentences under this heading. The number of sentences containing misconceptions was the highest in fossil fuels and the number of sentences was 21. Fossil fuels are one of the most discussed and encountered subjects because of their being one of the most important causes of environmental problems. Therefore it includes concepts related to very different branches of science. This makes it difficult for the students to learn and get the right inference.

Table 2

*Scientific content table formed with the statements about key concepts*

<i>Key Concept</i>	<i>Sample sentences containing scientific information</i>	<i>Sample sentences containing non-scientific or superficial information</i>	<i>Sample sentences containing misconception</i>
Fossil fuels	63	47	21
Nuclear energy	65	58	8
Wind power	98	17	6
Geothermal energy	78	37	12
Solar energy	91	16	17

It is seen that teacher candidates create sentences containing scientific information for each answer word (Table 3). In the second place there are examples of sentences containing non-scientific or superficial information. There are also a few examples of



sentences containing misconceptions, and this shows that students have a certain level of misconception about some subjects

Table 3

*Examples of sentences of teacher candidates written for related key concepts about "energy resources"*

Key Concept	Examples of sentences containing scientific information	Examples of sentences containing non-scientific or superficial information	Examples of sentences containing misconceptions
<b>Fossil</b>	<ul style="list-style-type: none"> <li>- Fossil fuels cause air pollution</li> <li>- Fossil fuels are consumable sources.</li> <li>- Fossil fuels are non-renewable energy sources.</li> <li>- Most of the energy in the world comes from fossil fuels.</li> <li>- Natural gas is the cleanest of fossil fuels.</li> <li>- Fossil fuels global warming.</li> <li>- Fossil fuels are formed by the fossilization of plant and animal remains.</li> <li>- Fossil fuels are often found in ancient lands.</li> <li>- In general, oil is liquefied hydrocarbons.</li> </ul>	<ul style="list-style-type: none"> <li>-Oil is cheaper than water in Saudi Arabia.</li> <li>- Stove poisoning happens due to coal.</li> <li>- Fossil Fuels protect our life on cold days.</li> <li>- Fossil Fuels cost too much.</li> <li>- Wars have happened on earth because of oil.</li> <li>- Energy produced from fossil fuels is a source of life.</li> <li>- In the early days coal use was high in trains.</li> <li>-Coal is used to heat the houses.</li> <li>-Oil is used to operate the vehicles.</li> </ul>	<ul style="list-style-type: none"> <li>- Coal is formed by finding the plant parts.</li> <li>- Old plant and animal remains change.</li> <li>-Tree turns into coal.</li> <li>- Fossil fuels form under pressure in the ground.</li> <li>- Frequent forests occur due to rainfall.</li> <li>- Oil from fossil fuels is plant remains.</li> <li>- Natural gas occurs when time passes over the living things.</li> <li>- Gases released into the air may perforate the atmosphere.</li> <li>- The exhaust gases from the vehicles destroy the ozone.</li> </ul>
<b>Nuclear</b>	<ul style="list-style-type: none"> <li>- Uranium thorium is important for nuclear energy.</li> <li>- Nuclear energy generation is largely transformed into electricity.</li> <li>- Nuclear explosions cause environmental pollution.</li> <li>- Much energy is obtained from small amount of uranium.</li> <li>- It may cause a disaster in possible accidents.</li> <li>- Nuclear energy is formed by fusion, and fission reactions.</li> <li>- A major risk of nuclear energy is radiation leakage.</li> <li>- It is used in atomic bomb and causes death</li> </ul>	<ul style="list-style-type: none"> <li>- The tea was poured into the sea as a result of the Chernobyl accident in the Black Sea Region.</li> <li>- Nuclear leaks cause death.</li> <li>- Many people are disabled due to Chernobyl.</li> <li>- Nuclear energy is very important for countries.</li> <li>- It is planning to construct nuclear power plant in Akkuyu and Sinop.</li> <li>- It is the most preferred energy source in developed countries today.</li> </ul>	<ul style="list-style-type: none"> <li>- It is harmless in terms of pollution.</li> <li>- Water is needed where the nuclear power plant is.</li> <li>- In places where nuclear power plants are, more human are poisoned.</li> <li>- Nuclear power plant is established where uranium, thorium deposits are located.</li> <li>- Nuclear energy is clean energy.</li> <li>- Turkey is rich in uranium and thorium.</li> <li>- Chernobyl exploded in tsunami.</li> </ul>
<b>Wind</b>	<ul style="list-style-type: none"> <li>- Excessive noise occurs when wind energy is obtained.</li> <li>- İzmir / Alaçatı in our country is important for this energy.</li> <li>- When the propeller is turning, it causes bird deaths and noise.</li> <li>- It is considered to be free because it is obtained from a natural way.</li> <li>- It is environmentally friendly and renewable energy.</li> <li>- Most wind energy in the world is produced in China.</li> <li>- Coasts and highlands are areas where this system will be applied.</li> </ul>	<ul style="list-style-type: none"> <li>- Electricity in Çanakkale started to be obtained from the wind.</li> <li>- The wind occurs as a result of pressure differences.</li> <li>-It develops our wealth.</li> <li>- The wind is coolness in summer.</li> <li>- Wind is used as an energy source.</li> <li>- North-East direction wind in Çanakkale is effective.</li> <li>- There are some sports that can be done thanks to the wind energy.</li> <li>- Windmills give a nice view around.</li> </ul>	<ul style="list-style-type: none"> <li>- Wind energy is an expensive energy source.</li> <li>- Wind energy is used in narrow areas.</li> <li>- Wind energy is a cheap and economical fuel.</li> <li>- It can be applied locally and on a smaller scale.</li> <li>- Wind energy is safe because it is renewable energy.</li> <li>- Severe winds cause material damage.</li> </ul>
<b>Geother Energy</b>	<ul style="list-style-type: none"> <li>- The faulted structure of the Aegean Region comes to the forefront in geothermal energy.</li> <li>- Geothermal energy is spread in tertiary lands.</li> <li>- Geothermal energy is widespread in areas where fault fractures occur.</li> </ul>	<ul style="list-style-type: none"> <li>-Hot springs are sources of health.</li> <li>- Besides energy, it can also be a source of tourism.</li> <li>- It is used in heating the greenhouses.</li> <li>-There is a geothermal power plant in Denizli.</li> </ul>	<ul style="list-style-type: none"> <li>- They are great liquids coming from the depths of the world.</li> <li>- It occurs with the use of hot water</li> <li>-It is used in hot springs.</li> <li>- Greenhousing is made with the steam of hot water.</li> <li>- It is the development of the region</li> </ul>

	<ul style="list-style-type: none"> <li>- Geothermal energy is clean energy</li> <li>- Geothermal energy in Turkey is in Gercmenlik and Saraykoy.</li> <li>- Its temperature is high and it is rich in mineral.</li> <li>- It is used for heating and electricity in houses.</li> <li>- These are also used as hot springs</li> <li>- It is the most important alternative energy source.</li> <li>- It is an environmentally friendly and renewable energy source.</li> </ul>	<ul style="list-style-type: none"> <li>- Technology is important in using every kind of energy.</li> <li>-Hot springs are open sources.</li> <li>- Old people like hot springs.</li> <li>- We benefit from hot water coming from underground.</li> <li>- They are quite important resources for health.</li> <li>- Geothermal energy is especially used in the field of health.</li> </ul>	<ul style="list-style-type: none"> <li>with geothermal energy.</li> <li>- Hot springs are the form of geothermal energy on earth.</li> <li>- Geysers are interesting examples of geothermal energy.</li> <li>- Waters leaking underground from fault fractures form geothermal energy.</li> <li>- Geothermal energy is the source of energy formed by fault fractures.</li> <li>- It develops on fractured structures.</li> <li>-It causes air pollution.</li> <li>- It is an inexhaustible energy source.</li> </ul>
<b>Solar</b>	<ul style="list-style-type: none"> <li>- South-eastern Anatolia has the highest level of regional capacity.</li> <li>- Solar energy is common in regions with low cloudiness.</li> <li>- Solar energy is used as hot water in houses.</li> <li>- Solar energy is an inexhaustible natural source.</li> <li>- Energy is produced from the panels placed towards the sun.</li> <li>- The sun is an endless source of renewable energy.</li> <li>- The greatest solar energy potential is in tropics.</li> <li>- Solar energy is obtained with the help of solar panels.</li> <li>- Solar batteries are charged.</li> <li>- Electricity generation is provided by solar energy.</li> <li>- The energy obtained is used directly or stored in solar batteries.</li> </ul>	<ul style="list-style-type: none"> <li>- Greenhouses became the main source of revenues.</li> <li>- Solar energy contributes to economy.</li> <li>- Solar energy is suitable for environment and budget.</li> <li>- Giant solar panels are being built in Karapinar in our country.</li> <li>- The hottest place is Morocco.</li> <li>- There are solar powered cars.</li> <li>- It does not cause too much pollution.</li> <li>- Greenhouse activities are carried out at places where the sun is mostly benefited.</li> <li>- Panels used for solar energy are quite expensive.</li> <li>- Agriculture is carried out in greenhouses.</li> <li>- It is the gift of nature to us.</li> <li>- It reduces external dependency.</li> </ul>	<ul style="list-style-type: none"> <li>- It is important for vitamin D.</li> <li>- It is mostly used on the roof of the houses in our country.</li> <li>- It spreads too much radiation around.</li> <li>- Solar energy affects evaporation.</li> <li>- It's the only type of energy we need for our body.</li> <li>- There is a risk of radiation.</li> <li>- The vegetation is disappearing because of the high temperature.</li> <li>- The vegetation cover disappears under the influence of the drought.</li> <li>- Typhoid fever occurs due to excessive temperature.</li> <li>- It is one of the most used energy sources.</li> <li>- The sun is very active in the South Eastern Anatolia region.</li> <li>- The sunshine is beneficial to living things.</li> </ul>

Concept networks were constructed according to the answer words related to the key concepts in Table 1. Interpretations of each concept network take place under the relevant concept network.

*Cut-Off Point 32 and Above*

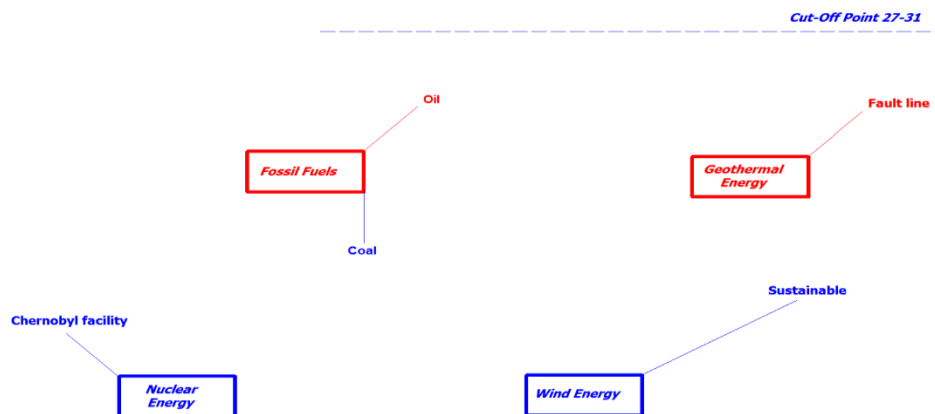


Figure 1. Concept Network Created According to Key Concepts (Cut-off Point 32 and Above)

**Cut-off Point 32 and Above**

Key words emerged at this cutting point are fossil fuels and geothermal energy. Teacher candidates mostly associated the answer word of oil with fossil fuels. The

answer word of oil was repeated ( $n = 34$ ) times at this level. The answer word of fault fracture in relation to the key concept of geothermal energy was written for ( $n = 35$ ) times by students at this level. Fossil fuel and geothermal energy are emerging in this range so just both of them are included in the concept network [Figure 1]. Teacher candidates could not produce words related to other key concepts at this level of the cut-off point. This suggests that knowledge level of teacher candidates about energy sources is low. Because both key concepts have not emerged at this level, and answer words were not associated with key concepts at this level.



*Figure 2.* The Concept Network Created According to Key Concepts (Cut-off Point between 27-31)

### **Cut-off Point between 27-31**

In addition to fossil fuels and geothermal energy, nuclear energy and wind energy have also appeared at this level of the cut-off point [Figure 2]. Teacher candidates associated nuclear energy with the answer word of Chernobyl disaster ( $n = 27$ ) and associated wind energy with the answer word of sustainable ( $n = 28$ ) in this range. The answer word of coal was associated with the key concept of fossil fuel that emerged at the previous cut-off point. But, teacher candidates considered that these key concepts are independent of each other. This result shows that students cannot establish relationships between concepts and meaningful learning could not have been provided. Another result supporting this situation is that the key concept of solar energy emerged in this range and was associated with the answer word of sustainable which emerged in the 27-31 range and which was related to wind energy.

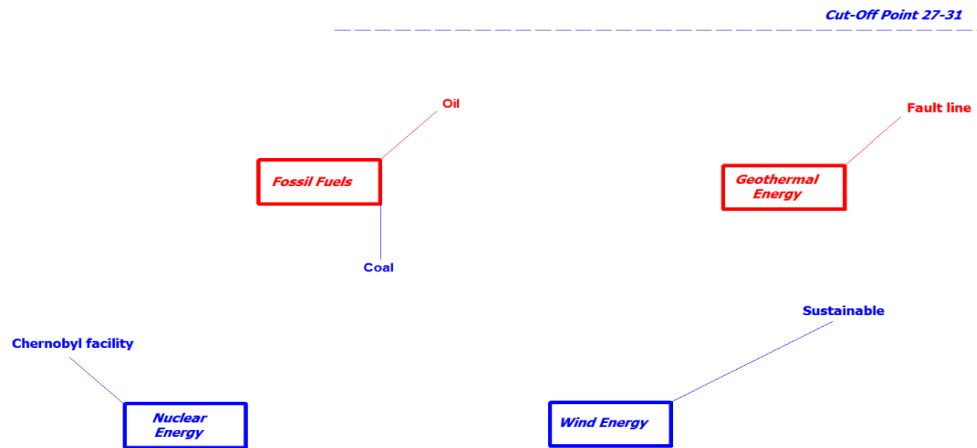


Figure 3. The Concept Network Created According to Key Concepts (Cut-off Point between 22-26)

### Cut-off Point between 22-26

In this range, solar energy is still not associated with answer words at a sufficient level [Figure 3]. Students are focused on other key concepts more than solar energy. We can say that the inability to make inferences about solar energy is caused by the lack of information and the inability to establish relations between concepts. At this level geothermal energy was associated with hot spring ( $n = 22$ ); nuclear energy was associated with uranium ( $n = 26$ ); and wind energy was associated with windmill ( $n = 23$ ). Although the frequencies of these concepts are high, the relationship between concepts was only established by the answer word of sustainable and this is not sufficient to form a network of concepts. At this level, students have considered the key concepts independently of one another. The fact that learners think these concepts independently reveals that meaningful learning has not taken place, and the integration of concepts has not been achieved. Since the concept of sustainable is an actual word, students can easily relate this expression to the key concepts because they always hear about it from different sources of information

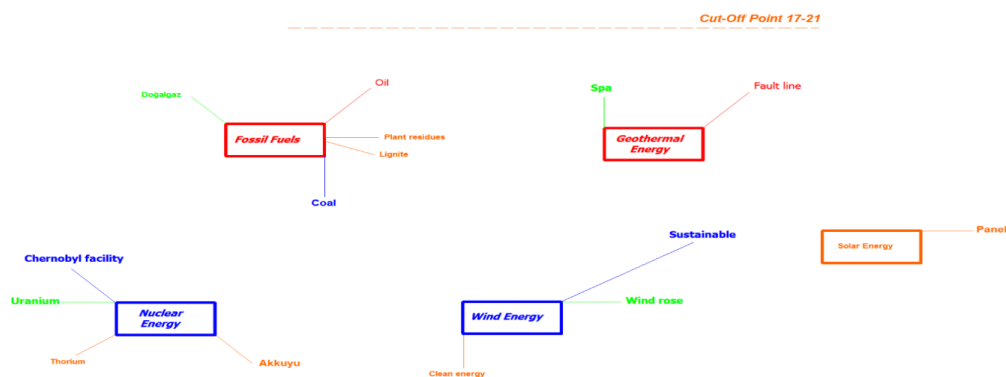


Figure 4. The Concept Network Created According to Key Concepts (Cut-off Point between 17-21)

### Cut-off Point between 17-21

In this cut-off point range, all 5 key concepts have emerged. The key concept of solar energy was associated with the response word of panel [Figure 4]. The frequency of the key concept of panel is  $n = 21$ . It is a correct association and more than half of the students expressed this word. This range includes plant residues ( $n = 17$ ) and lignite ( $n = 18$ ) besides fossil fuels. Teacher candidates produced answer words such as thorium ( $n = 20$ ) and Akkuyu ( $n = 18$ ) for nuclear energy at this cut-off point. The word they infer for wind energy is clean energy ( $n = 19$ ). The associated answer word for geothermal energy is not available. Although 5 key words appeared at this level, no relationship between concepts was established and they were seen as independent of each other. Because most of the produced answer words are not same words with key concepts, they are specific to key concepts. But answer words of clean energy ( $n = 19$ ) and sustainable taking part in wind energy could have associated to solar energy. This situation suggests that meaningful learning about energy resources has not emerged in teacher candidates. In short, although all key concepts have emerged in this range, this does not mean that the cognitive structures of teacher candidates have been fully revealed.

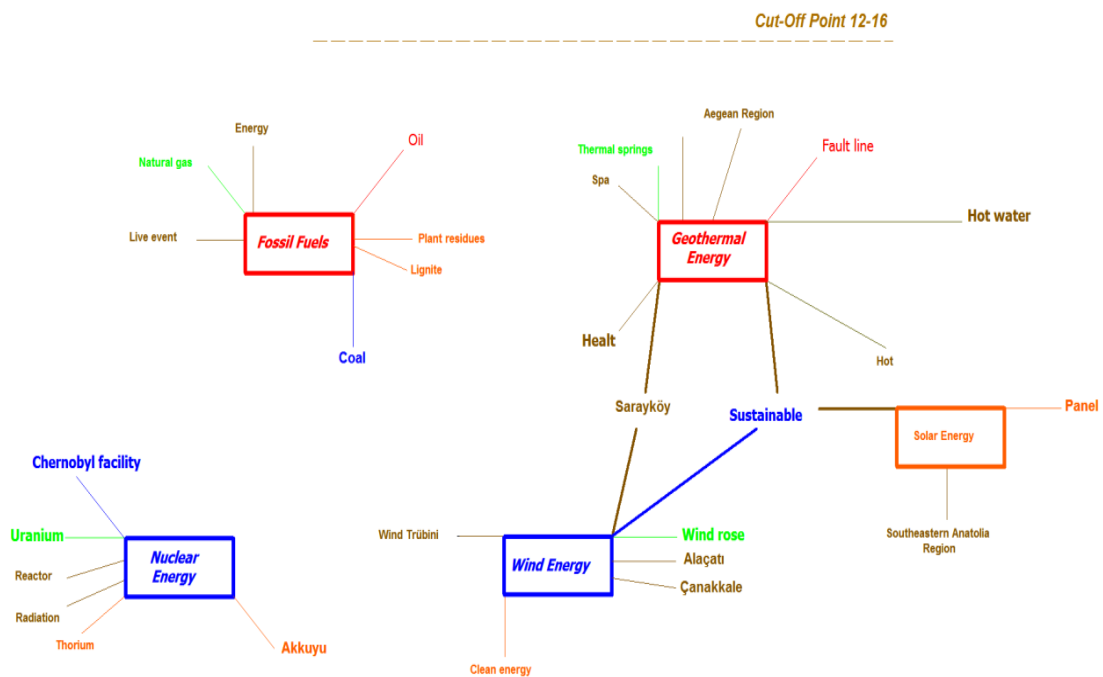


Figure 5. The Concept Network Created According to Key Concepts (Cut-off Point between 12-16)

### Cut-off Point between 12-16

In this range, the number of words produced for all key concepts increases, and it is seen that the relations between concepts have emerged in [Figure 5]. While energy (n = 12) and residues (n = 14) were added for fossil fuels at this level, the words of reactor (n = 13) and radiation (n = 12) were inferred by students for nuclear energy. Students did not establish any relationship between these concepts, and they considered that these concepts are independent of each other. In the range of 12-16 the most written answer word was written for geothermal energy. While the answer words of Aegean Region (n = 12), tourism (n = 12), hot spring (n = 14), hot water (n = 15) and health (n = 15) were added to geothermal energy, a relationship was established between the word of Sarayköy (n = 16) and the words of geothermal energy and wind energy. The words inferred about wind energy were Alaçatı (n = 14) and Canakkale (n = 14) and they were considered independent of other concepts. The independently emerged words about solar energy are South-eastern Anatolia Region (n = 12) and warm (n = 12).

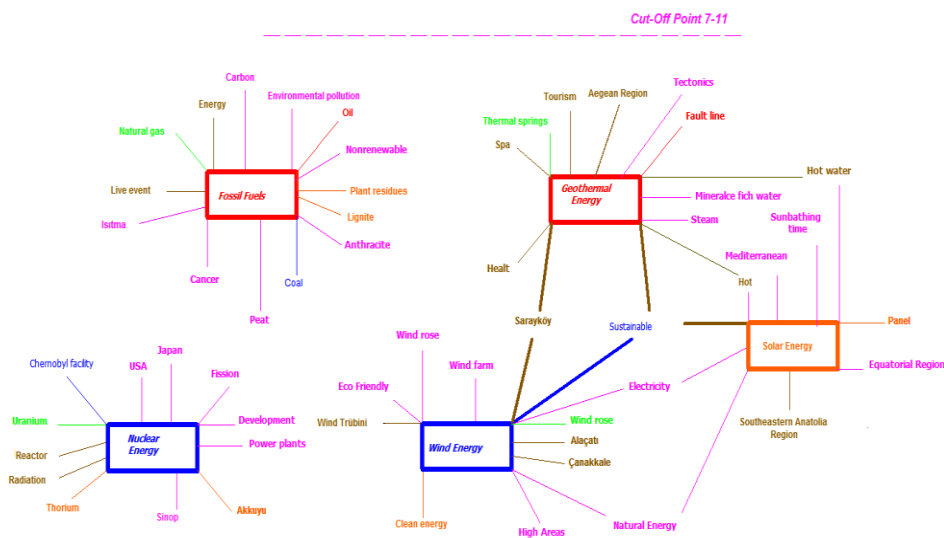


Figure 6. The Concept Network Created According to Key Concepts (Cut-off Point between 7-11)

### Cut-off Point between 7-11

In this cut-off range, the concept network, which shows the connections and relationships between key concepts and answer words, has emerged even if it is not at a sufficient level [Figure 6]. More words were produced but their frequencies are low. This can be expressed as the fact that teacher candidates have a medium level of knowledge about energy resources and most of the learners have difficulty in remembering the related topic and they have incomplete knowledge. In the range of 7-11, which is more complex than the other ranges, teacher candidates considered that answer words, written for the key concepts of fossil fuels and nuclear energy, are independent of each other. Many words that did not appear at the first level were expressed by students even if their frequencies are low. Some of these words for fossil fuels are carbon (n = 7), environmental pollution (n = 8), development for nuclear

energy (n = 8) and disease (n = 9) and it is seen that the concepts are disconnected and irrelevant. The words which have emerged in this range and caused establishing a relation between the concepts are; hot (n = 12), electricity (n = 9) and natural energy (n = 7). The conceptual network was created by establishing a relationship between the word hot and solar, geothermal energy; between the words of electricity, natural energy and wind, solar energy. Many answer words produced by teacher candidates are considered to be independent of each other. It is seen that there are just a few common words associated with key concepts. The low level of the connections between the concepts and the answer words makes it clear that the conceptual learning has not occurred and the cognitive structure is disconnected. Significant answer words providing connections between key concepts could not have been produced. Thus, a connection with key concepts that were previously emerged could not have been established, and each concept was considered as independent of each other. But at this level, new answer words related to each key concept were produced.

### **Result and Discussion**

In this study, it was tried to determine the cognitive structures of geography teacher candidates about the energy resources using five key concepts (fossil fuels, nuclear energy, wind energy, geothermal energy and solar energy). The total frequency of the words produced by the teacher candidates for these key concepts was calculated as 933. Fossil fuel from these answer words is the most represented key concept with 215 frequencies. Because fossil fuel is one of the concepts that teacher candidates meet most in their education and daily life. Nuclear energy takes the second place with 199 frequencies and it is followed by geothermal energy with 192 frequency, wind energy with 187 frequency and solar energy with 140 frequency. The word of oil inferred for fossil fuels has the highest response rate with 34 frequency. This word is a valid word and it was expressed by the almost all the students. For geothermal energy, fault line (n = 35) is a word that produced by the students at this level and its frequency is high. Both words, emerged at this level, are important concepts and their frequencies are high. However, the fact that no other answer words were produced at this level indicates that the cognitive structures of the students are not sufficient. In the range of 27-31, 4 key concepts emerged and it is seen that wind energy and geothermal energy were produced in addition to the cut-off point 32 and above. However, these four key concepts are independent of each other and a concept network did not exist at this level. In this range, the answer word of Chernobyl disaster was repeated 27 times for nuclear energy and the answer word of sustainable was repeated 28 times for wind energy. At the cut-off point between 22 and 26, the answer word of hot spring for geothermal energy, uranium for nuclear energy and a wind mill for wind energy were added. At this level, the teacher candidates considered the concepts independently of each other, and the relationship between the concepts could only be established with the answer word of sustainable. This situation reveals that perceptions of the students about the environment and their environmental awareness have not been developed sufficiently.

According to the results of the study of Saraç and Bedir (2014) (A Qualitative Study about the Perceptions of Primary School Teachers Related to Renewable Energy Sources), the perceptions of teachers about renewable energy sources were found to be very weak. This clearly shows that the curricula of the lesson of science and technology in our country do not have absolutely enough issues and achievements related to "education for sustainability", "sustainable environment" or "sustainable life". In the work of Kowasch (2017), "Resource Exploitation and Consumption in the Frame of Education for Sustainable Development in German Geography Textbooks", he points out that in textbooks, information about renewable energy sources seems as less important than the use of fossil fuels and those textbooks continue to focus on non-renewable energy sources. As Güneş et al. (2013) stated in their study of "Renewable Energy Sources Attitude Scale for Science Teacher Candidates: Validity and Reliability Study", in developing positive attitudes toward renewable energy sources, education that the individual takes with his/her surroundings and family is important. For this reason, the teachers who guide the students have great responsibilities. According to the results of Cebesoy and Karisan's research (2017), teacher candidates see renewable energy as a permanent solution and they declare that the reason for this is that these resources do not run out of and they are harmless to the environment.

All the key concepts emerged at the cut-off point between 17-21. The key concept of solar energy was associated with the answer word of panel. The frequency of the key concept of panel was calculated as 21. It is a correct association, and more than half of the students expressed this word. Also in this range, the words of plant residues and lignite were added to fossil fuels. At the cut-off point between 12 and 16, energy and residues were added for fossil fuels while the word of reactor expressed most for nuclear energy by students. The cut-off point between 7-11 has a more complex feature than the other cut-off points. The words that have emerged in this range and caused establishing the relationship between the concepts are; hot with 12 frequency, electricity with 9 frequency and natural energy with 7 frequency. The conceptual network was created by establishing a relationship between the word hot and solar, geothermal energy; between the word of electricity, natural energy and wind, solar energy. Many words produced by students at this level are considered independent of each other. This suggests that students do not have knowledge at a sufficient level and have difficulty in remembering some concepts.

The answer word of oil is at the beginning of the words that frequently expressed by teacher candidates. This word was only associated with the concept of fossil fuel. The fault line was associated with geothermal energy and considered independent of other concepts. When these two answer words are considered in association with the concepts they are related to, it shows that the cognitive structure has been formed and the concepts have been perceived correctly. At the second level, a relationship was established between the answer word of sustainable, which was inferred by the students, and wind energy and at other stages it was associated with geothermal energy and solar energy and by this way it was written as an answer word for three concepts. It caused the formation of a unified network with three concepts and formed a unity. All the



answer words expressed except this answer word are the expressions specific to key concepts and were produced as independent of one another. This maintains its characteristic up to the range of 12-16. It is noteworthy that at this level, students responded at academic level, but some expected answers were not written. The answers that students were expected to establish a relationship supposed to be related with such subjects as the environment, environmental problems, human and economic geography. If these words had been expressed by teacher candidates, a network of relations between key concepts would have been established with many words. This means that it may be related to some reasons, for example; students have lack of knowledge in some subjects, they have difficulties in remembering things, conceptual learning did not emerge, no relationship could be established between subjects, and due to rote-learning based education system. Because, it can be observed that most of the words did not emerge at the cut-off levels of 32 and above and between 27-31 and remained at lower levels, many words were not written and the answer words were not included in the cognitive structures of students to form a concept network. The features that reveal the relation between the key concepts were not expressed by the teacher candidates and there is no unity for the energy resources. However, at the cut-off point between 12-6 and at the cut-off point between 7-11, a large number of answer words were produced, but their frequencies are low. This shows that students' cognitive structures about energy resources are not deep; but they have the right inference about some key concepts and they did not produce incorrect and irrelevant words. We can say that they have learned the concepts correctly, but not sufficiently. All the key concepts have emerged in the range of 17-21 and the relationship has been established between wind energy and solar energy only with the word of sustainable. In the range of 7-11, more answer words were produced and a triple bond was established between wind energy, geothermal energy and solar energy with the answer word of sustainable. A bilateral relationship was established between geothermal energy and solar energy with the words of hot and hot water. The bilateral relationship between geothermal energy and wind energy was established with the words of Sarayköy, electricity and natural energy. While students associated the wind energy, solar energy, and geothermal energy with one another in terms of some respects, they considered fossil fuels and nuclear energy as independent from these concepts and they never wrote any related answers. Moreover, no relationship was established between fossil fuels and nuclear energy, and these two key concepts emerged independently. This indicates that the students do not have the knowledge at the top level and the conceptual level.

The fact that the frequencies of the answer words are low shows that the students have lack of information on some subjects, but several sentences containing scientific information indicates that the students have constructed the information they have learned correctly in their minds. Sentences that contain non-scientific or superficial information are samples that contain accurate information but show superficiality. This information that students have can be the associative product of different sources or can be attributed to the fact that they did not get serious while they were answering. Sentences containing misconceptions are at a low level. In fact, when looked at the

expressions that students wrote for the key concepts, it is seen that the answers that students created incorrect associations are rarely encountered. This situation is also seen in the sentences that they created. In short, it is seen in the concept networks that the teacher candidates did not make incorrect associations among the concepts. It is seen that even if it is low, teacher candidates have inaccurate knowledge at the level of explaining concepts.

According to literature researches, Tobin, Crissman, Doubler, Gallagher, Goldstein, Lacy, Rogers, Schwartz, & Wagoner (2012) found that primary and secondary school teachers do not have sufficient knowledge about the renewable energy resources. Toman & Çimer (2013) determined as a result of their study that primary school students have serious misconceptions about what energy sources are for plants and people. Senyuva & Bodur (2016) argued in their research that most of the students have knowledge about nuclear power plants and their being harmful to human health and environment. Similar results have been achieved in this study both in the words produced by the students and in the sentences they have created related to the key words. As a result, it can be seen that the findings obtained from this study overlap well with some similar studies carried out before. Especially some similarities can be identified, for example; the insufficient focus on renewable energy, the lack of training on energy resources and the need for further emphasis. According to Turan (2002), the definitions and characteristics of geographical concepts and terms should be given at a level that includes the principles of geography, the definitions should support the facts and generalizations in the student's mind and it must be at a level that will enable complete learning. Also with this study it can be said about word association test that it can be an effective technique in determining whether the conceptual learning, the connections between concepts, the misconceptions and meaningful learning has taken place in students or not and in detecting the lack of knowledge of students.

### **Suggestions**

In order for teacher candidates to have academic knowledge about renewable energy sources, environmental education should be promoted at all levels of education and throughout life with different educational activities.

Environment and environmental education should be considered as a multidisciplinary subject that should be given at every stage of education by starting from the education that the child receives in the family.

The importance of effective use of energy resources and turning to renewable energy sources more must be clearly understood both in terms of humanity and the future of nature.

Taking into consideration the fact that the way to design a society is possible through educating individuals, it is crucial to understand the importance of the education that must be given in terms of individual responsibilities.

By moving from the proverb of "the tree leans while it is young", it is important to start the cognitive structure about the environmental awareness from early ages.

Careful attention should be paid to the transfer of the theoretical information to the practice in the education system.

If the education system which cannot provide behaviour change, it should be examined and correct steps should be taken at this point.

The awareness must be created about that energy resources are the only natural resources which can be used not only by today's societies but also by future generations.

To educate generations who believe that energy resources, especially resources based on fossil fuels, will be consumed and who developed behaviour in this direction should be one of the most important responsibility of education.

The importance of renewable energy sources, both for the countries and for the future of the world should be taught to students thoroughly in their education processes.

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