High School Students' Knowledge Levels and Attitudes About Waste Batteries, Their on Health and Sustainability, and the Effect of Health Education: Two Selected High School Examples

Araştırma Research

Lise Öğrencilerinin Atık Piller, Sağlığa Etkileri ve Sürdürülebilirlik Hakkında Bilgi Düzeyleri, Tutumları ve Sağlık Eğitiminin Etkisi: Seçilmiş İki Lise Örneği

Mahmut Talha Uçar[1], Esra Çiçek[2], Rumeysa Sarıgül[3], Hasan Hüseyin Eker[4]

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Abstract

Objective: Waste batteries are both a risk factor that may affect human health and a resource that should be recycled due to the metals they contain. In this study, high school students' level of knowledge, sustainability attitudes and related factors about the properties of waste batteries, possible health effects and sustainability of waste batteries were examined.

Method: The study was conducted as a quasi-experimental design in a one-group pre-test-post-test design. The study was conducted with 168 9th grade students in science and vocational high schools. The entire population was selected as the sample. "Sustainability Awareness Scale (SCS)" and 'Waste Batteries Knowledge Level' were used for pre and post-study evaluation.

Results: The post-test median scores of male (p=0.004) and female (<0.001) science high school students are statistically significant and higher. In addition, the post-test median score of students whose family income was equal to their expenses (p=0.001) and whose income was more than their expenses (p=0.008) was statistically significant and higher. According to gender, the post-test median score for the total score of the SCS was statistically significant and higher in female (p=0.043). The post-test median score for knowledge level was higher and statistically significant in male (p=0.044) and female (p=0.012) vocational high school students. In addition, the post-test median score of the students whose family income was equal to their expenses (p=0.007) and whose income was more than their expenses (p=0.010) was higher and statistically significant. The median scores of knowledge level (<0.001), total score (p=0.001), knowledge (p=0.004) and attitude subdimension (<0.001) in science high school were higher than those in vocational high school and statistically significant.

Conclusion: In our study, while the total score of the SCS was found to be "moderate" in vocational high school students, it was found to be "high" in science high school students.

Keywords: education; environmental health; hazardous waste

Özet

Amaç: Atık piller, içerdikleri metaller nedeniyle hem insan sağlığını etkileyebilecek bir risk faktörü hem de geri dönüştürülmesi gereken bir kaynaktır. Bu çalışmada lise öğrencilerinin atık pillerin özellikleri, sağlığa olası etkileri ve sürdürülebilirliği hakkındaki bilgi düzeyleri, sürdürülebilirlik tutumları ve ilişkili faktörler incelenmiştir.

Yöntem: Araştırma tek gruplu ön test-son test düzeninde yarı deneysel desen olarak yürütülmüştür. Çalışma fen ve meslek liselerinde 9. sınıf 168 öğrenci ile yürütülmüştür. Araştırmada evrenin tamamı örneklem olarak seçilmiştir. Çalışma öncesi ve sonrası değerlendirmede "Sürdürülebilirlik Bilinci Ölçeği (SBÖ)" ve "Atık Piller Bilgi Düzeyi" kullanılmıştır.

Bulgular: Erkek (p=0,004) ve kız (<0,001) fen lisesi öğrencilerinin bilgi düzeyi son test ortanca puanları istatistiksel olarak anlamlıdır ve daha yüksektir. Ayrıca, ailesini geliri giderlerine eşit (p=0,001) ve geliri giderlerinden fazla (p=0,008) olan öğrencilerin bilgi düzeyi son test ortanca puanı istatistiksel olarak anlamlıdır ve daha yüksektir. Cinsiyete göre, kızlarda SBÖ toplam puanı için son test ortanca puanı istatistiksel olarak anlamlı ve daha yüksektir (p=0,043). Erkek (p=0,044) ve kadın (p=0,012) meslek lisesi öğrencilerinde bilgi düzeyi son test ortanca puanı daha yüksek ve istatistiksel olarak anlamlıdır. Ayrıca, ailesinin geliri giderlerine eşit (p=0,007) ve geliri giderlerinden fazla (p=0,010) olan öğrencilerin bilgi düzeyi son test ortanca puanı daha yüksek ve istatistiksel olarak anlamlıdır. Fen lisesinde bilgi düzeyi (<0,001), SBÖ toplam puanı (p=0,001), bilgi (p=0,004) ve tutum alt boyutu (<0,001) ortanca puanları meslek lisesinden daha yüksektir ve istatistiksel olarak anlamlıdır.

Sonuç: Çalışmamızda, meslek lisesi öğrencilerinin SBÖ toplam puanı "orta" düzeyde bulunurken, fen lisesi öğrencilerinin SBÖ toplam puanı "yüksek" düzeyde bulunmuştur.

Anahtar Sözcükler: eğitim; çevre sağlığı; tehlikeli atık

[1] *Arş. Gör. Dr., Sağlık Bilimleri Üniversitesi, Hamidiye Tıp Fakültesi, Halk Sağlığı Anabilim Dalı (Orcid no: 0000-0002-1433-4832)*
[2] *PhD, Konya İl Sağlık Müdürlüğü (Orcid no: 0000-0003-4010-8596)*
[3] *Sosyal Hizmet Uzmanı, Bandırma Onyedi Eylül Üniversitesi, Sağlık Bilimleri Enstitüsü (Orcid no: 0009-0003-3090-7068)*
[4] *Prof. Dr., Sağlık Bilimleri Üniversitesi, Hamidiye Tıp Fakültesi, Halk Sağlığı Anabilim Dalı (Orcid no: 0000-0002-9053-0835)*

Introduction

Batteries are an energy source that converts chemical energy into electrical energy through the various metals they contain; this conversion takes place with a flow between two poles, negative (anode) and positive (cathode) (1). Different hybrid batteries such as lithium, nickel-cadmium, zinc-carbon, nickel-metal are used in daily life.

These metals used in batteries are known to have various hazards on human and environmental health. The World Health Organization states that heavy metals can cause long-term health effects, especially on children; lead and mercury exposure is associated with problems such as neurodevelopmental disorders, learning disabilities and cognitive developmental delay" (2).

However, toxic elements such as lead and mercury can accumulate in organs such as the liver, kidneys and brain, causing serious health problems such as memory loss, visual disturbances, irritability, fatigue, weakness, decreased muscle strength, tremors, kidney failure and impaired liver function. Cadmium increases the risk of prostate cancer in the long term (3).

Batteries that lose their function over time, expire or become unusable due to physical damage are defined as "waste batteries" (4). Waste batteries are an important public health problem that negatively affects the environment and human health due to the harmful chemicals they contain.

If the harmful chemicals in waste batteries are not properly separated, disposed of or recycled, these harmful substances can enter the soil where they are stored. This causes harm to animals, plants and microorganisms living in the soil and indirectly to the creatures that feed on those plants. This pollution caused by waste batteries also negatively affects water resources by mixing into groundwater. These substances that enter the water also harm aquatic creatures and people who consume them. These metals, which enter the human body through water and soil or by direct contact, pose a threat to human health (5).

The United Nations Environment Programme (UNEP) highlights that electronic waste is increasing the toxic waste burden worldwide and that the lack of effective waste management policies, especially in developing countries, is deepening environmental inequalities (6).

The widespread use of batteries in our daily lives and the rapid increase in rechargeable batteries with smartphones and electric vehicles make it necessary to address this issue more in terms of public health.

Sustainability is an approach that aims to meet the needs of present and future generations, to use resources efficiently and to preserve the natural balance. This approach is considered together with its environmental, economic and social dimensions. Environmental sustainability includes the balanced and efficient use of natural resources, the protection of biodiversity and the minimization of environmental impacts. Economic sustainability ensures the sustainability of economic growth and development through the efficient use of resources. Social sustainability, on the other hand, refers to a structure that is based on respect for human rights, is egalitarian and inclusive, and respects the welfare and justice of society. Sustainability is critical for the survival of all living things in the universe. Human actions cause rapid depletion of natural resources, leading to problems such as environmental degradation and climate change. Therefore, sustainability principles include practices such as protecting natural resources, reducing waste and pollution, and promoting the use of renewable energy. However, sustainability is not limited to environmental measures; it is also directly related to social justice and economic development. Therefore, a holistic and integrated approach should be adopted for a sustainable future (7).

Various studies have shown that education has a decisive function in helping individuals develop environmental awareness and exhibit positive behaviors. The role of individual attitudes and behaviors in solving environmental problems is emphasized in this framework, it is stated that the main responsibility for solving environmental problems lies with human beings (8,9).

In the study conducted by Yüksel and Yıldız (2019) with high school students, it was determined that the sustainability awareness levels of students showed significant differences according to demographic variables; in line with these findings, the role of environmental education offered in the school environment in the development of sustainability awareness was emphasized (9).

In the protection and promotion of health, it is very important to take precautions and provide health education before problems arise. The aim of health education in schools is to ensure that students learn the behaviors that will keep their health at the highest level, to gain knowledge to protect their health and to create the desired behavioral changes related to health in students. Therefore, school-based health education and the evaluation of this education are important in terms of raising awareness of the individuals who make up the society.

The aim of this study was to evaluate the knowledge levels and attitudes of high school students about waste batteries, the effects of waste batteries on health and sustainability, and to determine the effect of health education on improving their knowledge and attitudes on these issues.

Materials and Methods

Type of Research

This research is a quasi-experimental design study in a one-group pretest-posttest design. Hypothesis of the study:

- There is no statistically significant difference between the pre-test and post-test scores of students from two high schools regarding their knowledge and sustainability attitudes following environmental health education (HO)
- There is a statistically significant difference between the pre-test and post-test scores of students from two high schools regarding their knowledge and sustainability attitudes following environmental health education. (H1)

Pilot Study

Before the main implementation in the 2023–2024 academic year, a pilot study was conducted with 9th grade students in two high schools during the 2022–2023 academic year to evaluate and revise the data collection tools and training modules. Based on the findings and feedback from this pilot phase, adjustments were made to improve the effectiveness of the program.
It was conducted with 9th grade students in two high schools in the 2022-2023 academic year. Interview forms were applied in April 2023. After this first implementation, some revisions were made to make the training program more effective. A total of 213 students (85.9%), 129 (81.6%) in vocational high school and 84 (93.3%) in science high school, participated in the plot implementation of the study.

Population and Sample of the Research

The population of this study consisted of a total of 277 ninth grade students studying in two public high schools (Beykoz Science High School and Şehit Murat Akdemir Vocational and Technical Anatolian High School) in Istanbul in the 2023-2024 academic year. Of these students, 90 were studying at Beykoz Science High School and 187 were studying at Şehit Murat Akdemir Vocational High School. No sample was selected in the study.

Data Collection Tools

Sociodemographic Information Form, Sustainability Consciousness Scale (SCS) and Waste Battery Knowledge Level Form were used to collect the data.

Sociodemographic Information Form: It includes 17 questions on gender, monthly household income and expenditures, being a civil society volunteer or member, knowing renewable energy sources, sustainability of natural resources, knowing the recycling emblem, environment where environmental awareness behaviors are acquired, collection points of waste batteries, criteria used in sorting, things to be done to prevent environmental problems, bicycle use, recyclable materials and reuse of used paper in manufacturing.

Sustainability Consciousness Scale (SCS): It is a self-report scale consisting of 50 items and three subdimension (Knowledge, Attitude and Behavior) developed by Michalos et al. and updated by Gericke et al. It consists of Likert type statements such as "strongly agree", "agree", "somewhat agree", "disagree" and "strongly disagree". These statements are scored as 1-5 (10,11). Yüksel et al. found the cronbach's alpha value of the scale adapted into Turkish to be 0.86 (12). In our study, cronbach's alpha value was found to be 0.90 for the pre-test and 0.88 for the post-test. The results of the analysis show that the scale is reliable. The minimum score that can be obtained from this scale is 50 and the maximum score is 250. Therefore, students with 50-117 points are grouped as low, students with 118-185 points are grouped as medium, and students with 186-250 points are grouped as high (12).

Waste Batteries Level of Knowledge Form: It was prepared by the researchers in line with the literature in order to measure the knowledge level of the participants about waste batteries (4,7). It consists of 26 multiple choice questions to measure the level of knowledge about waste batteries. Correct answers to the questions were given 1 (one) point and incorrect and don't know answers were given 0 (zero) points. The total score obtained from the test varies between 0-20. In our study, cronbach's alpha value was found to be 0.64 for the pre-test and 0.71 for the post-test. The results show that it is reliable.

Enterprise

The research process consisted of three stages: pre-test administration, training sessions and post-test administration. Students studying in two high schools in the 2023-2024 academic year who agreed to participate in the study were included in the study. Informed consent forms were obtained from the students. In order to ensure the confidentiality of the students, they were asked to write the last four digits of a phone number they knew in the pre-test and the same number information was compared on the questionnaire in the post-test. The pre-test data were collected by face-to-face visits to both high schools between March 1-24, 2024, under observation and by self-completion by the participants. A total of 210 students participated in the pretest implementation. The 67 students who did not participate were excluded because they were absent from school on the implementation days (n=45), did not want to participate in the study (n=12), or filled out the data form incompletely/invalidly (n=10).

Following the pre-test, the training sessions planned for the participating students were realized. The trainings consisted of four sessions between March 20 and May 25, 2024 (lasting 6 weeks), delivered by two people, one of whom was a public health specialist and the other an environmental engineer, and were held in classrooms in both high schools in groups of 25 people each. The session consisted of four modules titled "Characteristics of Batteries", "Recycling and Disposal of Batteries", "Health Effects of Waste Batteries" and "Ways to Prevent Health Hazards of Waste Batteries".

The post-test data were collected during two visits to both high schools between May 25 and June 10, again under observation and by the participants using the self-completion method. After the training process was completed, 168 students participated in the post-test. The 42 students who could not participate in the post-test application could not take part in this stage because they were not present at the school on the application dates.

In the data analysis of the study, only students with complete pre-test and post-test data were included in the evaluation. Accordingly, paired data obtained from 168 students were included in the analysis. Students with missing or invalid data were excluded (Figure 1).

Ethical Aspects of the Research

Written permission (Date: 10/03/2023 and Number: 2023/9) was obtained from Istanbul Provincial Directorate of National Education and Health Sciences University Hamidiye Scientific Research Ethics Committee. The principles of the Declaration of Helsinki were followed throughout the study.

Statistical Analysis

The research data were evaluated in IBM SPSS Statistics for Windows version 22.0 (IBM, Armonk, NY, USA) Package program. The normality of the data was evaluated with Kolmogorov-Smirnov and it was determined that the data were not normally distributed. Number (n) and percentage (%) were used for descriptive data. For nonparametric data, Mann Whitney U test was used for pairwise comparisons and Kruskal-Wallis analysis was used for more than two comparisons. Wilcoxon analysis was used for pre-test and post-test comparisons. For parametric data, Independent Samples t test was used for pairwise comparisons. All statistics were considered significant at $p<0.05$ level.

Results

It was determined that 32.7% of the students were studying at science high school, 73.8% of them were 15 years old, 65.5% of them had a family income equal to their expenses, 3.0% of them had CSO membership (Green Crescent, Bicycle Heroes, Tema, AFAD, Social Aid Project) and 39.9% of them were female. The average age of the students was 15.0±0.5 (Table 1).

In male science high school students, the post-

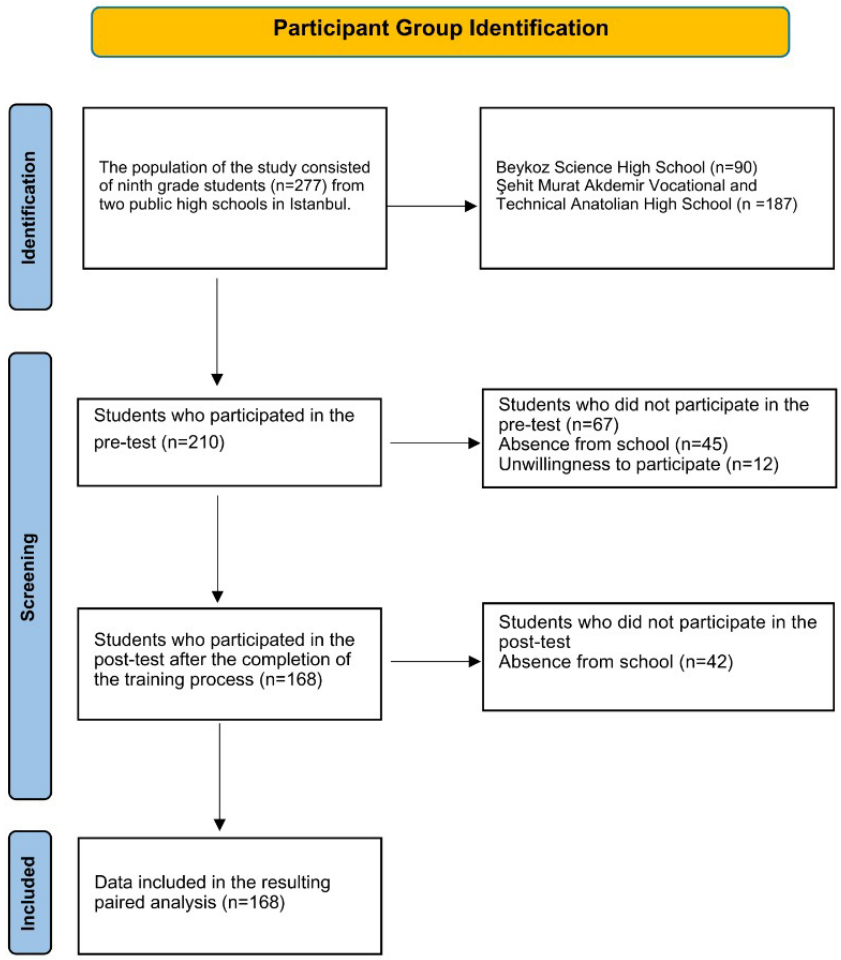

Figure 1. Work flow chart of the research.

test median scores for knowledge level were significantly higher than the pre-test scores (p=0.004). Similarly, in female science high school students, the post-test median scores were also higher and the difference was statistically significant (p<0.001). In both male and female students attending the science high school, knowledge scores increased significantly after the training. The median score for male students increased from 14.00 to 18.00 (p=0.004), while for female students it increased from 16.00 to 18.50 (p<0.001), indicating a statistically significant improvement in both groups.

The post-test median knowledge score was significantly higher among students whose family income was equal to their expenses (p=0.001) and among those whose income exceeded their expenses (p=0.008). According to gender, the post-test median score for the Sustainability Consciousness Scale (SCS) total score was significantly higher in female students (p=0.043). Students whose family income was higher than their expenditures had higher post-test median scores, and this difference was statistically significant (p=0.008).

In the knowledge subdimension, students whose family income was higher than their expenses had significantly higher post-test median scores (p=0.036), while in the pre-test, students whose income was less than their expenses had significantly higher scores (p=0.038). In the attitude subdimension, female students had significantly higher post-test median scores (p=0.009), as did students whose family income was higher than their expenses (p=0.016). In the behavior subdimension, no statistically significant difference was found based on either gender or family income status (Table 2).

In male vocational high school students, the post-test median knowledge score was higher

Table 1. Distribution of descriptive information.			
	Vocational high school	**Science high school**	**Total[a]**
	n (%)	**n (%)**	**n (%)**
Gender			
Male	74 (73.3)	27 (26.7)	101 (60.1)
Female	39 (58.2)	28 (41.8)	67 (39.9)
Age			
14	12 (60.0)	8 (40.0)	20 (11.9)
15	78 (62.9)	46 (37.1)	124 (73.8)
16	22 (95.7)	1 (4.3)	23 (13.7)
17	1 (100.0)	0 (0.0)	1 (0.6)
Age Mean	15.1±0.5	14.8±0.3	15.0±0.5
Income status			
Income less than expenditure	15 (83.3)	3 (16.7)	18 (10.7)
Income equals expenses	83 (75.5)	27 (24.5)	110 (65.5)
Income more than expenditure	15 (37.5)	25 (62.5)	40 (23.8)
CSO membership			
Yes	3 (60.0)	2 (40.0)	5 (3.0)
No	110 (67.5)	53 (32.5)	163 (97.0)
Total[b]	**113 (67.3)**	**55 (32.7)**	**168 (100.0)**
CSO: Civil Society Organization a= Row percentage b= Percentage of column			

than the pre-test score and the difference was statistically significant (p=0.044). Similarly, in female vocational high school students, the increase in the post-test median knowledge score was statistically significant (p=0.012).

Students whose family income equaled their expenses had significantly higher post-test knowledge scores (p=0.007). Likewise, those whose family income exceeded their expenses also showed a statistically significant increase in their post-test median knowledge scores (p=0.010).

In terms of the total score of the Sustainability Consciousness Scale (SCS) and its subdimensions -knowledge, attitude, and behavior- no statistically significant differences were observed based on gender or family income status (Table 3).

The median knowledge score of science high school students was higher than that of vocational high school students, and this difference was statistically significant (Z=-4.066, p<0.001). Similarly, the median score for the Sustainability Consciousness Scale (SCS) total score was significantly higher in science high school students compared to vocational high school students (t=-3.382, p=0.001).

In the knowledge subdimension of the SCS, the mean score of science high school students was also significantly higher than that of vocational high school students (t=-2.951, p=0.004). Likewise, the median score in the attitude subdimension was significantly higher in science high school students (Z=-5.422, p<0.001). However, in the behavior subdimension, no statistically significant difference was found between the two school types (t=-0.053, p=0.957) (Table 4).
Other descriptive information regarding the pre-test and post-test distributions by high school are given (Table 5).

Table 2. Intergroup and intragroup pre-test and post-test according to science high school.					
	Pre-test		**Post-test**		**Z[b] p**
	Knowledge Level		**Knowledge Level**		
	Median	**Mean±SD**	**Median**	**Mean±SD**	
Gender					
Male	14.00	13.93±4.05	18.00	17.07±4.30	-2.919 **p=0.004****
Female	16.00	15.11±3.31	18.50	18.25±3.38	-3.541 **p<0.001*****
Z[a] p	-1.083 p=0.279		-0.703 p=0.482		
Income status					
Income less than expenditure	14.00	13.00±1.73	19.00	19.33±1.52	-1.633 p=0.102
Income equals expenses	15.00	14.26±3.49	18.00	17.15±4.25	-3.451 **p=0.001****
Income more than expenditure	16.00	15.00±4.11	19.00	18.04±3.623	-2.638 **p=0.008****
KW[c] p	1.714 p=0.424		1.170 p=0.557		
	SCS Total Score		**SCS Total Score**		
Gender					
Male	197.00	194.93±25.76	193.00	193.70±26.27	-0.102 p=0.919
Female	200.50	199.75±17.16	205.00	207.04±15.03	-1.502 p=0.133
Z[a] p	-0.438 p=0.661		-2.022 **p=0.043***		
Income status					
Income less than expenditure	225.00	219.67±15.69	193.00	201.33±16.19	-1.604 p=0.109
Income equals expenses	197.00	199.11±19.56	200.00	198.74±20.11	-0.305 p=0.760
Income more than expenditure	201.00	192.84±23.27	206.00	202.28±25.24	-2.673 **p=0.008****
KW[c] p	3.801 p=0.150		1.230 p=0.541		
	SCS Knowledge Subdimension		**SCS Knowledge Subdimension**		
Gender					
Male	80.00	76.48±13.93	76.00	77.15±11.81	-0.421 p=0.674
Female	81.00	79.89±8.02	83.00	83.36±5.78	-1.827 p=0.068
Z[a] p	-0.598 p=0.550		-1.694 p=0.090		

Income status					
Income less than expenditure[1]	95.00	92.67±4.04	80.00	79.33±12.01	-1.604 p=0.109
Income equals expenses[2]	80.00	78.59±9.22	80.00	79.44±8.00	-0.547 p=0.585
Income more than expenditure[3]	81.00	76.08±12.83	86.00	81.36±11.29	-2.100 **p=0.036***
KW[c] **p**	6.523 **p=0.038*** **3<1** **2<1**		1.806 p=0.405		
	SCS Attitude Subdimension		**SCS Attitude Subdimension**		
Gender					
Male	60.00	58.59±8.62	60.00	58.26±8.93	-0.121 p=0.903
Female	58.50	59.11±5.52	62.00	62.07±4.25	-2.610 **p=0.009****
Z[a] **p**	-0.253 p=0.800		-1.485 p=0.137		
Income status					
Income less than expenditure	62.00	61.67±8.50	62.00	63.67±5.68	-0.447 p=0.655
Income equals expenses	60.00	59.63±6.47	60.00	58.85±7.84	-0.310 p=0.757
Income more than expenditure	58.00	57.68±7.78	63.00	61.24±6.41	-2.418 **p=0.016***
KW[c] **p**	0.740 p=0.691		2.356 p=0.308		
	SCS Behavior Subdimension		**SCS Behavior Subdimension**		
Gender					
Male	60.00	59.85±8.37	59.00	58.30±10.89	-0.081 p=0.936
Female	60.50	60.75±7.63	60.50	61.61±9.72	-0.080 p=0.936
Z[a] **p**	-0.287 p=0.774		-0.944 p=0.345		
Income status					
Income less than expenditure	67.00	65.33±3.78	59.00	58.33±7.02	-1.604 p=0.109
Income equals expenses	60.00	60.89±7.29	61.00	60.44±8.52	-0.323 p=0.746
Income more than expenditure	59.00	59.08±8.84	60.00	59.68±12.55	-0.727 p=0.467
KW[c] **p**	2.671 p=0.263		0.203 p=0.903		

Z[a]= Pre-test and post-test differences between groups (Mann-Whitney U) Z[b]= Pre-test and post-test differences within groups (Wilcoxon Analizi) KW[c]= Pre-test and post-test differences between groups (Kruskal-Wallis Analizi) *=p<0.05, **=p<0.01, ***=p<0.001, SD: Standard deviation, SCS: Sustainability Consciousness Scale

Table 3. Intergroup and intragroup pre-test and post-test according to vocational high school.					
	Pre-test		**Post-test**		**Z[b]** **p**
	Knowledge Level		**Knowledge Level**		
	Median	**Mean±SD**	**Median**	**Mean±SD**	
Gender					
Male	12.00	12.26±3.69	14.00	13.30±3.85	-2.014 **p=0.044***
Female	11.00	11.38±3.04	13.00	13.03±3.15	-2.498 **p=0.012***
Z[a] **p**	-1.010 p=0.313		-0.525 p=0.600		
Income status					
Income less than expenditure	13.00	13.73±3.24	14.00	13.80±4.10	-0.028 p=0.977
Income equals expenses	12.00	11.53±3.53	13.00	12.80±3.57	-2.688 **p=0.007****
Income more than expenditure	12.00	12.53±3.06	14.00	14.87±2.94	-2.561 **p=0.010***
KW[c] **p**	4.773 p=0.092		4.581 p=0.101		
	SCS Total Score		**SCS Total Score**		
Gender					
Male	184.00	184.36±25.62	186.00	184.84±23.57	-0.155 p=0.877
Female	176.00	182.72±25.93	176.00	183.03±20.95	-0.593 p=0.553
Z[a] **p**	-0.728 p=0.467		-0.480 p=0.631		
Income status					
Income less than expenditure	185.00	182.73±23.17	178.00	178.27±22.67	-0.691 p=0.490
Income equals expenses	179.00	182.24±24.69	182.00	184.40±22.20	-1.077 p=0.281
Income more than expenditure	191.00	193.47±32.07	195.00	189.13±25.11	-0.848 p=0.396
KW[c] **p**	3.899 p=0.142		1.464 p=0.481		
	SCS Knowledge Subdimension		**SCS Knowledge Subdimension**		
Gender					
Male	73.00	73.27±11.87	72.00	72.50±10.16	-1.299 p=0.194
Female	70.00	71.21±11.76	67.00	70.36±10.52	-0.008 p=0.994
Z[a] **p**	-1.281 p=0.200		-1.281 p=0.200		

Income status					
Income less than expenditure	74.00	72.33±10.11	69.00	70.87± 9.41	-0.769 p=0.442
Income equals expenses	71.00	72.11±11.15	70.00	71.70±10.42	-0.293 p=0.769
Income more than expenditure	77.00	75.27±16.68	74.00	73.00±10.95	-1.189 p=0.234
KW[c] p	3.377 p=0.185		0.539 p=0.764		
	SCS Attitude Subdimension		**SCS Attitude Subdimension**		
Gender					
Male	50.50	50.66±9.34	51.00	52.31±8.24	-1.236 p=0.216
Female	50.00	51.67±7.89	49.00	50.62±8.01	-1.274 p=0.203
Z[a] p	-0.426 p=0.670		-1.082 p=0.279		
Income status					
Income less than expenditure	51.00	50.60±7.59	47.00	49.13±7.50	-0.172 p=0.864
Income equals expenses	49.00	50.42±8.61	51.00	51.60±8.18	-0.633 p=0.527
Income more than expenditure	56.00	54.67±10.84	57.00	55.00±8.16	-0.283 p=0.777
KW[c] p	5.195 p=0.074		3.894 p=0.143		
	SCS Behavior Subdimension		**SCS Behavior Subdimension**		
Gender					
Male	61.00	60.43±8.57	59.00	60.03±9.66	-0.317 p=0.751
Female	59.00	59.85±11.03	60.00	62.05±7.68	-1.488 p=0.137
Z[a] p	-0.701 p=0.483		-1.034 p=0.301		
Income status					
Income less than expenditure	61.00	59.80±8.82	58.00	58.27±12.13	-0.342 p=0.733
Income equals expenses	60.00	59.71±9.51	59.00	61.10±8.34	-1.179 p=0.238
Income more than expenditure	62.00	63.53±9.63	60.00	61.13±9.56	-0.817 p=0.414
KW[c] p	1.782 p=0.410		0.507 p=0.776		

Z[a]= Pre-test and post-test differences between groups (Mann-Whitney U) Z[b]= Pre-test and post-test differences within groups (Wilcoxon Analizi) KW[c]= Pre-test and post-test differences between groups (Kruskal-Wallis Analizi) *=p<0.05, **=p<0.01, SD: Standard deviation, SCS: Sustainability Consciousness Scale

Table 4. Pre-test SCS knowledge level, total score and subdimensions according to high schools.

	Vocational high school		Science high school		Z, t p
	Median	Mean±SD	Median	Mean±SD	
Knowledge Level	12.00	11.96±3.49	15.00	14.53±3.71	Z=-4.066 **p<0.001*** **
SCS Total Score	183.00	183.80±25.62	199.00	197.38±21.74	t=-3.382 **p=0.001** **
SCS Knowledge Subdimension	72.00	72.56±11.82	81.00	78.22±11.33	t=-2.951 **p=0.004** **
SCS Attitude Subdimension	50.00	51.01±8.84	59.00	58.85±7.15	Z=-5.422 **<0.001*** **
SCS Behavior Subdimension	60.00	60.23±9.44	60.00	60.31±7.94	t=-0.053 p=0.957

Z= Mann-Whitney U, t= Independent Samples t Test, **=p<0.01, ***=p<0.001, SD: Standard deviation, SCS: Sustainability Consciousness Scale

Table 5. *Pre-test and post-test distribution of other descriptive information by high school.

	Vocational high school		Science high school	
	Pre-test	Post-test	Pre-test	Post-test
	n (%)	n (%)	n (%)	n (%)
Energy sources				
Sun	78 (69.0)	73 (64.6)	19 (34.5)	9 (16.4)
Wind	64 (56.6)	72 (63.7)	19 (34.5)	9 (16.4)
Hydroelectricity	10 (8.8)	17 (15.0)	13 (23.6)	6 (10.9)
Geothermal	9 (8.0)	18 (15.9)	11 (20.0)	7 (12.7)
Forests	41 (36.3)	39 (34.5)	5 (9.1)	3 (5.5)
All of them	34 (30.1)	38 (33.6)	36 (65.5)	46 (83.6)
Important issue				
Global warming	82 (72.6)	89 (78.8)	48 (87.3)	44 (80.0)
Noise	63 (55.8)	70 (61.9)	21. (38.2)	26 (47.3)
Air pollution	88 (77.9)	96 (85.0)	40 (72.7)	35 (63.6)
Water pollution	79 (69.9)	88 (77.9)	34 (61.8)	37 (67.3)
Soil pollution	69 (61.1)	82 (72.6)	25 (45.5)	28 (50.9)
Forest fires	83 (73.5)	85 (75.2)	34 (61.8)	36 (65.5)
Other	7 (6.2)	3 (2.7)	4 (7.3)	4 (7.3)
Behavior acquisition environment				
Lessons at school	64 (56.6)	78 (69.0)	37 (67.3)	48 (87.3)
Friend	65 (57.5)	63 (55.8)	15 (27.3)	19 (34.5)
Family	80 (70.8)	73 (64.6)	38 (69.1)	33 (60.0)
TV	40 (35.4)	40 (35.4)	33 (60.0)	28 (50.9)
Internet	69 (61.1)	71 (62.8)	41 (74.5)	42 (76.4)
Journal	19 (16.8)	17 (15.0)	18 (32.7)	11 (20.0)
Other	1 (0.9)	1 (0.9)	1 (1.8)	0 (0.0)

Gathering areas				
Schools	77 (68.1)	88 (77.9)	29 (52.7)	24 (43.6)
Supermarkets	23 (20.4)	39 (34.5)	14 (25.5)	17 (30.9)
Retail battery dealers	18 (15.9)	28 (24.8)	4 (7.3)	7 (12.7)
Hospitals	44 (38.9)	58 (51.3)	13 (23.6)	14 (25.5)
Public institutions and organizations	28 (24.8)	30 (26.5)	13 (23.6)	15 (27.3)
Hotels	8 (7.1)	14 (12.4)	0 (0.0)	2 (3.6)
Industrial organizations	12 (10.6)	22 (19.5)	7 (12.7)	2 (3.6)
Mukhtar Offices	18 (15.9)	33 (29.2)	12 (21.8)	11 (20.0)
All of them	20 (17.7)	17 (15.0)	19 (34.5)	27 (49.1)
Parsing criteria				
Shapes of batteries	36 (31.9)	43 (38.1)	7 (12.7)	19 (34.5)
Physical dimensions	18 (15.9)	26 (23.0)	6 (10.9)	12 (21.8)
Weights	23 (20.4)	28 (24.8)	4 (7.3)	9 (16.4)
Electromagnetic properties	51 (45.1)	37 (32.7)	20 (36.4)	21 (38.2)
Markings on the outer labels	19 (16.8)	22 (19.5)	13 (23.6)	17 (30.9)
All of them	38 (33.6)	44 (38.9)	27 (49.1)	26 (47.3)
Preventing problems				
Planting a sapling	18 (15.9)	19 (16.8)	5 (9.1)	4 (7.3)
Collection of dead batteries	14 (12.4)	17 (15.0)	5 (9.1)	4 (7.3)
Throwing garbage in the garbage bin	15 (13.3)	16 (14.2)	4 (7.3)	3 (5.5)
Using recycling bins	14 (12.4)	14 (12.4)	5 (9.1)	4 (7.3)
Installing filters on factory chimneys	11 (9.7)	15 (13.3)	4 (7.3)	2 (3.6)
All of them	93 (82.3)	86 (76.1)	50 (90.9)	49 (89.1)
Recyclable substances				
Glass	55 (48.7)	51 (45.1)	23 (41.8)	24 (43.6)
Paper	77 (68.1)	69 (61.1)	24 (43.6)	29 (52.7)
Aluminum	17 (15.0)	18 (15.9)	6 (10.9)	12 (21.8)
Plastic	69 (61.1)	68 (60.2)	21 (38.2)	27 (49.1)
Electronic wastes	34 (30.1)	24 (21.2)	8 (14.5)	14 (25.5)
Textile	15 (13.3)	19 (16.8)	11 (20.0)	13 (23.6)
All of them	29 (25.7)	39 (34.5)	30 (54.5)	24 (43.6)
Recycling emblem	95 (84.1)	100 (88.5)	52 (94.5)	54 (98.2)
Bicycle use	52 (46.0)	46 (40.7)	12 (21.8)	22 (40.0)
Paper reuse	65 (57.5)	70 (61.9)	47 (85.5)	51 (92.7)
*(More than one option is marked in this table)				

Discussion

In our study, while the total score of the SCS was found to be "moderate" in vocational high school students, it was found to be "high" in science high school students. In a study conducted with 1459 high school students in the Black Sea region, the mean total score of SCS was found to be 165.3, which was at a moderate level (12). In a study examining the effect of environmental education on university students' knowledge and attitudes towards waste separation, the knowledge level of the students in the trained group was high with 74%, while this rate was 49% in the control group and was at a medium level (13). The reason why it was found to be high in our study may be the difference between regions.

The post-test median scores of both male and female students of both science and vocational high schools are statistically significantly higher. In a study examining drawings related to zero waste made with 18 students studying in the 5th grade of primary school in Kahramanmaraş province, it was determined that waste awareness and recycling in female students and environmental protection and environmental cleaning in male students were more sensitive (14). In a study examining the environmental attitudes of secondary school students and their views on environmental education, the attitude score of females was found to be significantly higher than that of males (15). In a study conducted by universities on environmental awareness, it was found that women's actions sub-dimension scores were higher than men's (16). It was observed that the level of knowledge about waste batteries among female and male students increased especially after the training. Therefore, health education should be emphasized in schools. It has been observed that women's knowledge and attitudes about the environment are higher than men, and it is recommended that this situation should not be ignored in the education and curriculum.

In both science and vocational high school students, the post-test median scores of students whose family income was equal to their expenses and whose income was higher than their expenses were statistically significantly higher. Secondary school students with higher family income were found to have higher levels of awareness on environmental education (17). In a study conducted among vocational high school students, knowledge of e-waste management was not found to be related to the monthly income of the family (18). The development of the individual's income status and welfare may also grow. There is a need for more registered slaves according to income groups. There are very few studies in the literature on the sustainability of waste batteries conducted with high school students.

There was no statistically significant difference in the behavior subdimension according to gender and family income in both science and vocational high school students. In a study involving 15 science and technology teachers working in the province of Kocaeli, the least of the findings regarding the contributions of the activities they carried out to raise environmental awareness to the students was to make them become behaviors (19). It was observed that the post-test averages of behavioral scores regarding values in which applied environmental education was evaluated in 6th grade secondary school did not change according to gender (20). Students having high level of environmental knowledge does not mean that positive behavior will develop, you can not be sure about behavioral changes. The student needs to be gathered as a whole (family, servant, friend etc.). Information of applied and practical environmental health trainings.

The post-test knowledge level, total score, knowledge subdimension and attitude subdimension median score in science high schools were higher than those in vocational high schools and statistically significant. However, no significant difference was found in the behavior subdimension in both science and vocational high schools. In a study evaluating the knowledge and attitudes of university students regarding e-waste recycling practices, a significant relationship was found between knowledge, attitude and practice (21). In a study examining the knowledge, attitudes and practices regarding solid waste management among university students, a significant relationship was found between knowledge, attitudes and practices. (22). Although the changes made are

at different levels of education, it is expected that the knowledge, attitude and inclusion of environmental education will cause a difference. In a performance study examining the effects of environmental education on environmental awareness and attitudes in secondary school in out-of-school learning environments, significant differences were observed in the post-test knowledge and attitude dimensions of environmental awareness. However, no difference was detected in the behavior dimension (23). In a study examining the effect of environmental education on secondary school students' approach to environmental problems in Türkiye, it was observed that a 1 point increase in environmental education caused a 0.24 point increase in environmental awareness (24). In a study examining the effects of environmental education supported by extracurricular activities on 7th grade students, knowledge and attitude post-test scores were found to be statistically significant (25). Environmental training may have increased environmental awareness.

Conclusion

Waste batteries are an important issue that we need to address both in terms of our environment, human health and sustainability, which we will probably use more and more in the future as technological products such as smartphones, laptops, electric vehicles, which we use widely in our lives, become more and more widespread in our lives. Based on our research, trainings should be made widespread at high school and even earlier at all other educational levels to increase students' awareness, knowledge and sustainability awareness about waste batteries, and measurement and evaluation studies should be carried out to assess the current situation in this regard.

Contact: Esra Çiçek
E-Mail: esracicekakademik@gmail.com

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