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A Research on the Energy Literacy of Middle School Students

Ayşegül KAYA[1] **Süleyman AKÇAY** [2]

Abstract

The general purpose of this research is to examine the energy literacy status of secondary school students. In particular, the change in the energy literacy of secondary school students according to some independent variables was examined. Survey research technique, which is one of the quantitative research methods, was used in the research. Research data were collected in the fall semester of the 2020-2021 academic year. The universe of the research consisted of private and public secondary schools located within the borders of Isparta province in the Mediterranean region of Turkey. Data were collected from 1182 students studying in 7th and 8th grades, determined by convenient sampling method from these schools. The "Energy Literacy Scale" developed by DeWaters, Qagish, Graham, and Powers (2013) and adapted into Turkish by Güven, Yakar, and Sülün (2019) was used in the research. Due to the Covid 19 epidemic, the data was collected in the digital environment. As a result of the research, it was determined that the students were partially low energy literate in the affective sub-dimension and partially high-energy literate in the behavioural sub-dimension. If we look at the energy literacy of the students according to the determined independent variables: the energy literacy of the students studying in public secondary school is significantly higher than those studying in private secondary school. The energy literacy levels of the students in the schools located in the district centre are significantly higher than those in the city centre. The energy literacy levels of those whose father's education level is primary, secondary and high school graduates are significantly higher than those with a master's/doctorate degree. Finally, it can be suggested that science curriculum should be updated to increase energy literacy and that inquiry-based in-class and out-of-class activities should be encouraged in textbooks.

Keywords: Science Education, Energy Literacy, Middle School Students, Energy Education.

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[1] Master's degree, Mustafa Sökmen Secondary School, Isparta, Türkiye, aysgulky@gmail.com, ORCID: 0000-0003-3754-8320

[2] Assoc. Prof. Dr., Süleyman Demirel University, Faculty of Education, Department of Mathematics and Science Education, Isparta, Türkiye, suleyman.akcay@gmail.com, ORCID: 0000-0002-0651-6425

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2023, 12 (5), 2579-2602 | Araştırma Makalesi

Ortaokul Öğrencilerinin Enerji Okuryazarlıkları Üzerine Bir Araştırma

Ayşegül KAYA[1] **Süleyman AKÇAY** [2]

Öz

Bu araştırmanın genel amacı ortaokul öğrencilerinin enerji okuryazarlık durumlarını incelemektir. Özelde ise ortaokul öğrencilerinin enerji okuryazarlıklarının bazı bağımsız değişkenlere göre değişimi incelenmiştir. Araştırmada nicel araştırma yöntemlerinden biri olan tarama araştırması tekniği kullanılmıştır. Araştırma verileri 2020-2021 eğitim-öğretim yılı güz döneminde toplanmıştır. Araştırmanın evrenini Türkiye'nin Akdeniz bölgesinde Isparta ili sınırları içerisinde bulunan özel ve resmi ortaokullar oluşturmuştur. Bu okullardan uygun örnekleme yöntemi ile belirlenen 7. ve 8. sınıflarda öğrenim gören 1182 öğrenciden veri toplanmıştır. Araştırmada DeWaters, Qagish, Graham ve Powers (2013) tarafından geliştirilen ve Güven, Yakar ve Sülün (2019) tarafından Türkçeye uyarlanan "Enerji Okuryazarlığı Ölçeği" kullanılmıştır. İçerisinden geçilen Covid 19 salgını dolayısıyla dijital ortamda veriler toplanmıştır. Bunun için ilk önce belirlenen bağımsız değişkenleri içeren kişisel bilgi formu ve enerji okuryazarlığı ölçeği, Google formları aracılığıyla çevrimiçi ölçeğe dönüştürülmüştür. Etik kurul izinleri ve gerekli uygulama izinleri alındıktan sonra Google formunda oluşturulan anket linki kısaltılmıştır. Ölçek linki ve izin belgeleri dijital ortamda paylaşılmıştır. Veriler gönüllülük esasına göre toplanmıştır. Araştırma sonucu öğrencilerin duyuşsal alt boyutta kısmen düşük, davranışsal alt boyutta ise kısmen yüksek enerji okuryazarı oldukları belirlenmiştir. Belirlenen bağımsız değişkenlere göre öğrencilerin enerji okuryazarlıklarına bakacak olursak: devlet ortaokulunda öğrenim gören öğrencilerin enerji okuryazarlığı özel ortaokulda öğrenim görenlerden anlamlı biçimde daha yüksektir. İlçe merkezinde bulunan okullardaki öğrencilerin enerji okuryazarlık düzeyleri il merkezinde olanlara göre anlamlı biçimde daha yüksektir. Baba eğitim durumu ilkokul, ortaokul ve lise mezunu olanların enerji okuryazarlık düzeyleri, yüksek lisans/doktora mezunu olanlara göre anlamlı biçimde daha yüksektir. Son olarak, fen öğretim programlarının enerji okuryazarlığını artırmaya dönük güncellenmesi ve sorgulamaya dayalı sınıf içi ve dışı etkinliklerin ders kitaplarında özendirilmesi öneri olarak sunulabilir.

Anahtar Kelimeler: Fen Eğitimi, Enerji Okuryazarlığı, Ortaokul Öğrencileri, Enerji Eğitimi.

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[1] Yüksek lisans mezunu, Mustafa Sökmen Ortaokulu, Isparta, Türkiye, aysgulky@gmail.com, ORCID: 0000-0003-3754-8320

[2] Doç. Dr., Süleyman Demirel Üniversitesi, Eğitim Fakültesi, Matematik ve Fen Bilimleri Eğitimi Bölümü, Isparta, Türkiye, suleyman.akcay@gmail.com , ORCID: 0000-0002-0651-6425

Introduction

Energy is essential for human activities. It is the main source for the development and welfare of societies to increase. Today, people's demands and needs are getting more day by day. More energy sources are used to deal with all these demands and needs. Even today, the most important energy sources in the world and in our country are fossil-based sources (Kaya, Şenel and Koç, 2018). This brings with it environmental problems such as depletion of limited resources, global warming, climate change, drought and acid rain. At the top of these environmental problems is the problem of waste caused by non-renewable energy sources used to meet the increasing energy supply (Akitsu, 2015). Fossil-based and nuclear energy sources are called non-renewable energy sources. These resources are not sustainable due to both the damage they cause to the environment and the limited lifespan for usage. In this context, especially developed societies focus on using renewable energy resources efficiently and extensively (Kaya et al., 2018). Conversion to renewable energy is considered indispensable for a sustainable environment and economy (Yıldırım et al., 2019). On the other hand, only energy literate individuals can trigger countries' thoughts on this issue (Çakırlar, 2015).

Curriculums are generally shaped in line with the needs of societies and individuals in particular. Science curricula have been updated more rapidly today than in the past. Concepts such as science literacy, technology literacy, environmental literacy and energy literacy have emerged in today's curriculum. In addition, with the increasing importance of energy in today's life, the concept of energy literacy becomes more prominent among the concepts mentioned above (Çepni and Çil, 2016; DeWaters et al., 2007; Jin and Anderson, 2012).

An energy literate individual should have a broad knowledge of energy production, storage, transfer, consumption, saving and obtaining energy resources. In addition to understanding energy problems and offering solutions, they should also understand other concepts of Science (Güven et al., 2019). Energy literate individuals are able to use energy appropriately and are aware of its impact on society. An energy literate individual acts with this awareness in all areas related to energy in his daily life (DeWaters and Powers, 2011).

In the globalizing world, energy problems are increasing day by day. Each and every individual’s contribution in the solution of these problems is a must for the sustainability of the solution. Thus, the world can become more liveable. If it is not aimed to raise individuals who are conscious of environmental problems such as the reduction of fossil fuel reserves, global warming, climate change and depletion of the ozone layer, it is possible to face bigger problems in the future (Çetingöz-Akbay, 2012).

Energy has a critical importance in increasing population, industrialization and meeting increasing demands. It is very important to eliminate economic dependence on foreign energy needs, to reduce the damage to the environment, and to be economical while using resources. For this reason, it is necessary for future generations to be conscious consumers with high awareness and to acquire and display the right attitudes and behaviours (Cirit-Karakaya, 2017). The efficiency of energy education in schools is the most important step in the development of a positive attitude in society (Owens and Driffill, 2008).

Since energy is effective in all areas of life such as industry, transportation, lighting and nutrition, many studies have been carried out in the national and international areas (e.g.

Ayata, 2021; Bodzin et al., 2013; Chen et al., 2015; Takaoğlu-Başkan, 2018; Töman and Odabaşı- Çimer, 2013; Uğraş et al., 2017; Yıldırır et al., 2020). The number of studies on energy literacy at the national level is limited (Ayata, 2021; Boz, 2020; Göcük, 2015; Oluk et al., 2019). This is an important factor that contributes to the originality to the research. In addition, determining the affective and behavioural levels of students about energy adds originality to the research as it provides an opinion about how the current curriculum on energy contributes to education.

The Aim Study

The aim of this research was to determine the energy literacy levels of middle school students and to reveal the effects of demographic variables on the affective and behavioural sub-dimensions that make up energy literacy. For this purpose, the research questions were determined as follows.

Energy literacy levels of middle school students:

1. Does it differ significantly by gender?

2. Does it differ significantly by school type?

3. Does it show a significant difference according to grade level?

4. Does it show a significant difference according to the residential area of the school?

5. Does it show a significant difference according to education level of the mother?

6. Does it show a significant difference according to the mother's occupation?

7. Does it show a significant difference according to education level of the father?

8. Does it show a significant difference according to the father's occupation?

9. Does it show a significant difference according to the level of family income?

10. Does it show a significant difference according to the residence of the student (at least five years)?

11. Does it show a significant difference according to whether the student or his/her family follows a magazine about energy or not?

12. Does it show a significant difference according to whether or not there is a broadcast about the environment that individuals follow on social media, internet or television?

13. Does it show a significant difference according to whether the students find the energy education given at school sufficient or not?

Method

Research Model

In the study, the energy literacy levels of middle school students (7th and 8th grades) were determined using the survey model. The survey model is a research approach with predetermined data collection tools to collect information from a large population (Büyüköztürk et al., 2011).

Sample

The study was carried out in middle schools located in the province of Isparta. According to the data of the Ministry of National Education, 7672 students completed middle education at the end of 2020 within the borders of Isparta province (MoNE, 2021). The research was carried out with a sample selected from the universe consisting of these students. Reaching at least 610-622 students with a tolerance of 1% was considered sufficient for the representation of the population (Cohen et al., 2007, p. 104). As a result, data were collected from 1182 middle school students.

Data Collection Tool

"Energy Literacy Scale" developed by DeWaters et al. (2013) was adapted into Turkish by Güven et al. (2019). The original scale consists of three dimensions. These dimensions are cognitive (30 items), affective (17 items), and behavioural (10 items), respectively. The scale is a 5-point Likert type scale. In the affective dimension, responses that can be given to the scale are respectively as "strongly disagree=1, partially disagree=2, neither agree nor disagree=3, partially agree=4, strongly agree=5". The options for the answers given to the statements measuring the behavioural dimension are: "Never=1, Rarely=2, Sometimes=3, Often=4, Always=5". The Cronbach Alpha coefficient of the whole scale was determined as 0.83 (Güven et al., 2019). In this study, it was determined as 0.77.

The original scale consists of 57 items and three dimensions. However, it was thought that it would be difficult for the participant students to answer 57 items or they might hesitate to complete the scales that were too long. Therefore, only the affective and behavioural dimensions of the scale were used in the study. Güven et al. (2019) found the Cronbach Alpha coefficient of the scale to be 0.76 for the affective dimension and 0.82 for the behavioural dimension. In this study, the Cronbach Alpha coefficient was found to be 0.72 for the affective dimension and 0.78 for the behavioural dimension.

A 60-minute-long meeting was held with a faculty member who is an expert in science education, two science teachers who are doing a master's degree in science education, and two graduate students for the creation of the personal information form. As a result of this meeting, a personal information form consisting of 13 questions was created.

Data Collection and Analysis

Research data were obtained by the "energy literacy scale" developed by DeWaters et al. (2013) and adapted into Turkish by Güven et al. (2019) and the personal information form. Due to the Covid 19 epidemic, the data was collected in the digital environment. The energy literacy scale was converted to an online scale through Google forms. In addition, Süleyman Demirel University (SDU) Ethics Committee approval was obtained. In order to apply the energy literacy scale, necessary permissions were obtained from the Isparta Provincial Directorate of National Education. The survey link created in the Google form has been shortened. Data were collected by sharing the scale link and permission documents in digital media. In this process, the link of the scale was shared with the help of administrators and teachers in schools accessible by the researcher and via WhatsApp groups. Data were collected on a voluntary basis. Data were obtained from 1191 secondary school (7th and 8th grade) students. In order to increase validity and reliability, nine of the surveys were removed from the research data because they had the same answer to at least ten consecutive scale items. As a result, the research was conducted on 1182 data. Obtained data were analysed with statistical program. Skewness or kurtosis

values were used to determine whether the data showed a normal distribution. George and Mallery (2010) state that if one of the skewness or kurtosis values stays between ±2 limits, it is accepted as a normal distribution. Independent sample t-test and ANOVA tests were performed for the analysis of normally distributed data. Scheffe test results were examined in order to understand the reason for the difference between the groups.

Ethical Statement

This study was conducted with the permission of Social and Human Sciences Ethics Committee of SDU dated 14/10/2020 issued 97/9.

Results

In this section, the findings and comments that emerged as a result of the evaluation of the research problem and its sub-problems are included. The findings obtained as a result of the analysis of the data are presented under the sub-problems as a table.

Table 1. Distribution of students according to demographic variables

Demographic Variables	Variety	N	%
1. Gender	Female	702	59.4
	Male	480	40.6
	Total	1182	100.0
2. School type	Public School (1)	1077	91.1
	Private School (2)	105	8.9
	Total	1182	100.0
3. Residential area of school	Provincial Centre (1)	843	71.3
	District Centre (2)	252	21.3
	Village (3)	87	7.4
	Total	1182	100.0
4. Grade level	7th grade (1)	681	57.6
	8thgrade (2)	501	42.4
	Total	1182	100.0
5. Mother's educational level	Illiterate (1)	22	1.9
	Primary school (2)	298	25.2
	Middle school (3)	182	15.4
	High school (4)	361	30.5
	University (5)	271	22.9
	Master's/PhD (6)	48	4.1
	Total	1182	100.0

6. Mother's occupation	Housewife (1)	834	70.6
	Farmer (2)	9	0.8
	Worker (3)	101	8.5
	Public-servant (4)	192	16.2
	Tradespeople (5)	27	2.3
	Other (6)	19	1.6
	Total	1182	100.0
7. Father's educational level	Illiterate (1)	6	0.5
	Primary school (2)	208	17.5
	Middle school (3)	164	13.9
	High school (4)	385	32.6
	University (5)	327	27.7
	Master's/PhD (6)	92	7.8
	Total	1182	100.0
8. Father's occupation	Illiterate (1)	1182	100.0
	Farmer (2)	1	0.1
	Worker (3)	78	6.6
	Public-servant (4)	444	37.6
	Tradespeople (5)	377	31.9
	Other (6)	282	23.8
	Total	1182	100.0
9. The residential area of the student (at least five years) (Minimum 5 years)	Village-Town (1)	23	1.9
	District (2)	226	19.2
	City (3)	933	78.9
	Total	1182	100.0
10. Family income	0-2000tl (1)	264	22.3
	2001tl -4000tl (2)	410	34.7
	4001tl -6000tl (3)	247	20.9
	6001tl-8000tl (4)	110	9.3
	More than 8001tl (5)	151	12.8
	Total	1182	100.0
	Yes (1)	60	5.1

11. Whether any of the students or families follow an energy-related magazine.	No (2)	1122	94.9
	Total	1182	100.0
12. Whether or not an energy-related broadcast is followed from social media, the Internet or television.	Yes (1)	169	14.3
	No (2)	1013	85.7
	Total	1182	100.0
13. Whether he/she finds the energy education given at school sufficient	Yes (1)	614	51.9
	No (2)	568	48.1
	Total	1182	100.0

When the distribution of the students according to the demographic variables is examined, 59.4% of the 1182-person research group were girls and 40.6% of them were boys. According to the type of school, 91.1% were educated in public schools and 8.9% were educated in private schools. According to the settlement of the school, 71.3% of the participants (843) got education in the city centre, 21.3% of them got education in the district centre and 7.4% of them get education in the village middle school. In terms of class variable, it is seen that the rate of the students attending at the 7th grade is 57.6% (681) and 42.4% at the 8th grade level.

Tests were conducted to show whether the total scores obtained from the energy literacy scale and its sub-dimensions were normally distributed. Obtaining skewness or kurtosis values within the range of ±2 indicates normality (George and Mallery, 2010). Especially the fact that the skewness value is between ±1 values is an indication of the normal distribution (Büyüköztürk, 2012: 40). In normality tests, skewness or kurtosis was determined as a criterion. The results are given in Table 2.

Table 2. Normality results of energy literacy scale scores

Sub-dimensions	**$\bar{X}$**	**Median**	**Skewness**	**Kurtosis**
Affective Sub-dimension	58.55	59.00	-0.94	3.56
Behavioural Sub-dimension	38.66	39.00	-0.45	-0.12
Energy Literacy	97.22	98.00	-0.4	1.15

When Table 2 is examined, it is seen that the arithmetic mean value in the affective sub-dimension was 58.55, the median value was 59.00, the skewness value was -0.94, and the kurtosis value was 3.56. In the behavioural sub-dimension, the arithmetic mean value was 38.66, the median value was 39.00, the skewness value was -0.45, and the kurtosis value was -0.12. In the energy literacy scale, the arithmetic mean value is 97.22, the median value is 98.00, the skewness value is -0.4, and the kurtosis value is 1.15. George and Mallery (2010) state that if one of the skewness or kurtosis values stays between ±2 limits, it is accepted as a normal distribution. Parametric tests were applied due to the normal distribution of the data.

Table 3. Reliability test of the energy literacy scale

Reliability coefficients	Cronbach's Alpha	Number of items
Affective Sub-dimension	0.72	17
Behavioral Sub-dimension	0.78	10
Energy Literacy	0.77	27

When the energy literacy scale was examined, it was seen that the Cronbach's alpha value was 0.72 for the affective sub-dimension, 0.78 for the behavioural sub-dimension, and 0.77 for the energy literacy scale. Cronbach's alpha value above 0.70 indicates that it is a reliable scale (Büyüköztürk, 2012).

What are the Energy Literacy Levels of Middle School (7th and 8th Grade) Students?

Table 4. Descriptive statistics of the energy literacy scale

Sub-dimensions	N	$\bar{X}$	Median	Min	Max	Standard Deviation
Affective Sub-dimension	1182	58.55	59.00	17.00	85.00	7.95
Behavioural Sub-dimension	1182	38.66	39.00	10.00	50.00	6.68
Energy Literacy	1182	97.22	98.00	27.00	135.00	11.47

According to Table 4, the mean score of the affective sub-dimension of the energy literacy scale is $\bar{X}$=58.55. Güven et al., (2019) stated that the minimum score that can be obtained from this sub-dimension in the scale is $\bar{X}$=17.00, and the maximum is $\bar{X}$=85.00. The mean score of the students in the affective dimension is lower than the arithmetic mean ($\bar{X}$=59.50). In this sense, the energy literacy of the participants can be considered partially low.

Findings of Comparison of Energy Literacy Levels with Demographic Characteristics

In this part of the study, the findings that emerged as a result of the comparison of energy literacy levels with demographic characteristics are included.

The first sub-problem of the study

Table 5. Independent sample t-test results for gender

Sub-dimensions	Gender	N	$\bar{X}$	SD	t	df	p
Affective	Female	702	58.92	7.54	1.93	1180	0.06
	Male	480	58.02	8.50			
Behavioural	Female	702	38.70	6.57	0.24	1180	0.81
	Male	480	38.61	6.86			
Energy Literacy	Female	702	97.63	11.15	1.48	1180	0.15
	Male	480	96.62	1.91			

*p<0.05

When Table 5 is examined, no significant difference was found between the students' energy literacy levels and the two sub-dimensions according to the gender variable [t(1180)=1.93, p=0.06, 0.05<p], [t(1180)=0.24, p=0.81, 0.05< p], [t(1180)=1.48, p=0.15, 0.05<p]. This result shows that there is no significant difference between male and female students in terms of energy literacy levels.

The second sub-problem of the study

Table 6. Independent sample t-test results for school type

Sub-dimensions	School type	N	$\bar{X}$	SD	t	df	p
Affective	Public School	1077	58.57	8.16	0.34	1180	0.73
	Private School	105	58.37	5.44			
Behavioural	Public School	1077	38.98	6.64	5.33	1180	0.00*
	Private School	105	35.38	6.22			
Energy Literacy	Public School	1077	97.56	11.66	4.22	1180	0.00*
	Private School	105	93.62	8.50			

*p<0.05

When Table 6 is examined, a significant difference was found between the energy literacy levels of the students according to the type of school they attended [t(1180)=4.22, p=0.00, 0.05<p]. The energy literacy levels of the students studying in the public school ($\bar{X}$=97.63) are higher than the energy literacy levels of the students studying in the private schools ($\bar{X}$=96.62). In terms of affective sub-dimension, no significant difference was measured according to the type of school they attended [t(1180)=0.34, p=0.73, 0.05<p]. A significant difference was found in the behavioural sub-dimension according to the type of school the students attended [t(1180)=5.33, p=0.00, p<0.05]. Behavioural levels of students studying in public school ($\bar{X}$=38.98) are higher than students studying in private schools ($\bar{X}$=35.38).

The third sub-problem of the study

Table 7. ANOVA test results for the settlements where the schools are located

Sub-dimensions	The residential area of the school	Sum of Squares	df	Mean of squares	F	p	Sig.
Affective	Between Groups	199.64	2	99.82	1.58	0.21	
	In-group	74504.29	1179	63.19			
	Total	74703.93	1181				
Behavioural	Between Groups	869.88	2	434.94	9.88	0.00*	1<2 1<3
	In-group	51903.45	1179	44.02			
	Total	52773.33	1181				
Energy Literacy	Between Groups	1773.65	2	886.83	6.81	0.01*	1<2 1<3
	In-group	153533.16	1179	130.22			
	Total	155306.81	1181				

*p<0.05

When Table 7 is examined, it is seen that there is a significant difference between the energy literacy levels of the students according to the residential area of the school [F(2-1179)=6.81; η2=0.011, p=0.01; p<0.05]. The energy literacy level of those whose schools are in a district centre ($\bar{X}$=98.90) is higher than those whose schools are located in a city centre ($\bar{X}$=96.45). The energy literacy level ($\bar{X}$=99.78) of those whose schools are in a village-town is higher than the energy literacy level ($\bar{X}$=96.45) of those whose schools are in the city centre. According to the Scheffe test results, the energy literacy levels of the students show a significant difference in favour of the schools located in the village-town and district centre. In terms of affective sub-dimension, there is no significant difference according to this variable [F(2-1179)=1.58; η2=0.003, p=0.21; 0.05 <p]. It is concluded that there is a significant difference in the behavioural sub-dimension according to the residential area of the school [F(2-1179)=9.88; η2=0.016, p=0.00; p<0.05]. The average of the students whose schools are in the district centre ($\bar{X}$=39.99) is higher than the average ($\bar{X}$=38.12) of the students whose schools are in the city center. The averages of the students whose schools are in the village-town ($\bar{X}$=40.03) are higher than the averages of the students whose schools are in the city center ($\bar{X}$=38.12).

The 4th sub-problem of the study

Table 8. Independent sample t-test results for grade level

Sub-dimensions	Grade level	N	$\bar{X}$	SD	t	df	p
Affective	7th grade	681	58.68	7.49	0.63	1180	0.53
	8th grade	501	58.38	8.55			
Behavioural	7th grade	681	38.78	6.45	0.71	1180	0.48
	8th grade	501	38.50	6.99			
Energy Literacy	7th grade	681	97.46	10.94	0.85	1180	0.39
	8th grade	501	96.89	12.15			

*p<0.05

When Table 8 is examined, no significant difference was found between the energy literacy levels of the students according to the grade level variable [t(1180)=0.63, p=0.53, 0.05<p], [t(1180)=0.71, p=0.48, 0.05<p], [t(1180)=0.85, p=0.39, 0.05<p]. This result shows that there is no significant difference in terms of energy literacy levels and sub-dimensions of 7th and 8th grade students.

The 5th sub-problem of the study

Table 9. ANOVA test results of mother education

Sub-dimensions	Mother Education	Sum of Squares	df	Mean of Squares	F	p	Sig.
Affective	Between Groups	121.53	5	24.31	0.38	0,860	-
	In-group	74582.39	1176	63.42			
	Total	74703.93	1181				
Behavioural	Between Groups	650.34	5	130.07	2.93	0.01*	6<2

	In-group	52122.99	1176	44.32			
	Total	52773.33	1181				
	Between Groups	1147.23	5	229.45			
Energy Literacy	In-group	154159.58	1176	131.09	1.75	0.12	-
	Total	153306	1181				

*p<0.05

No significant difference was found between the energy literacy levels of the students according to the mother's education level variable [F(5-1176)=1.75; η2=0.007, p=0.12; 0.05 <p]. It was concluded that there was no difference in the affective sub-dimension according to the educational status of the mother [F(5-1176)=0.38; η2=0.001, p=0.86; 0.05 <p]. However, there is a significant difference in the behavioural sub-dimension according to the educational status of the mother [F(5-1176)=2.93; η2=0.012, p=0.01; p<0.05]. Behaviour levels of those whose maternal education level is primary school ($\overline{X}$=39.12) are higher than those whose mothers have master's/doctorate ($\overline{X}$=38.37).

The 6th sub-problem of the study

Table 10. Mother's occupation ANOVA test results

Sub-dimensions	**Mother's Occupation**	**Sum of Square**	**df**	**Means of Squares**	**F**	**p**	**Sig.**
	Between Groups	55.145	5	11.03			
Affective	In-group	74648.78	1176	63.48	0.17	0.97	-
	Total	74703.93	1181				
	Between Groups	793.02	5	158.60			
Behavioural	In-group	51980.31	1176	44.20	3.59	0.03*	5<1
	Total	52773.33	1181				
	Between Groups	1122.35	5	224.47			
Energy Literacy	In-group	154184.46	1176	131.11	1.71	0.13	-
	Total	155306.81	1181				

*p<0.05

When Table 10 is examined, no significant difference was found between the energy literacy levels of the students according to the mother's occupation variable [F(5-1176)=1.71; p=0.007; 0.05 <p]. It was concluded that there was no significant difference in the affective sub-dimension according to the mother's occupation of the students [F(5-1176)=0.17; η2=0.73,p=0.97; 0.05 <p]. However, there is a significant difference in the behavioural sub-dimension according to the mother's occupation [F(5-1176)=3.59; η2=0.015, p=0.03; p<0.05]. Scheffe test results were examined in order to understand the reason for the difference between the groups. Behaviour levels of those whose mothers are housewives ($\overline{X}$=38.94) are higher than those of tradespeople ($\overline{X}$=35.00).

The 7th sub-problem of the study

Table 11. Father's education ANOVA test results

Sub-dimensions	Father's Education	Sum of Squares	df	Means od Squares	F	p	Sig.
	Between Groups	431.43	5	86.29			
Affective	In-group	74272.50	1176	63.16	1.37	0.23	
	Total	74703.93	1181				
	Between Groups	1096.49	5	219.30			6<2
Behavioural	In-group	51676.83	1176	43.94	4.99	0.00*	5<2
	Total	52773.33	1181				6<3
	Between Groups	2779.21	5	555.84			6<2
Energy Literacy	In-group	152527.59	1176	129.70	4.29	0.01*	6<3
	Total	155306.81	1181				6<4

*p<0.05

When Table 11 is examined, it is seen that there is a significant difference between the energy literacy levels of the students according to the father's education level variable [F(5-1176)=4.29; η2=0.018, p=0.01; p<0.05]. The energy literacy levels of those whose father's education level is primary school ($\overline{X}$=98.85), middle school ($\overline{X}$=98.58) and high school ($\overline{X}$=97.56) graduates are higher than those whose fathers have master/doctorate ($\overline{X}$=93.08) degrees. There is no significant difference in the affective sub-dimension according to the educational status of the father [F(5-1176)=1.37; η2=0.006, p=0.23; 0.05 <p]. There is a significant difference in the behavioural sub-dimension according to the father's educational status variable [F(5-1176)=4.99; η2=0.021, p=0.00; p<0.05]. Behaviour levels of those whose fathers graduated from primary school ($\overline{X}$=39.92) were higher than those whose fathers graduated from university ($\overline{X}$=38.00) and whose fathers had master/doctorate degree ($\overline{X}$=36.30). In addition, the behavior levels of those whose fathers graduated from middle school ($\overline{X}$=39.48) were found to be higher than those whose fathers graduated from master's/doctorate program ($\overline{X}$=36.30).

The 8th sub-problem of the study

Table 12. Father's occupation ANOVA test results

Sub-dimension	Father's Occupation	Sum of Squares	df	Mean of Squares	F	p	Sig.
	Between Groups	209.72	3	69.91			
Affective	In-group	74494	1178	63.24	1.11	0.35	
	Total	74703.93	1181				
	Between Groups	503.54	3	167.85			3<1
Behavioural	In-group	52269.79	1178	44.37	3.78	0.01*	3<2
	Total	52773.33	1181				
	Between Groups	1180.55	3	393.52			2<1
Energy Literacy	In-group	154126.26	1178	130.84	3.01	0.03*	3<2
	Total	155306.81	1181				

*p<0.05

When Table 12 is examined, it is seen that there is a significant difference between the energy literacy levels of the students according to the father's occupation variable [F(3-1178)=3.01; η2=0.008, p=0.03; p<0.05). The energy literacy levels of those whose fathers are workers ($\overline{X}$=99.22) are higher than those whose fathers are civil servants ($\overline{X}$=98.58). The energy literacy levels of those who are civil servants ($\overline{X}$=98.58) are also higher than those who are tradesmen ($\overline{X}$=95.91). There is no significant difference in affective sub-dimension according to father's occupation [F(3-1178)=1.11; η2=0.003, p=0.35; 0.05 <p]. A significant difference was found in the behavioural sub-dimension according to the father's occupation variable of the students [F(3-1178)=3.78; η2=0.009, p=0.01; p<0.05]. Behaviour levels of those whose fathers are workers ($\overline{X}$=40.20) and civil servants ($\overline{X}$=39.16) are higher than those who are tradesmen ($\overline{X}$=37.96).

The 9th sub-problem of the study

Table 13. ANOVA test results according to student's residential areas

Sub-dimensions	Residential area of the students	Sum of Squares	df	Means of Squares	F	p	Sig.
Affective	Between Groups	162.05	2	81.03	1.28	0.28	
	In-group	74541.88	1179	63.23			
	Total	74703.93	1181				
Behavioural	Between Groups	711.11	2	355.56	8.05	0.00*	1<2
	In-group	52062.22	1179	44.16			
	Total	52773.33	1181				
Energy Literacy	Between Groups	1527.08	2	763.54	5.85	0.00*	1<2
	In-group	153779.73	1179	130.43			
	Total	155306.81	1181				

*p<0.05

When Table 13 is examined, it is seen that there is a significant difference between the energy literacy levels of the students according to the residential area of the students where they spent most of their lives [F(2-1179)=5.85; η2=0.009, p=0.00; p<0.05]. The energy literacy levels of the students who spent most of their lives in the district centre ($\overline{X}$=99.55) are higher than the energy literacy levels of the students who lived in the city centre ($\overline{X}$=96.67). There is no significant difference in the affective sub-dimension according to the residential area of the students [F(2-1179)=1.28; η2=0.002, p=0.28; 0.05 <p]. In the behavioural sub-dimension, there is a significant difference according to the residential area where the students spend most of their lives variable[F(2-1179)=8.05; η2=0.013, p=0.00; p<0.05]. Behaviour levels of those who spent most of their lives in a district centre ($\overline{X}$=40.25) are higher than those of a city center ($\overline{X}$=38.30).

The 10th sub-problem of the study

Table 14. Family income status ANOVA test results

Sub-dimensions	Family Income	Sum of Squares	df	Means of Squares	F	p	Sig.
	Between Groups	220.96	4	55.24			
Affective	In-group	74482.97	1177	63.28	0.87	0.48	-
	Total	74703.93	1181				
	Between Groups	1208.75	4	302.19			5<1
Behavioural	In-group	51564.58	1177	43.81	6.89	0.00*	5<2
	Total	52773.33	1181				
	Between Groups	1834.69	4	458.67			5<1
Energy Literacy	In-group	153472.11	1177	130.39	3.52	0.01*	5<2
	Total	155306.81	1181				

*p<0.05

According to the family income variable, there is a significant difference between the energy literacy levels of the students [F(4-1177)=3.52; η2=0.012, p=0.01; p<0.05]. The energy literacy levels of those with a family income of 0-2000 TL ($\bar{X}$=98.47) are higher than those with a family income of over 8001 TL ($\bar{X}$=94.64). In addition, the energy literacy levels of those with 2001-4000 TL income ($\bar{X}$=97.87) are higher than the energy literacy levels ($\bar{X}$=94.64) of those over 8001 TL. There is no significant difference in the affective sub-dimension according to family income [F(4-1177)=0.87; η2=0.003, p=0.48; 0.05 <p]. There is a significant difference in the behavioural sub-dimension according to the family income variable of the students [F(4-1177)=6.89; η2=0.023, p=0.00; p<0.05). Behaviour levels of those whose family income is 0-2000tl ($\bar{X}$=39.57) are higher than those whose family income is above 8001tl ($\bar{X}$=36.44). In addition, the behavior levels of those with 2001-4000TL income ($\bar{X}$=39.30) are higher than the behavior levels ($\bar{X}$=36.44) of those with an income of 8001 TL.

The 11th sub-problem of the study

Table 15. Energy journal follow-up independent sample t-test results

Sub-dimensions	The follow-up of the energy journal	N	$\bar{X}$	SD	t	df	p
Affective	Yes	60	59.02	9.38	0.46	1180	0.65
	No	1122	58.53	7.87			
Behavioural	Yes	60	39.53	6.30	1.03	1180	0.30
	No	1122	38.62	6.70			
Energy Literacy	Yes	60	98.55	13.71	0.92	1180	0.36
	No	1122	97.15	11.34			

*p<0.05

There was no significant difference between the energy literacy levels of the students according to whether the student or his/her family has a journal about energy [t(1180)=0.92, p=0.36, 0.05<p]. In addition, no significant difference was found between the two sub-dimensions [t(1180)=0.46, p=0.65, 0.05<p], [t(1180)=1.03, p=0.65, p<0.05). This result shows that there is no significant difference in terms of energy literacy levels between those who follow the journal and those who do not.

The 12th sub-problem of the study

Table 16. Independent sample t-test results of energy broadcast follow-up through social media

Sub-dimensions	The follow-up of the energy broadcast	N	$\bar{X}$	SD	t	df	p
Affective	Yes	169	59.42	9.12	1.53	1180	0.12
	No	1013	58.41	7.73			
Behavioural	Yes	169	39.56	6.20	1.87	1180	0.04*
	No	1013	38.52	6.75			
Energy Literacy	Yes	169	98.98	12.03	2.15	1180	0.03*
	No	1013	96.92	11.35			

*p<0.05

When Table 16 is examined, it is seen that there is a significant difference between the energy literacy levels of the students according to whether they follow an energy-related broadcast via social media or television [t(1180)=2.15 p=0.03, 0.05<p). The energy literacy levels of the students who follow an energy-related broadcast via social media or television ($\bar{X}$=59.42) are higher than the energy literacy levels of the students who do not ($\bar{X}$=58.41). In the affective sub-dimension, there is no significant difference according to whether or not to follow an energy-related broadcast via social media or television [t(1180)=1.53, p=0.12, 0.05<p]. There is a significant difference in the behavioural sub-dimension according to this variable [t(1180)=1.87, p=0.04, 0.05<p]. The behaviour levels of the students who follow an energy-related broadcast via social media or television ($\bar{X}$=39.56) are higher than the behavior levels of the students who do not ($\bar{X}$=38.52).

The 13th sub-problem of the study

Table 17. Independent sample t-test results on whether the energy education she/he received at school is sufficient or not

Sub-dimensions	Finding Energy Education Sufficient	N	$\bar{X}$	SD	t	df	p
Affective	Yes	614	58.20	8.35	-1.61	1180	0.11
	No	568	58.94	7.49			
Behavioural	Yes	614	38.79	6.78	-0.67	1180	0.50
	No	568	38.53	6.59			
Energy Literacy	Yes	614	96.99	11.82	-0.73	1180	0.47
	No	568	97.47	11.08			

*p<0.05

When Table 17 is examined, no significant difference was found between the energy literacy levels of the students according to the students' finding that the energy education is sufficient [t(1180) =0.73, p=0.47, 0.05<p]. In addition, no significant difference was found between the two sub-dimensions [t(1180)=-1.61, p=0.11, 0.05<p], [t(1180)=-0.67, p=0.50, 0.05<p]. This result shows that there is no significant difference in terms of energy literacy levels between students who find energy education sufficient and those who do not.

Discussion and Conclusions

It is seen that the energy literacy levels of the students are around the average in terms of both dimensions and the whole scale (Table 2). In this case, it can be said that the students are partially interested in the problems that may arise related to energy. Ayata (2021) measured the energy literacy levels of 7th grade students in Turkey at high levels in affective and behavioural sub-dimensions. DeWaters and Power (2011) also reported that middle and high school students in the United States have high energy literacy levels in the affective and behavioural sub-dimension. Fah et al. (2012) concluded that secondary school students in Malaysia have high energy literacy levels. Differently, Chen et al. (2015) also stated that the energy literacy levels of secondary school students in Taiwan are low. It is seen that different results emerge in different countries. When we look at the literature, it is generally seen that energy literacy is high in countries with a high level of education. In this sense, it can be said that increasing the quality of education will positively affect energy literacy.

The energy literacy levels of middle school students do not show a significant difference in terms of gender. According to both sub-dimension scores, there is no significant difference in terms of gender (Table 5). Similarly, Oluk et al. (2019) stated that the affective dimension scores of pre-service teachers regarding energy conservation did not show a significant difference in terms of gender. Again, Akitsu and Ishihara (2019) reported that the energy literacy of middle school students in Japan did not differ significantly in terms of gender. Oral (2020) also stated that energy literacy did not show a significant difference according to gender. Çelikler and Kara (2011) also stated that there was no significant difference according to gender in the research they conducted with pre-service teachers. On the other hand, there are studies stating that energy literacy in the affective sub-dimension shows a significant difference in favour of girls (Ayata, 2021; DeWaters and Powers, 2011; Lee et al., 2017). There is also a study showing a significant difference in favour of men (Çakırlar, 2015). As a result, when the literature is examined, it is seen that there is no relationship between the energy literacy of the students and gender. This may be due to the fact that boys and girls pay similar attention to energy-related issues in their daily lives. However, it is necessary to determine the real cause with new researches.

The energy literacy of students studying in public middle school is significantly higher than those studying in private middle school. In the behavioural sub-dimension of energy literacy, the average scores of students studying in public middle schools are significantly higher than those in private middle schools. No significant difference was found in the affective sub-dimension (Table 6). Similarly, Lee et al. (2022) stated that the energy literacy scores of students studying in public school were found to be significantly higher than those studying in private school. This difference may be due to the fact that public schools are more careful about energy saving or that families who send them to private schools have low energy saving concerns. However, this needs to be confirmed by other research.

The energy literacy levels of the students in the schools located in the district centre are significantly higher than those in the city centre. The energy literacy levels of the students who continue their education in village schools are higher than those in the city centre. In the affective sub-dimension, there was no significant difference in terms of the residential area of the school. In the sub-dimension of behaviour, the average scores of the students in the schools located in the district centre are significantly higher than those in the city centre. Again, the average scores of students studying in villages-towns are significantly higher than those in the city centre (Table 7). Similarly, Aktamış (2011) stated that students living in rural areas have higher energy literacy scores than those living in urban areas. Çelikler and Kara (2011) also concluded that those living in the district centre and in the village were significantly higher than those living in the city centre. Differently, Fah et al. (2012) reported that students living in urban areas had significantly higher energy literacy scores than those living in rural areas. Ayata (2021), on the other hand, did not detect a significant difference in the scores of those living in rural and urban areas. The fact that energy literacy is predominantly high in favour of those living in rural areas in the literature can be interpreted as they better transfer energy-related issues to their daily lives. The probable reason for this may be the partial difficulty of accessing energy in rural areas. However, the real reason for this needs to be confirmed by new research.

No significant difference was found in middle school students' energy literacy and grade level in both sub-dimensions. When the average scores according to the grade level are examined, it can be said that the 7th and 8th grade students have similar scores (Table 8). DeWaters and Powers (2011) found that the energy literacy levels of middle school students in the affective sub-dimension were significantly higher than those of high school students. Chen et al. (2015) stated that the energy literacy scores of the 7th grade students were significantly higher than the 8-12 students in the behavioural sub-dimension. Mola et al. (2018) reported that energy literacy scores increased as the grade level increased. Differently, Akitsu and Ishihara (2019) measured 7th and 8th grade students' energy literacy scores to be significantly higher in favour of 7th graders. It is an expected result that energy literacy will increase as the grade level increases. The fact that there is no opposite or significant difference in the literature may be due to the students not focusing enough on energy in their curriculum. However, the real reason for this needs to be examined by new studies.

No significant difference was found in the energy literacy levels of the students and in the affective sub-dimension according to the mother's education level variable. In the behavioral sub-dimension, the average scores of students whose mothers are primary school graduates are significantly higher than those whose mothers are university graduates (Table 9). Çakırlar (2015) stated that there was no significant difference between maternal education status and energy awareness. Lee et al. (2022) reported that there was no significant difference in students' energy literacy. Ayata (2021) also concluded that there is no significant difference in energy literacy scores in affective and behavioural sub-dimensions. On the other hand, Okuyucu (2011) stated that the energy literacy scores of students whose mothers are university graduates are significantly higher than those whose mothers are primary and middle school graduates. Considering the relevant literature and the results of this research, it can be said that energy literacy does not differ according to the educational status of the mother.

No significant difference was found between the energy literacy levels of the students according to the mother's occupation variable (Table 10). Lee et al. (2022) also stated that

there was no significant difference. In the affective sub-dimension, no significant difference was found between the energy literacy scores of the students according to the mother's occupation variable (Table 10). However, there is a significant difference in the behavioural sub-dimension according to the mother's occupation. Mean behavioural scores of those whose mothers are housewives are significantly higher than those of tradespeople (Table 10). The probable reason for this may be the low income level of those whose mothers are housewives. Because the data in Table 14 show that energy literacy decreases significantly as the family income level increases.

The energy literacy levels of those whose father's education level is primary, middle and high school graduates are significantly higher than those with a master's/doctorate degree. No significant difference was found in the affective sub-dimension according to the educational status of the father. In the behavioural sub-dimension, the average behavioural scores of those whose fathers were primary school graduates were significantly higher than those whose fathers graduated from university, master's/doctorate. In addition, the average behavioural scores of those whose fathers were middle school graduates were found to be significantly higher than those with a master's/doctorate degree (Table 11). Ayata (2021) reported that energy literacy did not differ significantly according to father's education level. Lee et al. (2022) revealed that there was no significant difference according to father's education level. According to the results of this research, it can be said that as the education level of the father increases, the energy literacy of the students' decreases. The probable reason for this may be that the income level of the family increases as the education level of the father increases (Table 14).

Energy literacy levels of those whose fathers are workers are significantly higher than those whose fathers are public servants. The energy literacy levels of those who are civil servants are also significantly higher than those who are tradespeople. There is no significant difference in the affective sub-dimension in terms of father's occupation. In the behavioural sub-dimension, the behaviour levels of those whose fathers were workers and civil servants were significantly higher than those of tradesmen (Table 12). The reason for this may be that the income level of tradespeople is higher than that of workers and public servants. Because as the income level increases, there is a decrease in energy saving behaviours (Table 14). However, new research is needed to clarify the real reason for this situation.

The energy literacy levels of the students who have spent most of his/her life in the district centre are significantly higher than those in the city centre. In the behaviour sub-dimension, the scores of those who lived in the district centre were significantly higher than those who lived in the city centre. In the affective dimension, no significant difference was determined in terms of this variable (Table 13).

The energy literacy levels of those with a family income of 0-2000 TL are significantly higher than the energy literacy levels of those with a family income of 8000 TL or more. In addition, the energy literacy levels of those with a family income between 2000 and 4000 TL are significantly higher than the energy literacy levels of those with a family income of 8000 TL or more. In the affective sub-dimension, there is no significant difference according to family income. In the behavioural sub-dimension, the behaviour levels of those whose family income is 0-2000 TL are higher than those whose income status is above 8000 TL. In addition, the behaviour levels of those with an income of 2000-

4000 TL are higher than the behaviour levels of those with an income of over 8001 TL (Table 14). Similarly, Oluk et al (2019) stated that as the family income level increases, energy saving behaviours decrease. On the other hand, Okuyucu (2011) found a significant difference in favour of those with high income. Çakırlar (2015), on the other hand, concluded that there is no significant difference between family income level and high school students' energy awareness. Lee et al. (2022) reported that there was no significant difference between family income level and energy literacy scores. Looking at the literature, it can be said that different findings show a homogeneous distribution. As a result of this research, the possible reason for the decrease in energy saving behaviours as the family income level increases may be the lower level of economic anxiety as the family income level increases. Because energy has a predominantly economic aspect for families as well. However, new research can be done to clarify the real reason for this.

There was no significant difference between the students' energy literacy levels according to whether the student or his/her family followed an energy-related publication or not (Table 15). However, the energy literacy levels of students who follow an energy-related broadcast via social media or television are significantly higher than the energy literacy levels of students who do not follow. The behavior levels of students who follow an energy-related broadcast via social media or television are significantly higher than those who do not follow. In the affective sub-dimension, there is no significant difference according to whether or not to follow an energy-related broadcast via social media or television (Table 16). Çakırlar (2015) stated that the new generation of students use the Internet and social media intensively. In this sense, it seems that the participants in this study also mostly acquired their knowledge about energy through social media or television. In addition, based on this finding, it can be concluded that energy education-oriented publications from digital media will be beneficial.

There was no significant difference between the energy literacy levels of the students in terms of finding the energy education sufficient. In addition, the situation is the same in both sub-dimensions (Table 17).

Implications

In the middle school science curriculum, the sections containing energy-related content can be updated and the content can be enriched with examples from daily life. In order to develop students' affective and behavioural energy literacy, inquiry-based and out-of-class scientific energy activities can be prepared with the participation of families. It may be beneficial to disseminate energy-related content via social media and television in cooperation with non-governmental organizations. In addition, students' energy literacy can be examined by taking data from different samples. Again, the relationship between the energy literacy of the teacher and his students is a different research topic. Finally, energy literacy and the factors affecting it can be investigated in more depth with qualitative research.

Limitations

This study has several limitations. First, the study is limited to data from 1182 middle school students reached within the borders of Isparta province, thus making it difficult to generalize the findings. The second is the sincerity of students' responses to the scales, so it can weaken their objectivity. The possible reason for this may be that the students made their own self-evaluations in terms of affective or behavioural on the scales. Third,

more comprehensive findings can be obtained with qualitative or mixed methods instead of quantitative methods.

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