Preservice Science Teachers' Knowledge of Energy Resources: An Adaptation Study

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Abstract: The main energy resource is still fossil fuels on Earth and they are decreasing day by day. Energy generation from fossil fuels is accepted as the primary reason for climate change. Energy conservation is important to decrease the impact of climate change and knowledge of energy resources may have a role in energy conservation behavior. Therefore, measuring energy knowledge is of great importance. The aim of this study is to adapt the energy knowledge instrument of DeWaters, Qaqish , Graham and Powers (2013) to Turkish. Two pilot studies were conducted and a questionnaire with 15 items measuring participants' knowledge of energy resources was adapted. The KR-20 value for the instrument was found to be 0.70. This instrument creates an opportunity to measure the basic understanding of energy resources.

Keywords: energy resources, knowledge scale

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Fen Bilgisi Öğretmen Adaylarının Enerji Kaynakları Hakkındaki Bilgisi: Bir Adaptasyon Çalışması

Özet: Dünyadaki temel enerji kaynağı hala fosil yakıtlar olup, bu kaynaklar günden güne azalmaktır. Bunun yanında, fosil yakıtlardan enerji üretmek iklim değişikliğinin başlıca sebebi olarak kabul edilmektedir. Enerji tasarrufu iklim değişikliğinin etkilerini azaltma açısından önemlidir ve enerji kaynakları bilgisi enerji tasarrufu davranışında rol oynayabilir. Bu nedenle, enerji bilgisinin ölçülmesi kritik öneme sahiptir. Bu çalışmanın amacı, DeWaters, Qaqish, Graham ve Powers'ın (2013) enerji bilgi ölçeğinin Türkçe'ye uyarlanmasıdır. Bu kapsamda, iki pilot çalışma yapılmış ve katılımcıların enerji kaynakları konusundaki bilgilerini ölçen 15 maddelik bir anket uyarlanmıştır. Ölçeğin KR-20 değeri 0.70 bulunmuştur. Bu ölçek, enerji kaynakları ile ilgili temel bilgiyi ölçmek için kullanılabilir.

Anahtar Kelimeler: enerji kaynakları, bilgi ölçeği

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INTRODUCTION

Energy is one of the main needs of the society since the industrial revolution. The main energy resource is still fossil fuels today and the use of these energy resources has many effects on the environment, society and policy (Tietenberg & Lewis, 2012). Fossil fuels are limited energy resource types, and they are primarily responsible for the increase in greenhouse gases in the atmosphere. This increase has resulted in climate change. Many studies (e.g., Anderegg, Prall, Harold & Schneider, 2010; Doran & Zimmerman, 2009) and Intergovernmental Panel on Climate Change (2007) evidenced that the majority of the warming on earth's surface has stemmed from human activities (e.g., burning fossil fuels). Decreasing the amount of greenhouse gases is the main strategy to mitigate the climate change (Intergovernmental Panel on Climate Change, 2007). In order to support this strategy, energy literacy has been considered as a crucial factor.

According to Barrow and Morrissey (1989), a person who is knowledgeable about energy is also aware of and knowledgeable about the necessity of and reasons for energy conservation, and the need for the development of alternative energy, and ponders on the effects of the use of certain types of energy on the environment. DeWaters, Qaqish , Graham and Powers (2013) developed an energy literacy scale to measure middle and high school students' literacy level. As a part of energy literacy, knowledge domain was defined within energy literacy framework. DeWaters and Powers (2011) conducted a study with middle and high school students to reveal their energy-related knowledge, attitudes toward energy, and energy-related behaviors. The results showed that students' overall energy knowledge scores related to energy conservation, power and energy, practical energy use, and their knowledge of energy resources were quite low. Moreover, they had a low score on energy-related behaviors. Another study was conducted by Bodzin (2012) with eighth-grade students in the US to investigate students' knowledge of energy resources. The results regarding the level of knowledge of urban middle school were parallel with those of DeWaters and Powers (2011). In other words, students in the middle school did not have a basic understanding of issues related to energy sources. In addition, a nationwide survey was conducted by the National Environmental Education and Training Foundation (NEETF) in 2002 in the US. The result of this survey also showed that only 12% of citizens were successful in energy knowledge test and many of the participants overestimated their knowledge. Another study conducted by Bittle et al. (2009) supported the findings of previous studies and found that 40% of participants had limited energy knowledge and even they could not write examples to fossil fuel, and 51% could not name renewable energy (RE) types. Limited energy knowledge might lead individuals to show inappropriate energy behavior. For example, the study of Attari et al. (2010) indicated that people tend to focus on curtailment actions, like turning lights off rather than efficacy actions, like using energy efficient light bulbs. Besides, the authors concluded that participants were unaware of how much energy is used by various household appliances. In addition to limited knowledge about the energy consumption of household appliances, citizens lacked knowledge

about differentiating energy resources. For example, Sovacool (2009) claimed that the public had confusion about RE and the need for this technology. According to the author, the source of this confusion is the limited understanding of electricity production. As to energy resource types, the studies on public knowledge and perception of RE has been important especially for energy-dependent countries (Yüksel & Arman, 2014). An example of RE study is the study of Zyadin, Puhakka, Ahponen, & Pelkonen (2014). The authors investigated secondary school teachers' knowledge, perceptions and attitude toward RE in Jordan. It was found that teachers had limited knowledge about RE, and so, they needed training about RE before it was included in the curriculum. On the other hand, teachers had positive attitudes toward the development of RE, but they were neutral about the use of RE. Another study was conducted by Zyadin, Puhakka, Ahponen, & Pelkonen (2012) with tenth-grade students to figure out their knowledge, perceptions, and attitudes toward RE. According to this study, tenth graders also had limited energy content knowledge to differentiate the renewable and nonrenewable energy types. However, they had positive attitudes toward RE and were willing to adopt RE.

As mentioned above, knowledge of energy-related issues may contribute to energy conservation behaviors (Attari, DeKay, Davidson, & de Brui, 2010; Bittle, Rochkind, & Ott, 2009). Therefore, exploring energy knowledge is important. However, an instrument investigating this knowledge in Turkish is necessary. Energy resources and energy-related issues are included in the current science education curriculum (MoNE, 2018). Therefore, preservice science teachers' (PSTs') knowledge related to energy is critically important. By considering all these issues, the aim of the study is to adapt the energy knowledge instrument of Dewaters et al. (2013) to Turkish.

METHOD

Instrument

The energy knowledge scale of DeWaters et al. (2013) was used in this study. The instrument includes 52 questions. Two pilot studies were conducted in order to adapt the energy knowledge scale to Turkish. In the first pilot study, all these questions were translated into Turkish by the researcher and the translation was checked by the Academic Writing Center of a public university. Then, the questions were adapted to the Turkish context. In the instrument of DeWaters et al. (2013), there were questions related to the energy policies of the US (e.g., the dependence of the US on foreign energy). These questions were adapted to Turkey. While doing this, the opinions of experts- two experts in environmental education, one expert in science education, and one expert in the renewable energy engineering field- were taken. According to the expert suggestions, one additional question, which asks about the types of energy resources, was added to the scale, while five questions were excluded from the scale since they were thought to be too technical for PSTs or they were not appropriate for

the Turkish context. In conclusion, the first pilot study was conducted with 48 questions. The results of the pilot studies and the main study were presented below.

Item Analysis

In order to figure out the items to be kept in the knowledge scale, item analysis was conducted. This analysis was conducted with the test analysis program (TAP), which conducts item analyses based on classical test theory (Brooks & Johanson, 2003). In the analysis, item difficulty index, item discrimination index, and correlational indices of item discrimination were examined.

Item difficulty index shows how easy an item is for a group of examinees. The p value is the percentage of examinees selecting the correct answer. The optimum index for item difficulty (p) is closer to 0.50 (Crocker & Algina, 1986). In addition, Henryssen (1971, as cited in Crocker & Algina, 1986) suggests that if biserial correlation index is in the range between 0.30 and 0.40, item difficulty should be between 0.40 and 0.60; but, if the biserial correlation index is above 0.60, a wider range of item difficulty may be acceptable. Therefore, it is decided to keep items having p value closer to 0.50 or higher than 0.50 for the study, and when the items have 0.60 and higher biserial correlation index, a wider range of item difficulty is accepted (Henryssen, 1971 as cited in Crocker & Algina, 1986).

Item discrimination index (D) is a measure showing how effectively an item discriminates the examinees scoring high on the test as a whole from the examinees scoring low on the test as a whole. The range for the index is between 0 and 1. This index is calculated by considering the scores in upper 27% and in lower 27%. D value with 0.30 and higher is accepted as reasonably good items and D value with higher than .040 is accepted as very good items (Ebel & Frisbe, 1991). Items having D value higher than 0.30 were kept in the study.

Correlation index is a measure showing the correlation of a dichotomous item with the whole test score. The biserial correlation coefficient is one of the indexes used for the correlation index. If the scores for achievement test are normally distributed, biserial correlation coefficient is preferred (Crocker & Algina, 1986). Biserial correlation with 0.30 and higher values is accepted as satisfactory (Backhoff, Larrazola, & Rosas, 2000). Rather than using this index directly, Domino and Domino (2006) suggested using the biserial correlation index to show the degree of the similarity between the item and the whole scale. Ebel and Frisbe (1991) recommended using the biserial correlation index when a test is built on the basis of the discrimination index.

RESULTS

The Results of Pilot Studies

The energy knowledge instrument of Dewaters et al. (2013) was used in the study. The instrument includes 52 items. All these items were examined by four experts, and the experts suggested excluding five items, which were believed to be too technical for preservice science teachers

(PSTs). There were some items measuring knowledge regarding the US energy policy. These questions were either adapted to the context of the energy policy of Turkey or deleted. In addition, one question, which asks about the classification of energy resources, was added. Totally, 48 questions were included in the study. The instrument was applied to 305 junior and senior PSTs. The data was collected in two public universities in the south of Turkey. The first pilot study revealed that twenty items did not meet the criteria (i.e., item difficulty, biserial correlation, and discrimination index) for analysis. The number of these items was so high that content validity threat emerged. The results were examined with the experts. The content of energy knowledge scale was very comprehensive, which might be the reason for this result. By considering the opinions of experts, it was decided to narrow down the content of the instrument to energy resources. The items which did not meet the criteria were excluded, and the items related to energy resources were revised and three new questions were added. Two of these questions are related to hydroelectric power plants and one of them is related to nuclear energy power plants. The second pilot study was conducted with 21 items. The instrument was applied to 172 PSTs who were juniors and seniors in a public university in south of Turkey. The item analysis indicated that the item difficulty values of six items were very low ($d<0.30$), and their biserial correlation values were also very low. It means that these items did not discriminate high and low achievers, and the correlation between the items and the whole test was very low. Although the item difficulty of these questions was higher than 0.50, low indexes in the discrimination index and biserial correlation indicated removing these items. For this reason, these items were decided to be excluded from the main study. Cronbach's alpha (α) value of the knowledge test which included 15 items was found as 0.73. The Cronbach's alpha (α) value shows that the scale is reliable in the accepted range (Kline, 2008). As a result, 15 questions were included in the main study (see Appendix).

The Main Study

The pilot studies showed which items worked properly. According to the results, the content of the instrument was narrowed down to energy resources. The main study was conducted with 1136 PSTs in the central Anatolian region. The reliability of the test was measured with KR-20 and it was found to be 0.70 in the main study. Table 1 shows the values for the whole test. According to these findings, mean item difficulty, mean discrimination index and mean biserial correlation were found as 0.63, 0.36 and 0.50, respectively. These values are acceptable for the knowledge test (Ebel & Frisbe, 1991; Backhoff, et al., 2000; Crocker & Algina, 1986).

Table 1. Findings for the whole test with 15 items

Mean Item Difficulty	Mean Discrimination Index	Mean Biserial Correlation
0.63	0.36	0.50

Table 2 shows the values (i.e., item difficulty index, item discrimination index, biserial correlation index and correct percentage in high and low groups) for each item in a detailed manner.

Table 2. The results of item analysis for each item

Item Number	Item difficulty index	Item discrimination index	Correct percentage in high group (%)	Correct percentage in low group (%)	Biserial correlation index
1	0.68	0.31	0.82	0.51	0.33
2	0.77	0.25	0.88	0.63	0.34
3a	0.73	0.55	0.96	0.41	0.74
3b	0.86	0.37	0.98	0.62	0.75
3c	0.78	0.50	0.97	0.47	0.76
3d	0.69	0.57	0.93	0.36	0.67
3e	0.91	0.27	0.99	0.73	0.88
3f	0.83	0.43	0.98	0.55	0.78
3g	0.42	0.31	0.58	0.26	0.34
3h	0.60	0.45	0.82	0.37	0.46
3i	0.84	0.29	0.94	0.64	0.63
3j	0.65	0.40	0.85	0.46	0.46
4	0.42	0.40	0.62	0.22	0.40
5	0.42	0.49	0.71	0.23	0.48
6	0.66	0.38	0.83	0.45	0.46
7	0.71	0.35	0.89	0.53	0.45
8	0.35	0.28	0.50	0.22	0.30
9	0.17	0.24	0.34	0.01	0.35
10	0.23	0.25	0.39	0.14	0.34
11	0.92	0.17	0.99	0.82	0.53
12	0.77	0.38	0.94	0.56	0.50
13	0.52	0.34	0.69	0.35	0.34
14	0.66	0.32	0.80	0.48	0.36
15	0.54	0.44	0.77	0.33	0.42

Items numbered as 1 (definition of RE), 6 (energy-related activities which are least harmful to human health and the environment), 7 (atmospheric gas leading to concerns for climate change), 12 (related to energy conservation), and 14 (related to energy conservation), were easy questions, but their discrimination index was effective in discriminating high achievers from low achievers. Items 2 (asking features of RE) and 11 (the best reason for choosing A+++ certificated products) were found to be easy questions and their discrimination indexes were low. However, biserial correlation of these items was good, meaning that they were in harmony with the whole test. To provide construct validity, these items were kept in the test. Questions asking for the classification of energy resources (Item 3) as renewable and nonrenewable were found to be easy, and almost all these questions had a good

discrimination index. Questions 4 (the most common RE type used in Turkey for generating electricity), 5 (the reason for the increase in the temperature of earth's surface), 13 (related to energy conservation), and 15 (related to energy conservation) were found to be good items whose item difficulty and discrimination indexes were appropriate. Items 8 (related to hydroelectric power plants), 9 (related to nuclear power plants), and 10 (well-known city for nuclear power plant accident) were found to be hard questions and their discrimination indexes were below .30, which means that the discrimination ability of these three items was low. However, as their biserial correlation indexes were good, they were used.

The item analysis showed that item difficulty, discrimination index and biserial correlation of 15 items were acceptable. The majority of the items were found to be easy for the PSTs. However, many of these items could discriminate high achievers from low achievers. These results showed that this instrument could be used in further studies to explore PSTs' knowledge of energy resources.

Table 3. Correct Answer Percentage of Knowledge of Energy Resources

Item Number	% of correct answer
1. Which one of the following best describes renewable energy resources?	67.5
2. Which of the following is not a feature of a non-renewable resource?	77.2
3. Please classify the following energy resources as renewable or non-renewable.	
a. Coal	73.3
b. Sun	85.6
c. Petroleum	78.3
d. Natural Gas	68.8
e. Wind	91.1
f. Wave	83.1
g. Bio Mass	42.1
h. Nuclear Power	60.3
i. Hydro Power	83.7
j. Geothermal Power	65.5
4. Which of the renewable energy is used to derive most of the electricity in our country?	42.3
5. Many scientists say the Earth's average temperature is increasing. Which of the following is one of the most important reasons for this change?	42.4
6. Which of the following energy-related activities is the least harmful to human health and the environment?	66.3
7. The concern about global climate change typically focuses mostly on an increase in which atmospheric gas?	70.6
8. Which of the following is correct for hydroelectric power plants?	34.9
9. Which of the following is incorrect for nuclear power plants producing electricity?	17.3
10. Which of the following cities was involved in one of the biggest nuclear accidents?	22.5
11. Which of the following is the best reason for choosing A+++ certificated products?	92.2
12. If a person traveled alone to work 30 miles every day and wanted to save gasoline, which one of the following options would save the most gasoline?	77.2

13. Which of the following choices always saves energy?	51.9
14. Which of the following choices wastes energy?	66.3
15. Which of the following is wrong for hydropower plants?	53.9

The most difficult item was the 9th question, which is related to nuclear power plants. The number of PSTs who answered this question correctly was very low. Concerning nuclear energy, many PSTs gave a wrong answer to the question related to the current nuclear energy accident in Fukushima. Furthermore, the number of the PSTs who gave the correct answer to the features of hydroelectric power plants was low. On the other hand, the majority of the participants answered the third question correctly, which asked about the classification of energy resources as renewable and nonrenewable. Moreover, the question which asked about the reason for the increase in the Earth's average temperature was answered correctly by less than half of the PSTs. These findings indicate that although the PSTs knew renewable and nonrenewable energy types, they had limited knowledge about the features of these energy resources and their impacts on the environment. Regarding the questions related to energy conservation, the majority of the PSTs answered the questions correctly.

Discussion and Implications

Energy-related issues are critical for energy-dependent countries like Turkey. Energy-related knowledge, attitude and behavior studies are crucial to understand the perspectives of the public (Ugurlu, 2006). The studies investigating the awareness of public regarding energy resources are limited in Turkey (Yüksel & Arman, 2014). In this study, the instrument of DeWaters et al. (2013) was adapted to Turkish to fill this gap. In the first pilot study, the items which did not work properly were determined. The number of items which did not work was very high, which may be because the content was broad. To deal with this problem, the content of the instrument was narrowed down to energy resources which include types of energy, impacts of these energy resources (i.e., climate change), and energy conservation. Then, the items were revised, and three more questions related to hydroelectric power and nuclear energy power plants were added to the instrument. According to the results of the second pilot study, the instrument was reformulated. The final version of the instrument included 15 items. The KR-20 value was found to be 0.70, which showed that the test is reliable and can be used in further studies. In addition to the adaptation of the instrument to Turkish, PSTs' knowledge of energy resources and their impacts (i.e., climate change) was also analyzed in the study.

This current study showed that the PSTs knew the definition and features of RE resources, could classify the types of energy resources, and were aware of the ways of conserving energy. However, their knowledge related to hydroelectric power plants and nuclear power plants was found to be highly limited. In fact, they were not aware of the well-known nuclear energy power plant accident which recently happened in Fukushima. News related to energy-related issues may not attract the interest of the PSTs in their daily life. Likewise, the study conducted by Karatepe, Nese, Kecebas and Yumurtaci

(2012) with engineering students showed that these students were aware of the RE types, but their technical knowledge bout RE and RE technology was quite limited. Karabulut, Gedik, Kecebas and Alkan (2010) also found the curriculum in universities inadequate to give students a global perspective about energy issues. Another study in Turkey about students' ideas about RE was done by Kilinc, Stanisstreet and Boyes (2009) with 7th and 8th graders. As revealed by their study, the students believed that RE is both a reliable and a safe source of electricity. However, the study by Kilinc et al. (2009) did not measure the energy knowledge of students, and thus, this perception may be intuitive.

The current study also showed that the majority of the PSTs knew that CO_2 gas is mainly responsible for climate change, but many of them were not aware of the reasons for the increase in the temperature of earth's surface. Similarly, the study of Arslan, Cigdemoglu and Moseley (2012) showed that preservice teachers' knowledge related to global warming was quite limited. The reason for this result may be the curriculum the PSTs followed during their teacher education program.

These results suggest some implications to science teacher education program. Although PSTs knew the types of energy resources and energy conservation, they had limited knowledge regarding the nuclear energy power plant and hydroelectric power plants. It means that they were not aware of how energy is generated and their impacts. Generating energy from fossil fuels, renewable energy types and nuclear energy has several impacts on the environment, society, economy and policy. That is, the topic should be introduced to PSTs by considering the dimensions of sustainability (i.e., environment, society, and economy) and PSTs should be encouraged to discuss all these dimensions in energy-related topics in their environmental courses such as Environmental Sciences.

In conclusion, this instrument is valid and reliable to measure PSTs' knowledge of energy resources and can be used in future studies. For instance, studies may explore PSTs' knowledge of energy resources and its relationship with various variables (e.g., energy conservation behavior, attitudes toward energy conservation). Another suggestion is to make a research on the role of gender in the knowledge of energy resources. In these studies, the role of knowledge can be explored and suggestions on teacher education program can be offered. As a limitation, the main data was collected from the central Anatolian region and, the study can be replicated by collecting data from other regions of Turkey.

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Appendix

1. Aşağıdakilerden hangisi **yenilenebilir enerji** kaynaklarını en iyi tanımlamaktadır?

A. Kullanımı uygun ve ücretsiz kaynaklardır.
B. Isı veya elektriğe direkt çevrilebilir kaynaklardır.
C. Hava kirliliği yaratmayan kaynaklardır.
D. Enerji üretmek için çok verimli olan kaynaklardır.
E. Doğa tarafından kısa sürede yerine konulabilen kaynaklardır.

2. Yenilenemeyen enerji kaynaklarının özelliklerinden biri nedir?

A. 80 yıl içinde kendisini yenileyebilecektir
B. Sadece bir kere kullanabiliriz
C. Çevreye zarar vermez
D. Geri dönüştürülebilir
E. Kullanımı sonucu atık oluşmaz

3. Aşağıdaki enerji kaynaklarını yenilenebilir ve yenilenemez enerji kaynakları olarak **sınıflandırınız.** Yenilenebilir/Yenilenemez olduğunu düşündüğünüz enerji kaynağının karşısına "X" işareti koyunuz.

Enerji Kaynağı	Yenilenebilir	Yenilenemez	Fikrim Yok
Kömür			
Güneş			
Petrol			
Doğalgaz			
Rüzgâr			
Dalga			
Biyokütle			
Nükleer güç			
Hidro (su) gücü			
Jeotermal Güç			

4. Ülkemizde üretilen elektrik **en çok** hangi **yenilenebilir enerji** kaynağından elde edilmektedir?

A. Güneş
B. Su (Hidro) gücü
C. Rüzgâr
D. Doğal gaz
E. Kömür

5. Pek çok bilim insanı dünya atmosferinin ortalama sıcaklığının arttığını söyler. Bu değişimin **en önemli** nedenlerinden biri olarak aşağıdakilerden hangisi gösterilir?

A. Ozon tabakasının incelmesi
B. Kuzey kutbu buzullarının erimesiyle deniz seviyesinin yükselmesi
C. Volkanik etkinlikler sonucu atmosfere yayılan karbondioksit miktarı
D. Fosil yakıtların yakılması ile atmosferdeki karbondioksit miktarının artması
E. Nükleer güç santrallerinden çıkan su buharıyla atmosferde su buharı miktarının artması

6. Enerji ile ilgili aşağıdaki faaliyetlerden hangisi çevre açısından **en az** zararlıdır?

A. Kömür madenciliği
B. Petrol arama ve taşıma
C. Elektrik üretmek için fosil yakıtları yakmak
D. Elektrik üretmek için fotovoltaik hücreleri üretmek
E. Fotovoltaik hücreleri kullanarak elektrik üretmek

7. Küresel iklim değişikliği ile ilgili kaygılar genellikle hangi atmosferik gazın artışı ile ilgilidir?

A. Ozon
B. Sülfür dioksit
C. Karbondioksit
D. Nitroz oksit
E. Hidrojen

8. Hidroelektrik santraller (HES) için aşağıdakilerden hangisi doğrudur?

A. Sadece derin nehir yatakları üzerine kurulur.
B. Sadece hızlı akan nehirler üzerine kurulur.
C. İşletme masrafları yüksektir.
D. Bulundukları bölgedeki doğal habitata zarar verirler.
E. Bir akarsu üzerine birden fazla HES kurulamaz.

9. Günümüzde elektrik üretimi yapan nükleer enerji santralleri ile ilgili aşağıdakilerden hangisi **yanlıştır?**

A. Çekirdek birleşimi sırasında ortaya çıkan enerjiyi kullanırlar.
B. Oluşan nükleer atıkların yok edilmesi ile ilgili problemler vardır.
C. Su kaynakları kenarına kurulurlar.
D. Yapımları ileri teknoloji gerektirir.
E. Yakıt olarak genellikle Uranyum kullanılır.

10. Büyük nükleer kazalardan biri aşağıdaki şehirlerden hangisinde olmuştur?

A. Belgrad
B. Fukuşima
C. Hiroşima
D. Moskova
E. Bükreş

11. A+++ belgeli bir ürün tercih etmenin **en iyi** nedeni aşağıdakilerden hangisidir?

A. Genellikle daha büyük olmaları
B. Daha pahalı olmaları
C. Daha az enerji harcamaları
D. Daha modern görünmeleri
E. Daha kaliteli olmaları

12. Eğer bir kişi günde tek başına 50 km yol kat ediyorsa ve yakıt tasarrufu yapmak isterse aşağıdakilerden hangisi **en fazla** yakıt tasarrufu yapmasını sağlar?

A. 100 km de 5 lt yakıt harcayan bir araç yerine 100 km de 4 litre yakıt harcayan bir araba almak.
B. Saate 100 km süratle aracı sürmek yerine saatte 90 km süratle sürmek.
C. Saate 100 km süratle aracı sürmek yerine saatte 80 km süratle sürmek.
D. Toplu taşıma araçlarını kullanmak.
E. Hepsi aynı miktarda yakıt tasarrufu sağlar.

13. Aşağıdaki aktiviteleri yapan bir kişi hangisinde **en fazla** enerji tasarrufu sağlar?

A. Doğalgaz ile ısınan evlerde garaj gibi ilave alanlar için portatif elektrikli ısıtıcı kullanmak.
B. Daha az yakıt harcayan bir araba satın almak ve otobüse binmek yerine bu arabayı kullanmak.
C. Kısa bir süre için kapatılacaksa floresan lambaları kapatmayıp açık bırakmak.
D. Bilgisayarın kullanılmadığı zamanlarda ekran koruyucu kullanmak.
E. Araba 15 saniye ya da daha fazla süre duracak ise motorunu durdurmak.

14. Aşağıdaki seçeneklerden hangisi enerji **israfıdır**?

A. Dışarısı soğukken, termostatı gündüz 18 °C'ye, gece 15 °C' ye ayarlamak
B. Araba 15 saniye duracaksa motoru durdurmak
C. Ampulleri, kompakt floresan ampuller ile değiştirmek
D. Yeni bir buzdolabı almak yerine 20 yıllık eski buzdolabımızı kullanmak
E. Bilgisayarımızı kullanmadığımız zamanlarda uyku moduna almak yerine kapatmak

15. Hidroelektrik santraller (HES) ile ilgili aşağıdakilerden hangisi **yanlıştır?**

A. İnşaat aşamasında çevreye zarar verirler.
B. Akarsuların doğal akımını (debisini) değiştirirler
C. Akarsularda yaşayan canlıların göç hareketlerini etkilerler.
D. Bulundukları bölgede mikro iklimi değiştirirler.
E. Elektrik üretimi sırasında çevreye bol miktarda CO2 gazı yayarlar.