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Assessing Energy Literacy of Iranian Ninth-Grade Students

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ABSTRACT
The extent to which people understand the role of energy in everyday life is called energy literacy. The purpose of this study is to investigate the levels of energy literacy among 393 Iranian 9th-grade students using the 'Energy Literacy Questionnaire'(ELQ) and study the effective factors on their energy literacy. The Mann-Whitney U test, Spearman product-moment correlation, and Z test were used to analyze the data. The results showed that the level of energy knowledge of students is discouragingly low, but students were aware of energy-saving behaviours and they had relatively good attitudes and values towards the energy issues. Gender, school location, and the level of parent's education were the effective factors in the level of energy literacy of students. Male students were better than female students in the behaviour part and rural students had more positive attitudes and values than urban students. Parents' education level was an effective factor in students' level of knowledge in energy.

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Introduction

Every activity requires energy. The survival and development of human societies depend on energy supply. High energy consumption has led to issues such as resource depletion, greenhouse gas emissions, and global climate change. Energy consumption and production cause such environmental problems. Thus, improving people's awareness of conserving energy, using clean energy and solving energy issues are necessities for any modern society. In recent years, these necessities have been referred to as energy literacy. Energy literacy is the degree to which people understand the role of energy in the world around them and everyday life.

Having energy literacy for ordinary citizens is very important and necessary to evaluate the government's executive policies in this field that cause general bias of society and various industries for energy development and consumption, lifestyle change, and environmental protection (DeWaters & Powers, 2011). Also, Iran as one of the largest producers of fossil energy in the world has led to a strong dependency on energy in various economic and social fields. Thus, much Iranian think they should not be worried about energy consumption and their issues. It appears energy literacy is necessary for Iranian students.

Akitsu et al. (2017) quote Barrow and Morrisey (1987) and DeWaters and Powers (2011) by indicating Energy literacy is not just knowledge. An energy-literate individual is characterized as one who is cognizant and knowledgeable; understands energy use in daily life, the impact of energy overconsumption on the society and environment, and the need for energy conservation and alternative energy resource development; can make appropriate energy choices and decisions; and can take actions reflecting one's skills and action for a sustainable society (Akitsu et al., 2017).

In sustainable development, which is known as a process to meet the different needs of the present generation, without interfering with the needs of the next generation, the use of limited and finite resources is particularly sensitive. Among these resources, energy (as a driver and driver of today's world) and its supply is one of the most sensitive categories of the sustainable development process. Although most of the required energy in Iran is provided from non-renewable sources, the need for long-term planning and management of energy supply and consumption is being strongly felt.

Efforts to measure energy literacy began around the late 1970s. Except for a few general cases (Gambro & Switzky, 1999; Hanson 1993; Holden & Barrow 1984), researchers mostly tried to measure students' knowledge and attitudes orally or after completing an energy-related course. In such knowledge-based researches, there was no difference between the students and the ordinary people, they were all measured together. Barrow et al. (1987) studied factors such as gender, school location that are affected attitudes toward energy of students in Maine and New Brunswick in their research. They found that gender is an effective factor and other factors do not have a significant effect (Barrow et al., 1987). In another research, Gambro and Switzky (1999) studied the effect of factors such as parental level of education, the number of Energy-related courses in high school and gender on students' awareness of environmental issues. Their results showed that all of these factors have a significant effect on students' awareness of energy issues (Gambro & Switzky, 1999).

In 2011, DeWaters and Powers developed an instrument for assessing the energy literacy of high school students as Energy Literacy Assessment Project. They aimed to develop a valid and reliable standard for measuring energy literacy that would meet the following criteria: In terms of language, level of comprehension and appropriateness of subjects for high school students; suitable to use in the classroom; can be completed in 30 minutes; can be easily scored; be inclusive, that is, closely related to the criteria needed to define energy concerning relevant knowledge, attitudes, intentions and behaviours (DeWaters & Powers, 2013). They used their questionnaire to assess the energy literacy levels of New York students. They found that although students being familiar with energy-related issues and problems, they have little knowledge about the energy and their role as the person whose actions and decisions are influential in this area are unknown (DeWaters &Powers, 2008; DeWaters &Powers, 2011).

After designing this questionnaire, the energy literacy levels of high school students were assessed in different countries. Many researchers also designed modified questionnaires based on DeWaters and Powers's questionnaire for assessing the energy literacy of people. In the following, we review these researches.

Lay et al. (2013), in their research assessed the energy literacy of Malaysian students using the DeWaters and Powers' Questionnaire (2011). They found the levels of energy literacy relatively low suggesting that the implemented curriculum had failed to meet the specifications of the intended curriculum which emphasizes the relevance of energy-related issues to students' everyday life experiences (Lay et al., 2013).

In research done by Chen et al (2015), they tried to improve the energy literacy questionnaire designed by DeWaters and Powers and complied a series of contextualized question items into a computer-based test. The results indicate that the energy literacy level of Taiwanese secondary school students are discouragingly low and inter-correlations between the dimensions of energy literacy levels revealed that energy knowledge and behaviour are more closely correlated than affect and behaviour (Chen & Liu, 2015).

In a research entitled" Energy literacy of vocational students in Taiwan", Lee and et al (2015) studied the energy literacy of vocational students with regard to saving and carbon-emissions reduction (ESCER) and the effects of age and academic major on energy literacy. They found (1) behaviours pertaining to ESCER among vocational high school students should be enhanced by promoting appropriate affect rather than solely by conveying knowledge; (2) female students displayed superior knowledge and affect regarding ESCER compared with male students; and (3)

students majoring in agriculture performed better than other students in terms of knowledge, affect, and behavioural aspects related to ESCER (Lee et.al, 2015).

In another research, Akitsu et al. (2017), found that female students and students who have family discussions about energy-related issues scored higher than their counterparts. Students in Fukushima scored lower than those in Tokyo and Kyoto/Nagasaki (Akitsu et al., 2017).

Sultana et al. (2017) assessed the Environmental knowledge and attitude of secondary school students of Tangail, Bangladesh. In this research, the role of factors such as parental education, teacher, media, private reading and school curriculums were examined (Sultana et al.., 2017).

Yusup and et al. assessed the pre-service physics teachers' energy literacy in six field: retrieval, comprehension, analysis, knowledge utilization, metacognition and self-system. Their findings indicate that pre-service physics teachers show their low self-system toward energy conservation. They were also still lack of metacognitive and cognitive competencies (Yusup and et al., 2017).

In the research entitled" Energy literacy survey at high schools in Northern Cyprus", Oykun and Abbasoglu (2017) evaluated the energy knowledge, behaviour and attitudes of students. The study reveals that the overall knowledge levels of the students on energy issues are very low, and an energy education program should be applied in Northern Cyprus as soon as possible (Oykun &Abbasoglu, 2017).

Recently, Martins and her colleagues (2020) study the effect of age and education on student's energy literacy. Their results about the effect of age on energy literacy show that seniors perform better than the other age groups in energy literacy and all of its dimensions, except in the behaviour dimension (Martins et al., 2020). Their result about the effect of education on energy literacy show the levels of energy literacy are moderate, but they did not find significant differences between the different education fields analyzed (Martins et al., 2019).

Gotebiowska (2020) assessed the energy literacy in households in Poland and studied the effects of age, gender, education on it. They found showed the energy literacy (measured by knowledge of energy prices, environmental effects of consumption, and knowledge about climate change) is relatively low and among the factors that affect the consumption of electricity in households in Poland, the financial ones are the most important (Gotebiowska, 2020).

Lowan-Trudeau and Flower (2021) in a research entitled" Towards a theory of critical energy literacy: The Youth Strike for climate, renewable energy and beyond" proposed critical energy literacy as an emerging theory that denotes understanding of the social, environmental, political and economic challenges, benefits and impacts of various energy sources, developments and technologies (Lowan-Trudeau and Flower ,2021).

Aim of the Research

The purpose of this study is to investigate the levels of energy literacy among 393 (9th Grade) Iranian high school students. So far, no similar research has been previously conducted in Iran, as well as the contribution of students' energy-related knowledge and attitudes on their energy-related behaviours. Here, the effect of three factors: Gender, school location, and parental level of education on students' energy literacy levels have studied. This study involving ninth- grade students in first high school was conducted with the view to address the following research questions:

Q1: What is the difference, if any, in the students' proficiency of displaying their knowledge, concern and behaviour about energy-related issues in their daily lives based on gender?

Q2: What is the difference, if any, in the students' proficiency of displaying their knowledge, concern and behaviour about energy-related issues in their daily lives based on school location?

Q3: What is the difference, if any, in the students' proficiency of displaying their knowledge, concern and behaviour about energy-related issues in their daily lives based on parents' education level?

Methodology

This study involved a non-experimental quantitative research method. Non-experimental research is a systematic empirical inquiry in which the researcher does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulable. Hence, inferences about relations among variables are made, without direct intervention, from concomitant variation of independent and dependent variables (Johnson & Christensen, 2000).

Data Collection Tool, Sampling and Data Analysis

Data Collection Tool

The modified version of the Energy Literacy Questionnaire (ELQ) was used to measure Iranian ninth-grade high school students' energy literacy in terms of cognitive, affective, and behavioural dimensions (DeWaters & Powers, 2008).

The ELQ consists of four subscales: Self-efficacy (4 items), affective (17 items), behavioural (10 items), and cognitive (30 items). The Self-efficacy subscale includes items 1 to 4. Items from 1 to 3 relate to cognitive, affective, and behavioural, and item 4 searches the source of information about the energy of students. The affective subscale used a 5point Likert-type scale ranging from 1 to 5 for the responses 'strongly disagree, disagree, not sure, agree and strongly agree'. Similarly, the behavioural subscales also used a 5-point Likert type scale ranging from 1 to 5 for the responses 'hardly ever or never, not very often, sometimes, quite frequently and almost always'.

Table 1

The Structure of Energy Literacy Questionnaire

Subscales	Item Numbers	Number of Items
Self- efficacy	1 to 4	4
Affective	5 to 21	17
Behavioural	22 to 31	10
Cognitive	31 to 61	30

The cognitive subscales used 5-option multiple-choice questions to cover eight main topic areas that encompass basic energy science concepts as well as the citizenship knowledge of energy that is crucial to everyday life, in addition to cognitive skills such as critical thinking and analysis. The topic areas include: (1) saving energy; (2) energy forms, conversions, and units; (3) home energy use; (4) basic energy concepts; (5) energy resources; (6) critical analysis about renewable resources; (7) environmental impacts; and (8) energy-related societal issues.

The Cronbach's alpha reliability coefficients obtained for the ELQ in this study are summarized in Table 2.

Table 2

Cronbach's Alpha Reliability Coefficients of the Energy Literacy Questionnaire (ELQ)

Subscales	Item Nos.	Cronbach's Alpha Reliability
Affective	5 to 21	0.70
Behavioural	22 to 31	0.74
Cognitive	31 to 61	0.74
Overall		0.82

As the results in the above table show, the internal consistency reliability scores of each subscale, as measured by Cronbach's alpha reliability coefficient, were 0.74 (cognitive subscale), 0.70 (affective subscale), and 0.74 (behavioural subscale), all satisfying generally accepted criteria for internal consistency. The overall internal consistency reliability of ELQ was 0.82.

Sampling

The participants in this study were 393 ninth-grade high school students, randomly selected by the cluster random sampling technique, from rural and urban secondary schools located in the state of Tehran in Iran. The distribution of students according to gender and school location are summarized Table 3 in below:

Table 3

Distribution of Ninth-Grade Students According to Gender and School Location

`	Gender		School location	
	Female	Male	Rural	Urban
Number of Students	173	220	68	325
Percentage	44.03	55.97	17.30	82.70

In the questionnaires, the parents' education levels of students were asked, then collected data are summarized in Table 4 below:

Table 4

Distribution of Ninth-Grade Students According to Parental Education Level

	Mother Education Level (MEL)			Father Education Level (FEL)		
	illiterate	Non-academic	academic	illiterate	Non-academic	academic
Number of students	47	300	46	52	278	62
Percentage	12	76	12	13	71	16

Data Analysis

The data were converted to numeral scores ranging from 1 to 5 for the items in the affective and behavioural subscales based on students 'responses as mentioned previously. Blank responses in these two subscales were omitted case-wise from the analysis. Items in the cognitive subscale were scored '1' if correct and '0', if incorrect.

The data were analyzed using the SPSS software package (version 16). Responses to each of the three subscales were analyzed separately: Student scores were summed across each subscale, with maximum scores of 30 on the cognitive, 85 on the affective, and 50 on the behavioural subscales. Item mean responses (ranging from 1 to 5) were calculated for the Likert-type affective and behavioural subscales. The percentage of correct responses to the items in the cognitive dimension was also computed.

Different statistical tests of SPSS software were used in order to answer the research questions. At first, we used the Kolmogorov-Smirnov (1-sample K-S) test for checking the normality of the variables, then regarding the results of the normality test and type of variables, tests were chosen for analysis. Because of ordinal variables (affective and behavioural dimension) and non-normal distribution of cognitive variable for gender, location, and parents 'level education, the Mann-Whitney U test and Kruskal Wallis H test analyses, were used to determine if there was a significant difference in the students' energy literacy based on gender, school location, and parent education level at a

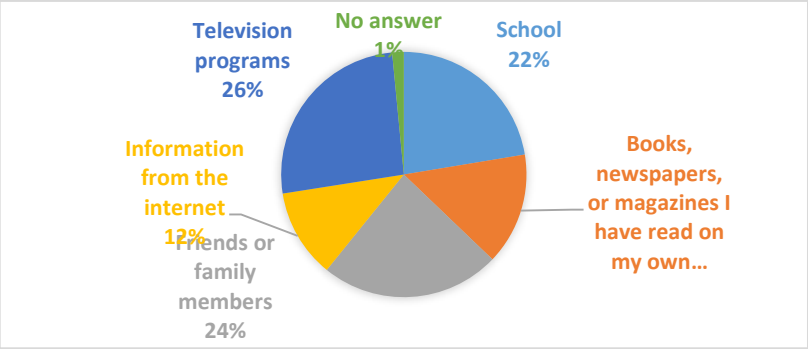
predetermined significance level of 0.05. Spearman's product-moment correlation coefficients (r) were computed to identify any significant linear relationships between the cognitive, affective, and behavioural subscales of energy literacy.

Findings and Results

The first part of the questionnaire is related to personal knowledge of the students about energy issues. The results are presented in Table 5 and Figure 1.

Figure1

Sources of Understanding of Energy Issues and Problems



The data in Figure 1 shows that most of the students believe they are somewhat informed about energy, they are medium energy user, and they talk enough to their family about the energy-saving ways. Figure 1 shows that half of the students obtain information about the energy from TV programs or friends and family members. These results show that informal education has an important role in energy education.

Table 5

Ninth-Grade Students' Responses to Self-Efficacy Questions

Questions	Answers					No Answer
How much do you feel you know about energy?	A lot-expert	Quite a bit – informed	A "medium" amount – somewhat informed	Not much – novice	Nothing – not in the running	1.3%
	6.9%	8.9%	68.7%	12.70%	1.5%	
When it comes to energy use, how would you describe yourself?	High energy user	Moderately high energy user	Medium energy user	I try to save energy sometimes	I almost always try to save energy	0.3%
	3.8%	16.8%	48.3%	22.7%	8.1%	
How often do you talk to your family about ways you can save energy in and around your home?	A lot	A fair amount	Only a little bit	I may have mentioned something once or twice	Not at all	0.8%
	19.6%	48.6%	16.3%	10.9%	3.8%	

The maximum percentage scores achieved by the students on the ELQ in descending order were as follows: behavioural subscale (76.44%), Affective subscale (75.18%), and cognitive subscale (35.29%). Students' performance in the cognitive subscale shows that they have a low understanding of the energy concepts.

Table 6

Means and Standard Deviations of Students' Energy Literacy

Subscales	Nos. of Items	Maximum Attainable Scores	% of the Maximum Attainable Scores	Mean	Standard Deviation
Cognitive	30	30	35.29	10.59	4.68
Affective	17	85	75.18	63.90	8.18
Behavioural	10	50	76.44	38.22	6.14
Overall ELQ	57	164	68.75	112.74	14.71

The overall student performance on each subscale shows that students have the lowest score on the cognitive subscale and highest on the behavioural subscale. The low score in the cognitive subscale is consistent with earlier findings from the other studies (Lay et al., 2013, DeWaters & Powers, 2011). The overall student performance shows that students are concerned about energy problems and familiar with the skills needed for energy issues, but they may have lacked the knowledge about these problems. The responses of students to energy-related knowledge, attitude, and behaviour are summarized in Table 7, 8 and 9 below:

Table 7

Percentage of Ninth-Grade Students' Responses to Energy-Related Attitude Items

No. items	Energy-Related Attitude Items	Strongly Agree	Moderately Agree	Neither agree nor disagree	Moderately Disagree	Strongly Disagree
5	Energy education should be an important part of every school's curriculum.	33.8	37.7	23.4	3.6	0.8
6	I would do more to save energy if I knew how.	46.6	37.9	10.4	2.8	1.3
7	Saving energy is important.	75.1	18.6	4.3	1.3	0.3
8	The way I personally use energy does not really make a difference to the energy problems that our nation face.	14.5	23.7	29.5	18.6	12.5
9	I don't need to worry about turning the lights or computers off in the classroom, because the school pays for the electricity.	10.4	9.4	19.3	19.8	41
10	Iranians should conserve more energy.	61.1	23.4	9.2	3.8	2.0
11	We don't have to worry about conserving energy, because new technologies will be developed in order to solve the energy problems for future generations.	6.1	10.7	18.8	26.2	37.2
12	All electrical devices should have a label that shows the resources used for making them, their energy requirements, and operating costs.	58	22.1	14.8	3.3	0.5
13	The government should have stronger restrictions about the fuel mileage of new cars.	33.8	32.3	20.9	6.4	4.8
14	We should produce more of our electricity from renewable resources.	43.5	32.1	20.6	1.5	0.8

15	Iran should develop more ways of using renewable energy, even if it means that energy will cost more.	25.7	30.3	30.5	9.4	1.8
16	Efforts to develop renewable energy technologies are more important than efforts to find and develop new sources of fossil fuels.	26.0	29.3	29.8	9.9	1.5
17	Laws protecting the natural environment should be made less strict in order to allow more energy to be produced.	9.4	18.6	30.5	16.5	21.4
18	More wind farms should be built to generate electricity, even if the wind farms are located in scenic valleys, farmlands, and wildlife areas.	16.0	26.2	27.7	14.2	14.50
19	More oil fields should be developed as they are discovered, even if they are located in areas protected by environmental laws.	7.4	18.3	27.0	17.8	27.2
20	I believe that I can contribute to solving the energy problems by making appropriate energy-related choices and actions.	30.8	34.9	24.2	5.1	1.5
21	I believe that I can contribute to solving energy problems by working with others.	35.1	37.7	19.8	2.8	2.3

Table 8

Percentage of Ninth-Grade Students' Responses to Energy-Related Behaviours Items

No. Items	Energy-Related Behaviours Items	almost always or always (%)	quite frequently	Sometimes	not very often	hardly ever or never (%)
22	I try to save water	25.2	48.1	20.1	4.6	1.0
23	I walk or ride bicycle to travel short distances, instead of asking for a ride in the car.	28.5	28.0	19.8	13.0	9.9
24	When I leave a room, I turn off the lights.	51.9	29.3	12.0	4.8	2.0
25	I turn off the computer when it is not being used.	66.2	23.2	4.6	2.8	2.5
26	Many of my everyday decisions are affected by my thoughts on energy use.	6.9	21.4	39.7	20.9	9.2
27	My family turns the heat down at night or the air conditioner temperature up when we are not home to save energy.	49.9	29.8	12.2	5.9	1.0
28	I am willing to encourage my family to turn the heat down at night or the air conditioner temperature up when we're not home to save energy.	35.9	33.1	18.1	7.1	5.1
29	My family buys energy efficient compact fluorescent light bulbs.	56.7	26.5	11.7	3.1	1.3
30	I am willing to encourage my family to buy energy efficient compact fluorescent light bulbs.	43.8	26.5	15.3	7.6	5.1
31	I am willing to buy fewer things in order to save energy.	13.5	23.4	29.3	16.5	16.3

Table 9

Percentage of Ninth-Grade Students' Responses to Energy-Related Knowledge Items

No. Items	Knowledge Section Questions	Correct Response
32	Each and every action on Earth involves..... Answer: Energy	71.50
33	The original source of energy for almost all living things on Earth is..... Answer: Sun	50.38
34	Which of the following statements best defines energy? Answer: The ability to do work	47.07
35	How do you know that a piece of wood has stored chemical potential energy? Answer: It releases heat when burned.	24.17
36	All of the following are forms of energy except..... Answer: Coal	40.71
37	The amount of electrical energy (electricity) we use is measured in units called..... Answer: Kilowatt-hours (kWh)	20.86
38	Which two things determine the amount of electrical energy (electricity) an electrical device will consume? Answer: The power rating of the device (watts or kilowatts), and the length of time it is turned on.	20.61
39	When you turn on an incandescent light bulb, some of the energy is converted into light and the rest is converted into ..... Answer: Heat	73.79
40	What does it mean if an electric power plant is 35% efficient? Answer: For every 100 units of energy that go into the plant, 35 units are converted into electrical energy.	30.53
41	It is impossible to..... Answer: Build a machine that produces more energy than it uses	29.77
42	The term "renewable energy sources" means ..... Answer: Resources that can be replenished by nature in a short period of time	33.33
43	Which of the following energy resource is not renewable? Answer: Coal	46.31
44	Which resource provides about 85% of the energy used in developed countries like Iran? Answer: Fossil fuels	37.40
45	Most of the renewable fuels used in Iran comes from ..... Answer: Water(hydro) power	11.95
46	Over the last 10 years, petroleum exports of Iran to other countries have..... Answer: Decreased and become less expensive.	11.19
47	Scientists say the single fastest and most cost-effective way to address our energy needs is to..... Answer: Promote energy conservation	16.79
48	Which is the most abundant fossil fuel found in Iran? Answer: Natural gas	18.57
49	The best reason to buy an ENERGY STAR device is..... Answer: ENERGY STAR devices use less energy	67.43
50	Some people think that if we run out of fossil fuels, we can just switch over to electric cars. What is wrong with this idea? Answer: Most electricity is currently produced from fossil fuels (coal, oil, natural gas)	30.27
51	If a person travelled alone to work 30 miles every day and wanted to save gasoline, which one of the following options would save the most gasoline? Answer: Carpooling to and from work with one other person.	17.55
52	Which of the following always leads to energy savings?	28.75

	Answer: Turning off the car engine when the car has stopped for 15 seconds or more	
53	Which uses the most energy in an average Iranian home in one year? Answer: Heating and cooling rooms	26.97
54	Which uses the least energy in an average Iranian home in one year? Answer: Heating and cooling water	22.90
55	Which of the following items uses the most electricity in an average Iranian home? Answer: Lights	31.04
56	Which resource provides most of the energy used in Iran each year? Answer: Petroleum	40.71
57	Which one of the following sources generates the most electricity in Iran? Answer: Burning natural gas	32.82
58	One advantage of using nuclear power instead of coal or petroleum for energy is that…… Answer: There is less air pollution	45.54
59	Many scientists say Earth's average temperature is increasing. They say that one important cause of this change is..... Answer: Increase in carbon dioxide concentrations via burning fossil fuels	42.74
60	Which of the following energy-related activities is least harmful to human health and the environment? Answer: Generating electricity with photovoltaic (solar) cells	20.35
61	Which of the following choices is not a biofuel? Answer: Gasoline	18.32

Students' responses to affective subscale items show that they generally acknowledge the existence of an energy problem and accept the need to conserve energy and increase the use of renewable resources. The results were found by Lay et al. (2013). Most students agreed that saving energy is important (93.7%) that Iranians should conserve more energy (84.5%) and that more of our electricity should come from renewable energy sources (75.6%). Also, they acknowledge they would do more to save energy if they knew how (84.5%). However, when the payment of electricity cost was proposed, their agreement to save energy dropped (60.8%). These answers clearly show the positive attitude of students towards energy. Despite the positive attitude of students, most of them believe in their role as an effective individual in solving energy problems: 65.7 % of students believed that they could contribute to solve the energy problems by making appropriate energy-related choices and actions, and 72.8% of them believed that they could contribute to solve energy problems by working with others.

The results in Table 8 show that students were familiar with skills which are needed to work effectively toward energy problems. A comparison of student's performance in affective and behaviour subscales (Table 7 and 8) shows that there appears to be an agreement between students' attitudes and their actions, although they lacked the needed knowledge for these attitudes and behaviours.

The Relationship between the Cognitive, Affective, and Behavioural Subscales of Energy Concepts

Correlation analysis results in Table 10 show that there are significant, positive correlations among the cognitive, affective, and behavioural subscales of energy literacy and overall energy literacy. On the other hand, all the three subscales of energy literacy were positively and significantly correlated with ninth grade students' overall energy literacy. Also, the correlation analysis shows that there are interactions between cognitive, affective, and behavioural subscales, and all of these subscales affect the overall energy literacy of students. In other words, not just content knowledge but students' attitudes, values, and behaviours may improve students' overall energy literacy. DeWaters and Powers (2011) suggest that affect and behaviour are more closely correlated than knowledge and behaviour. The findings in Table 10 support this result as well.

Table 10

Spearman's Product Moment Correlations Among Cognitive, Affective and Behavioural Subscales of Energy Literacy

	Cognitive Subscale	Affective Subscale	Behavioural Subscale	Overall Energy Literacy
Cognitive Subscale	-	0.49	0.16	0.66
Affective Subscale		-	0.41	0.83
Behavioural Subscale			-	0.68

Note. Correlation is significant at the 0.01 level ($p<0.01$)

Mean Differences Of Ninth-Grade Student's Understanding Of Energy Concepts Based On Gender

In order to compare the performance of male and female students in different subscales, Mann-Whitney U test was used because the affective and behavioural are ordinal variables and the distribution of cognitive variable based on gender does not fit to normal distribution (See Table 11).

Table 11

Normality Analysis of Ninth-Grade Students' Response Distributions Based on Gender

Subscales	Gender		Statistic	P
Cognitive	Female		0.101	<0.001
		73		
	Male		0.146	<0.001
		20		
Affective	Female		0.065	0.024
		73		
	Male		0.051	0.200
		20		
Behavioural	Female		0.095	<0.001
		73		
	Male		0.113	<0.001
		20		
Overall	Female		0.061	0.045
		73		
	Male		0.060	0.200
		20		

Note. In this table, 1-Sample K-S test was used.

Results of Mann-Whitney U test show that significance levels of the affective, behavioural and overall are less than 0.05 but significance level of the cognitive variable is upper than 0.05. These significance levels show that there is no significant difference based on gender, in ninth grade students' overall understanding of energy concepts as well as in behavioural and affective subscales. Also, there wasn't any significant difference between performance of male and female students in cognitive subscale. Generally, female students have better performance than male students (See Table 12). Female students are more concerned than male students about the conservation of energy but male students are more familiar than female students with energy-saving behaviours.

Table 12

Analysis of Ninth-Grade Students' Responses Based on Gender

Subscales	Gender	N	M	SD		P
Cognitive	Female	173	10.62	4.63		0.91
	Male	220	10.56	4.72		
					0.107	
Affective	Female	173	63.61	8.32		0.006
	Male	220	64.13	8.10	2.76	
Behavioural	Female	173	37.39	5.90		0.007
	Male	220	38.87	6.25	2.70	
Overall	Female	173	111.63	15.29		0.001
	Male	220	113.61	14.22	3.192	

Note. In this table, Mann-Whitney U test was used.

Mean Differences of Ninth-Grade Student's Understanding of Energy Concepts Based on School Location

In order to compare the performance of rural and urban students in different subscales, Mann-Whitney U test was used because the affective and behavioural are ordinal variables and the distribution of cognitive variable based on school location variable does not fit to normal distribution (See Table 13).

Table 13

Normality Analysis of Ninth-Grade Students' Response Distributions Based on School Location

Subscales	Gender	N	Statistic	P
Cognitive	Rural	68	0.116	0.025
	Urban	325	0.122	<0.001
Affective	Rural	68	0.071	0.200
	Urban	325	0.060	0.007
Behavioural	Rural	68	0.115	0.025
	Urban	325	0.101	<0.001
Overall	Rural	68	0.094	0.200
	Urban	325	0.059	0.008

Note. In this table, 1-Sample K-S test was used.

Results of the Mann-Whitney U test show that significance levels of the affective, behavioural, and overall are less than 0.05 but the significance level of the cognitive variable is upper than 0.05. These significance levels show that there is a significant difference based on school location, in the ninth-grade students' overall understanding of energy concepts as well as in behavioural and affective subscales. There wasn't any significant difference between performance of rural and urban students in cognitive subscale. Urban students had better performance in behavioural subscale and rural students had better performance in affective subscale but overall, urban students were better (see Table 14).

Table 14

Analysis of Ninth-Grade Students' Responses Based on School Location

Subscale	School Location	N	M	SD	Z	P
Cognitive	Rural	68	10.23	4.20	-0.32	0.74
	Urban	325	10.66	4.77		
Affective	Rural	68	63.51	8.58	-3.87	0.001
	Urban	325	63.99	8.10		
Behavioural	Rural	68	39.63	5.46	-2.04	0.04
	Urban	325	37.93	6.23		
Overall	Rural	68	113.38	13.47	-3.21	0.001
	Urban	325	112.60	14.99		

Note. In this table, Mann-Whitney U test was used.

Mean Differences of Ninth-Grade Student's Understanding of Energy Concepts Based on Parental Education Level

The parental education factor has been studied in two part: mother's and father's education levels. In each part, three levels of education were considered: Illiterate, nonacademic, and academic. At first, to check fitting data to normal distribution, it was used 1 sample K-S test, then regarding results of pervious step (See Table 15), data analyzed by Kruskal-Wallis H test and Mann-Whitney U test.

First, performance of the students was examined based on mother's education. Results of the Kruskal-Wallis H test showed that significance level in cognitive subscale was 0.007 which was less than 0.05 but in affective and behavioural were 0.14 and 0.44, respectively those were less than 0.05 (See Table 16). These results showed that there was a significant difference based on mother's education level in ninth-grade students only in cognitive dimension and generally, there was not any significant difference in performance of students based on mother's education level.

Because of the significant difference in cognitive subscale, Bonferroni correction test was used to compare means based on mother's education level in cognitive dimension. The results showed that mother literacy was directly related to the knowledge of students, but level of the mother's education was not significant (See Table 16).

Table 15

Normality Analysis of Ninth-Grade Students' Response Distributions Based on Mother's Education

Subscale	Mother's Education Level	N	Statistic	P
Cognitive	Illiterate	47	0.170	0.002
	Non academic	300	0.120	<0.001
	Academic	45	0.114	0.172
Affective	Illiterate	47	0.106	0.200
	Non academic	300	0.060	0.012
	Academic	45	0.123	0.073

Behavioural	Illiterate	47	0.106	0.200
	Non academic	300	0.106	<0.001
	Academic	45	0.127	0.069
Overall	Illiterate	47	0.111	0.195
	Non academic	300	0.058	0.016
	Academic	45	0.093	0.200

Note. In this table, 1-Sample K-S test was used

Table 16

Kruskal-Wallis H Test for Analysis of Ninth-Grade Students 'Responses Based on Mother's Education Level

Subscale	Mother's Education Level	N	M	SD	χ^2	P
Cognitive	Illiterate	47	8.74	4.00	10.06	0.007
	Non academic	300	10.62	4.52		
	Academic	45	12.31	5.70		
Affective	Illiterate	47	62.09	8.63	3.88	0.14
	Non academic	300	63.97	8.00		
	Academic	45	65.40	8.72		
Behavioural	Illiterate	47	37.49	6.89	1.61	0.44
	Non academic	300	38.40	6.14		
	Academic	45	37.83	5.33		
Overall	Illiterate	47	108.32	14.92	0.61	0.73
	Non academic	300	112.98	14.37		
	Academic	45	115.80	16.03		

Note. Kruskal-Wallis test was used; significant level was 0.05.

Table 17

Bonferroni Test for Analysis of Ninth-Grade Students 'Responses Based on Mother's education Level

Subscale	Mother's Education Level	N	M	SD	Z	P
Cognitive	Illiterate	47	8.74	4.00	-2.72	.006
	Non-Academic	300	10.62	4.52		
	Illiterate	47	8.74	4.00	-2.87	.004
	Academic	45	12.31	5.70		
	Academic	45	12.31	5.70	-1.32	.18
	Non academic	300	10.62	4.52		

Note. Bonferroni test was used; significant level was 0.017.

Also, in the following, the same analysis was done for the father's education. The results are shown in the below tables (See Table 18, 19) which shows that there are differences in cognitive and affective subscales but these differences are marginal and not significant differences overall. Comparing these results with mother's education level, it appears that mother literacy is more effective than father literacy in cognitive dimension.

Table 18

Normality Analysis of Ninth-Grade Students' Response Distributions Based on Father's Education

Subscale	Father's Education Level	N	Statistic	P
Cognitive	Illiterate	52	0.136	0.17
	Non academic	278	0.132	<0.001
	Academic	62	0.096	0.200
Affective	Illiterate	52	0.105	0.200
	Non academic	278	0.066	0.006
	Academic	62	0.146	0.002
Behavioural	Illiterate	52	0.113	0.092
	Non academic	278	0.100	<0.001
	Academic	62	0.155	0.001
Overall	Illiterate	52	0.108	0.182
	Non academic	278	0.049	0.099
	Academic	62	0.115	0.037

Note. In this table, 1-Sample K-S test was used

Table 19

Kruskal-Wallis Test for Analysis of Ninth-Grade Students 'Responses Based on Father's Education Level

Subscale	Father's Education Level	N	M	SD	χ^2	P
Cognitive	Illiterate	52	9.25	4.20		
	Non academic	278	10.50	4.57	.93	.01
	Academic	62	12.11	5.20		
Affective	Illiterate	52	62.44	8.86		
	Non academic	278	63.92	7.72	.15	.02
	Academic	62	65.04	9.47		
Behavioural	Illiterate	52	37.88	6.62		
	Non academic	278	38.60	6.00	.11	.12
	Academic	62	36.80	6.28		
Overall	Illiterate	52	109.58	15.53		
	Non academic	278	113.02	14.22	.99	.36
	Academic	62	114.14	16.03		

Note. Kruskal-Wallis test was used; significane level was 0.05

Because of significant differences in cognitive and affective subscales, Bonferroni correction test was used to compare means based on father's education level in both (See Table 20 and 21). The results showed that father literacy was directly related to knowledge of students, but its effect depends on father's education level; score differences in cognitive and affective subscales becomes significant when the difference in the father's education level was higher as reported in Table 20; only between two groups of students who have illiterate and academic father, there was significant difference (0.005) in cognitive performance. The results of Bonferroni correction test in affective dimension shows that having father literacy is enough for different performance in this dimension. There was a significant difference between two groups of students who have illiterate and non-academic father (0.01). In both dimensions, higher fathers' education levels improve scores, but this improvement is significant in cognitive subscale.

Table 20

Bonferroni Test for Analysis of Ninth-Grade Students 'Responses Based on Father's Education Level

Subscale	Father's Education Level	N	M	SD	Z	P
Cognitive	Illiterate	52	9.25	4.20		
	Non academic	278	10.50	4.57	1.76	.07
	Illiterate	52	9.25	4.20		
	Academic	62	12.11	5.20	2.78	.005
	Academic	62	12.11	5.20		
	Non academic	278	10.50	4.57	1.87	.06

Note. Bonferroni test was used; significance level was 0.017

Table 21

Bonferroni Test for Analysis of Affective Ninth-Grade Students 'Responses Based on Father's Education Level

Subscale	Father's Education Level	N	M	SD	Z	P
Affective	Illiterate	52	62.44	8.86		
	Non academic	278	63.92	7.72	2.52	.01
	Illiterate	52	62.44	8.86		
	Academic	62	65.04	9.47	2.33	.02
	Academic	62	65.04	9.47		
	Non academic	278	63.92	7.72	0.49	.62

Note. Bonferroni test was used; significance level was 0.017

Conclusion

The purpose of this research was to assess of Iranian ninth-grade students, for this three question were asked. With respect to the first question (What is the difference, if any, in the students' proficiency in displaying their knowledge, concern and behaviour about energy-related issues in their daily lives based on gender?), this study has shown that only in the behavioural part, the male students have better proficiency than females and in other parts they are the same. This result in behaviour part is the same as Malaysian students (Lay et al., 2013), but there isn't difference between performance of students in behaviour part in Japan, USA (Akitsu et al., 2017; DeWaters and Powers, 2011). The result in cognitive part is the same as results of research done in USA (DeWaters and Powers, 2011). Although results of researches in Cyprus, Malaysia and USA showed the difference between male and female students in effective subscale, our results don't support the mentioned results (Oykun and Abbasoglu, 2017; Lay et al., 2013; DeWaters and Powers, 2011).

With respect to the second question (What is the difference, if any, in the students' proficiency in displaying their knowledge, concern and behaviour about energy-related issues in their daily lives based on school location?), this study has shown that there isn't any difference between performance of students in various parts based on school location. This result was not in agreement with what was achieved in Malaysia and the United States (Lay et al., 2013; Barrow and Morrisey, 2016).

With respect to the third question (What is the difference, if any, in the students' proficiency in displaying their knowledge, concern and behaviour about energy-related issues in their daily lives based on parents' education?), this study has shown that parental education was an important factor

in cognitive part. This result is supported by several types of research such as ones done in USA and Japan (Akitsu et al., 2017; Gambro & Switzky, 1999).

Generally, the results from data analysis showed that Iranian ninth- grade students have good knowledge about the attitude, values and the behaviour for saving energy in everyday life. This result is supported by the results of Suryana and her/his colleagues (Suryana et al.,2019). but also these results showed that they lacked necessary knowledge for these attitudes and behaviours. It appears that the implemented curriculum has failed to meet the specifications of the intended curriculum that emphasizes relevance of energy-related issues to students' everyday life experiences. This result agrees to Lay et al. (2013) in Malaysia. Thus, a revision in the Iranian science curriculum which is based on context in energy education appears necessary. Data analysis in self-efficacy part showed that most of the students have their understanding of energy issues and problems via TV programs, friends and family members. Their performance in the cognitive subscale clearly showed the correctness of their response, and exhibited the role of informal education compared to formal education.

Table correlation (Table 10) shows the relation between affective and cognitive subscales, affective and behavioural subscales, but the table shows low correlation between cognitive and behavioural performance. The results of assessing of energy literacy of Taiwanian students showed that the behavioural subscale was more closely correlated with energy knowledge than the affective subscale (Chen and et al., 2015). Results of present study suggest that effective educational programs should target not only content knowledge, but should also strive to impact student attitudes, beliefs, and values (Lay et al., 2013). Other research showed for improving energy awareness, doing learning activities about energy can show significant effects on students' effective subscale of energy literacy (Pranda, L. N. et al., 2019)

In this research, effect of three factors (gender, school location, and parental education level) on students' skills in displaying knowledge, behaviours, and attitudes about energy-related issues were studied. None of them affected the overall performance of students, but gender affected behavioural performance, and parental education level affected cognitive performance of students. Male students were more familiar than female students with energy-saving behaviours and students whose parents were literate displayed an overall understanding of energy knowledge better than others. Mother literacy was more important than father literacy.

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Appendix

Note: questions have been updated in September 2013 with most recent data available from the U.S. Energy Information Administration.

Energy Literacy Survey
A Broad Assessment of
Energy-related Knowledge,
Attitudes and Behaviours
middle School issue

Energy Literacy Survey

The questions in this survey will ask you about what you know and think about energy issues, and about some of the personal choices you make. Please answer the questions truthfully and to the best of your ability.

Keep in mind: This is a survey, not a test. You will not get a grade, but your answers are very important because we need to understand what your whole class knows and thinks about energy. With that in mind, please do your best to answer each question as well as you can. If you don't know the answer, try to make your best guess. If you have absolutely no idea at all, skip the question and move on. Don't forget to also skip that line on the answer sheet.

Your parent/guardian has agreed to allow you to be part of this research, but you may choose whether or not you want to fill out this survey. By filling out the survey, you agree to be part of this research. Your participation is greatly appreciated!

Directions

PLEASE USE A NUMBER 2 OR SOFT LEAD PENCIL

You should have received this survey booklet and an answer sheet for recording your answers. Please put all your answers on the answer sheet; do not mark in the test booklet. On side 2 of the answer sheet, record your name in the space provided, last name followed by first name. Next, mark your sex (male/female) and birth date (year and month only). Fill in the circle that corresponds to your current grade level where it says "grade or education."

Under "identification number" copy the 9 digits provided by your teacher, and fill in the appropriate circles. Begin recording your answers on side 1. It is important to fill in the answer sheet carefully using the number 2 pencil. Choose the **one best** answer for each question, and fill in the corresponding circle on the answer sheet. If you change your answer, be sure to completely erase your first answer. Do not make any stray marks outside the circles. Keep in mind that there is ***only one answer for each question***.

Sample:

100. How many feet are there in a mile?
A. 1760
B. 4840
C. 5280
D. 6460
E. Don't know

Response on the answer sheet:

A B C D E
100.
Fill in the circle for your answer completely!
There are four sections in the survey. Each section is different, so please read the directions carefully before starting each section. Complete the entire survey – you do not need to stop between sections. Feel free to ask questions of your teacher at any time.
Thank You

Section I. Fill in the circle on your answer sheet for the letter of the answer that best indicates your response to the following questions. Be honest, remember - this is not a test!

1. How much do you feel you know about energy? (rate yourself as "expert" to "novice" or less, as described below)
A. A lot – expert
B. Quite a bit – informed
C. A "medium" amount – somewhat informed
D. Not much – novice
E. Nothing – not in the running
2. When it comes to energy use, how would you describe yourself?
A. High energy user
B. Moderately high energy user
C. Medium energy user
D. I try to save energy sometimes
E. I almost always try to save energy

3. Of the following choices, which **one** thing has contributed **most** to your understanding of energy issues and problems?
A. School
B. Books, newspapers, or magazines I have read on my own
C. Friends or family members (including parents)
D. Information from the internet
E. Television programs
4. How often do you talk to your family about ways you can save energy in and around your home? (for example, shutting off lights when they are not in use, turning down the heat, closing doors and windows)
A. A lot
B. A fair amount
C. Only a little bit
D. I may have mentioned something once or twice
E. Not at all

Section II. Please indicate **how you feel** about each statement below. There are no right or wrong answers. Read each statement carefully, then fill in the circle on your answer sheet for the letter that best describes how much you agree or disagree, using the following key:

"A" represents "strongly agree"
"B" represents "agree moderately"
"C" represents "neither agree nor disagree"
"D" represents "disagree moderately"

"E" represents "strongly disagree"

5. Energy education should be an important part of every school's curriculum.
6. I would do more to save energy if I knew how.
7. Saving energy is important.
8. The way I personally use energy does not really make a difference to the energy problems that face our nation.
9. I don't need to worry about turning the lights or computers off in the classroom, because the school pays for the electricity.
10. Iranians should conserve more energy.
11. We don't have to worry about conserving energy, because new technologies will be developed to solve the energy problems for future generations.
12. All electrical appliances should have a label that shows the resources used in making them, their energy requirements, and operating costs.
13. The government should have stronger restrictions about the gas mileage of new cars.
14. We should make more of our electricity from renewable resources.
15. Iran should develop more ways of using renewable energy, even if it means that energy will cost more.
16. Efforts to develop renewable energy technologies are more important than efforts to find and develop new sources of fossil fuels.
17. Laws protecting the natural environment should be made less strict in order to allow more energy to be produced.
18. More wind farms should be built to generate electricity, even if the wind farms are located in farmlands, and wildlife areas.
19. More oil fields should be developed as they are discovered, even if they are located in areas protected by environmental laws.

Section II, continued

"A" represents "strongly agree"
"B" represents "agree moderately"
"C" represents "neither agree nor disagree"
"D" represents "disagree moderately"
"E" represents "strongly disagree"
20. I believe that I can contribute to solving the energy problems by making appropriate energy-related choices and actions.
21. I believe that I can contribute to solving energy problems by working with others.

Section III. For the following statements, please select the choice that **best describes your behaviour**. Be honest, there are no right or wrong answers. Read each statement carefully, then fill in the circle on your answer sheet for the letter that best describes how much you agree or disagree, using the following key:
"A" represents "almost always" or "always"
"B" represents "quite frequently"
"C" represents "sometimes"
"D" represents "not very often"
"E" represents "hardly ever" or "never"
22. I try to save water.
23. I walk or bike to go short distances, instead of asking for a ride in the car.
24. When I leave a room, I turn off the lights.
25. I turn off the computer when it is not being used.

26. Many of my everyday decisions are affected by my thoughts on energy use.
27. My family turns the heat down at night or the air conditioner temperature up when we are not home to save energy.
28. I am willing to encourage my family to turn the heat down at night or the air conditioner temperature up when we're not home to save energy.
29. My family buys energy efficient compact fluorescent light bulbs.
30. I am willing to encourage my family to buy energy efficient compact fluorescent light bulbs.
31. I am willing to buy fewer things in order to save energy.

Section IV. For each of the following questions, choose the **one best** answer. Fill in the circle for the letter of the answer on your answer sheet.
32. Each and every action on Earth involves…
A. Food
B. Energy
C. Sun
D. Water
E. Motion
33. The original source of energy for almost all living things on earth is…
A. Sun
B. Water
C. Soil
D. Plant life
E. Wind
34. Which of the following statements best **DEFINES** energy?
A. A force that moves something
B. Potential and kinetic
C. The rate at which work is done
D. The ability to do work
E. Fossil fuels
35. How do you know that a piece of wood has stored chemical potential energy?
A. It can be converted into other things such as paper and furniture
B. It is a stationary object
C. It releases heat when burned
D. It was once a living thing
E. Wood does not have stored potential energy
36. All of the following are forms of energy **EXCEPT**…
A. Chemical
B. Heat
C. Mechanical
D. Electromagnetic
E. Coal
37. The amount of ELECTRICAL ENERGY (ELECTRICITY) we use is measured in units called…
A. Kilowatt-hours (kWh)
B. Kilowatts (kW)
C. British Thermal Units (BTU)
D. Volts (V)
E. Horsepower (HP)
38. *Which two* things determine the amount of ELECTRICAL ENERGY (ELECTRICITY) an electrical appliance will consume?
A. The size of the appliance (liters or gallons), and the cost of electricity
B. The temperature of the appliance when it is turned on, and the length of time it is turned on

C. The power rating of the appliance (watts or kilowatts), and the cost of electricity
D. The power rating of the appliance (watts or kilowatts), and the length of time it is turned on
E. The power rating of the appliance (watts or kilowatts), and the size of the electric outlet
39. When you turn on an incandescent light bulb, some of the energy is converted into light and the rest is converted into…
A. Glare
B. Freon
C. Heat
D. Space
E. Electrons
40. What does it mean if an electric power plant is 35% efficient?
A. For every $100 invested in the production of energy, $35 is made into profit
B. For every $35 invested in the production of energy, $100 is made into profit
C. For every 100 units of energy that go into the plant, 35 units are lost during energy transformations
D. For every 35 units of energy that go into the plant, 100 units of electrical energy are produced
E. For every 100 units of energy that go into the plant, 35 units are converted into electrical Energy
41. It is impossible to…
A. Convert chemical energy to heat energy
B. Measure the amount of energy in foods
C. Build a machine that produces more energy than it uses
D. Use ethanol to power an automobile
E. Save energy by reducing, reusing, and recycling products
42. The term "renewable energy resources" means …
A. Resources that are free and convenient to use
B. Resources that can be converted directly into heat and electricity
C. Resources that do not produce air pollution
D. Resources that are very efficient to use for producing energy
E. Resources that can be replenished by nature in a short period of time
43. Which of the following energy resources is **NOT** renewable?
A. Solar
B. Coal
C. Biomass (wood, waste, plants, alcohol fuels)
D. Water (hydro) power
E. Geothermal
44. Which resource provides about 85% of the energy used in developed countries?
A. Biomass (wood, waste, plants, alcohol fuels)
B. Water (hydro) power
C. Nuclear
D. Wind
E. Fossil fuels
45. Most of the RENEWABLE ENERGY used in the Iran comes from …
A. Solar
B. Water (hydro) power
C. Wind
D. Biomass (wood, waste, plants, alcohol fuels)
E. Geothermal
46. Compared to 2000, petroleum imports to Iran from other countries in 2011 have ……
A. Increased and become less expensive
B. Increased and become more expensive
C. Decreased and become less expensive

D. Decreased and become more expensive
E. Increased but stayed the same price
47. Scientists say the single fastest and most cost-effective way to address our energy needs is to…
A. Develop all possible domestic sources of oil and gas
B. Build nuclear power plants
C. Promote energy conservation
D. Develop more power plants that use renewable energy sources
E. Develop alternative fuel vehicles
48. Which is the most abundant fossil fuel found in the Iran?
A. Coal
B. Natural gas
C. Crude oil (petroleum)
D. Tar sands
E. Wood
49. The best reason to buy an ENERGY STAR® appliance is …
A. ENERGY STAR appliances are usually bigger
B. ENERGY STAR appliances cost more
C. ENERGY STAR appliances use less energy
D. ENERGY STAR appliances are more modern looking
E. ENERGY STAR appliances cost less
50. Some people think that if we run out of fossil fuels we can just switch over to electric cars. What is wrong with this idea?
A. Most electricity is currently produced from fossil fuels (coal, oil, natural gas)
B. Switching to electric cars will make unemployment rates go up
C. It has been proven that it is impossible to build electric cars in great quantities
D. You can't use electricity to operate a car
E. There is nothing wrong with this idea
51. If a person travelled alone to work 30 miles every day and wanted to save gasoline, which one of the following options would save the **MOST** gasoline?
A. Buying a car that gets 30 miles per gallon rather than one that gets 20 miles per gallon
B. Driving 55 miles per hour rather than 65 miles per hour
C. Driving 45 miles per hour rather than 65 miles per hour
D. Carpooling to and from work with one other person
E. All would save about the same amount of gasoline
52. Which of the following choices **ALWAYS SAVES** energy?
A. Using portable electric heaters for added space heat in oil or gas heated homes
B. Buying a more fuel-efficient car and driving that instead of riding the bus
C. Leaving fluorescent lights on instead of turning off for a short period when not in use
D. Using your computer's screen saver in between use
E. Turning off the car engine when the car is stopped for 15 seconds or more
53. Which uses the **MOST ENERGY** in the average Iranian home in one year?
A. Refrigerating food and beverages
B. Heating and cooling rooms
C. Heating and cooling water
D. Lighting the home
E. Cooking and preparing food
54. Which uses the **LEAST ENERGY** in the average Iranian home in one year?
A. Refrigerating food and beverages
B. Heating and cooling rooms
C. Heating and cooling water
D. Lighting the home

E. Cooking and preparing food

55. Which of the following items uses the **MOST ELECTRICITY** in the average Iranian home in one year?

A. Refrigerator
B. Lights
C. Telephone
D. Television
E. Computer

56. Which resource provides **MOST** of the **ENERGY** used in the Iran each year?

A. Petroleum
B. Coal
C. Natural gas
D. Water (hydro) power
E. Nuclear energy

57. Which one of the following sources generates the most **ELECTRICITY** in the Iran?

A. Burning petroleum
B. Burning coal
C. Nuclear power
D. Solar energy
E. Water (hydro) power

58. One advantage to using nuclear power instead of coal or petroleum for energy is that…

A. Nuclear power plants are not expensive to build
B. There is less air pollution
C. It is totally safe
D. The waste products are easy to store
E. Nobody objects to building new nuclear power plants

59. Many scientists say the Earth's average temperature is increasing. They say that one important cause of this change is…

A. Acid rain
B. Rising ocean levels
C. The sun is moving closer to the earth
D. Increasing carbon dioxide concentrations from burning fossil fuels
E. Increasing carbon dioxide concentrations from nuclear power plants

60. Which of the following energy-related activities is **LEAST** harmful to human health and the environment?

A. Coal mining
B. Petroleum exploration and transportation
C. Burning fossil fuels to produce electricity
D. Manufacturing photovoltaic (solar) cells for generating electricity
E. Generating electricity with photovoltaic (solar) cells

61. Which of the following choices is **NOT** a biofuel?

A. Ethanol
B. Diesel fuel made from vegetable oil
C. Vegetable oil
D. Gasoline
E. Methane captured from decaying cow manure

END – Thank You