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# Raising awareness in sustainable environment education: Waste batteries

Dilek Celikler [1*], Zeynep Aksan [2], Ayhan Yilmaz [3]

[1] Deparment of Science and Mathematics Education, Faculty of Education, Ondokuz Mayıs University, Samsun, TURKEY
[2] Science Education, Sinop, TURKEY
[3] Department of Science and Mathematics Education, Faculty of Education, Hacettepe University, Ankara, TURKEY
***Corresponding Author:** dilekc@omu.edu.tr

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**ABSTRACT**

The aim of this study is to provide training for science teachers on batteries, areas of use of batteries, types of batteries, things that should be paid attention to while using batteries, waste batteries, and collection, handling, recovery and/or disposal of waste batteries, and help teachers receiving the training to raise awareness among grade 5 students on these issues. The study was carried out with 58 science teachers and 575 secondary school grade 5 students. Within the scope of the study, a detailed training on the issue was provided to the teachers and attempts at raising awareness among students in four lessons were made by the teachers receiving the training. Data were obtained by making students draw "adventure of the waste battery" themed pictures and write "story of the waste battery" themed compositions as a pre-test before the workshop and a post-test after the workshop. Data were analyzed using content analysis. As a result of the study, it was observed that awareness was raised among students on the elements available in batteries, battery powered objects, points of disposal for waste batteries, places of waste battery bins, recycling of waste batteries, positive effects of collection of waste batteries, negative effects of waste batteries, and things to be done to avoid these negative effects.

**Keywords:** sustainability, waste battery, awareness, secondary school student

## INTRODUCTION

Many materials used in daily life are handled due to their different features in terms of recycling and recovery with regards to environmental problems they cause, economic factors and cautious use of national resources. Some of the materials which contain very different substances require complex processes for recycling and recovery. It is necessary to consider different types of metals in the recycling and recovery processes of batteries that contain recyclable metals (e.g., nickel) and toxic metals (e.g., cadmium) (Nogueira & Margarido, 2007). The fact that waste batteries with toxic features are abundant and resistant creates a great threat for environment and health (Bernandes et al., 2004; Kierkegaard, 2007).

One of the materials that are commonly used in daily life is batteries. Common use of batteries arises the problem of waste batteries, which are regarded within the scope of dangerous waste. Thus, it is necessary to be more careful about the use of batteries and waste batteries. Avoiding unnecessary use of batteries, having the awareness that could contribute to the disposal of waste batteries in a way that harms the environment and human health at a minimum scale and acting in line with this awareness are required to form a healthy environment. It is vital to conduct public regulations in addition to personal efforts (Yavuz et al., 2013).

Awareness plays an important role in understanding the level of knowledge that individuals have about environmental problems, realizing the necessity of tackling environmental problems, and revealing how much of what they know they have or should strive to implement (Malkoc, 2011). Awareness is a mind and body practice that involves focusing attention on momentary experiences and observing internal experiences (Kabat-Zinn, 2005), a process in which the flow of internal and external stimuli is observed without judgment (Baer, 2003). According to Siegel et al. (2009) awareness is expressed as the discrimination and acceptance of subjective experiences while it is seen as the attention is directed to the flow of instant experiences, voluntarily, and without judgment by Kabat-Zinn (2003).

The main purpose in environmental education; to raise individuals who are knowledgeable about the bio-physical, socio-cultural environment and environmental problems, who are motivated to gain the skills necessary to solve environmental problems and are aware of how they can contribute to the solution. In addition, defining the psychological, sociological, economic, ideological, political and cultural dimensions affecting and determining the behavior of the individual in environmental issues and

revealing their contributions are among the objectives of environmental education (Uzunoglu, 1996). Considering the purpose and objectives of environmental education, it is necessary to raise environmentally conscious and sensitive individuals for the protection and efficient use of the environment and natural resources. Raising environmentally conscious and responsible individuals is possible with teachers who are well-equipped with environmental awareness and environmental issues. For this reason, it is extremely important to raise awareness of teachers and students about environmental awareness through relevant institutions and organizations, and to create a sustainable awareness about waste batteries that cause heavy metal pollution in the soil and recycling. At the same time, it is considered that it is important to popularize environmental awareness and recycling culture in our country by transferring knowledge, skill, culture, and positive behavioral changes developed in the target audience to their close connections.

Raising individuals with environmental consciousness is possible with teachers who are sufficiently equipped with environmental consciousness and environmental issues. Therefore, it is highly important that teachers and students are informed about environmental consciousness by relevant institutions and organizations and that a sustainable consciousness is raised about waste batteries causing heavy metal pollution in soil and their recycling. A sustainable environment is possible through raising informed, conscious and aware individuals. Raising informed, conscious and aware individuals is possible with teachers to whom the future generations are commended. In this regard, the aim of this study is to educate science teachers about batteries, where batteries are used, types of batteries, what should be paid attention to while using batteries, waste batteries, and collection, handling, recovery and or disposal of waste batteries, and then, for these teachers to raise the awareness of fifth-grade students about these subjects. There are studies on raising awareness of middle school students about batteries (Kansu & Tuysuz, 2009), and determining the knowledge (Aksan et al., 2015) and opinions (Yilmaz et al., 2016) of candidate teachers in the relevant literature. There are also studies with educational approach to waste batteries (Celikler & Aksan, 2015; Celikler & Kara, 2015) The limited number of studies on waste batteries shows the importance of this study.

## METHOD

### Study Design and Study Group

The study was designed in one group pre- and post-test experimental design based on its main objective. In the single group pre- post-test experimental pattern, a single group post-test pattern is developed by adding a pre-test to measure the dependent variable before the participants are intervened. These types of studies are thought to be a good way to fulfill the purpose of the research, both in terms of seeing and documenting the change in performance and being easy to understand and use (Christensen et al., 2015). The study was conducted with 58 science teachers who worked at state schools of a city located in the northern Turkey, and 575 middle school fifth-grade student who studies in the same schools.

### Study Process

In the first stage of the study, the teachers were given education about

- what are batteries and where are they used,
- types of batteries,
- what should be considered while using batteries,
- the effects of waste batteries on the environment and living creatures,
- collection of waste batteries,
- recycling process of waste batteries and the disposal of batteries which are impossible to recycle,
- introduction of the training and information materials (poster and waste battery collection boxes) prepared by the Portable Battery Manufacturers and Importers Association (TAP), and
- school campaigns carried out by TAP (prize competition about waste batteries carried out in schools) and schools activities using the “teacher training presentation” which was prepared by TAP in detail.

In the second stage of the study, the teachers who participated in the training provide education to

- middle school students about waste batteries, the effects of waste batteries on the environment and living creatures, collection of waste batteries, recycling process and the disposal of waste batteries which are impossible to recycle using the “school presentation” CD prepared by TAP for the duration of courses. Additionally, it was aimed to raise the students’ awareness by hanging the posters sent by TAP and placing waste battery boxes in school hallways.

Posters sent to schools by TAP are provided in **Figure 1**, and waste battery collection boxes are provided in **Figure 2**.

Examples of the visuals in the “school presentation” CD sent to schools by TAP are provided in **Figure 3**.


**Figure 1.** Posters prepared by TAP (2018)


**Figure 2.** Waste battery collection boxes prepared by TAP (2018)


**Figure 3.** Visual examples on the "school presentation" CD prepared by TAP (2018)

## Data Collection and Analysis

Data were collected by asking students make a drawing about the "the adventure of the waste battery" and write an essay about "the story of the waster battery" before the application as the pre-test and after the application as the post-test. The data were analyzed using the content analysis method. While the main purpose of content analysis is to reach a definite idea in explaining the information collected, the basic method is collecting similar information within the framework of a specific idea and subject, and finding a way to ensure that they are understood by the reader (Yildirim & Simsek, 2011).

In qualitative research, coding procedures by different coders on same data set, and the similarity ratio determining the reliability of the qualitative research are important (Fidan & Ozturk, 2015). Similarity ratio is conceptualized as the consensus

between coders, which is called internal consistency, and according to the coding control, the consensus between coders is expected to be at least 80%, in Miles and Huberman (1994) model (Patton, 2002).

The data obtained from the students' drawings and written statements were coded, grouped, categorized and arranged by two researchers. The reliability coefficient of the study was 90.29%. Considering the content analysis of drawings and essays obtained in the study, the main themes of the "elements in the batteries," "usage areas of batteries," "places where waste batteries are thrown," "the places where the waste battery boxes are," "positive effects of collecting waste batteries," "negative effects of waste batteries," "recycling of waste batteries," "what to do to prevent the negative effects of waste batteries," and "message" were determined.

## RESULTS

The distribution of the response frequencies of the elements in the battery stated by the students in their pre- and post-test drawings on "the adventure of the waste battery" and their composition on "the story of the waste battery" are provided in **Figure 4** and **Figure 5**. When **Figure 4** and **Figure 5** are examined, it can be seen that the students stated the elements in the battery as heavy metals, mercury, zinc, carbon, lead and cadmium in both the pre- and post-test drawings, as well as in the pre- and post-test compositions, and their awareness of these elements increased in the post-test.

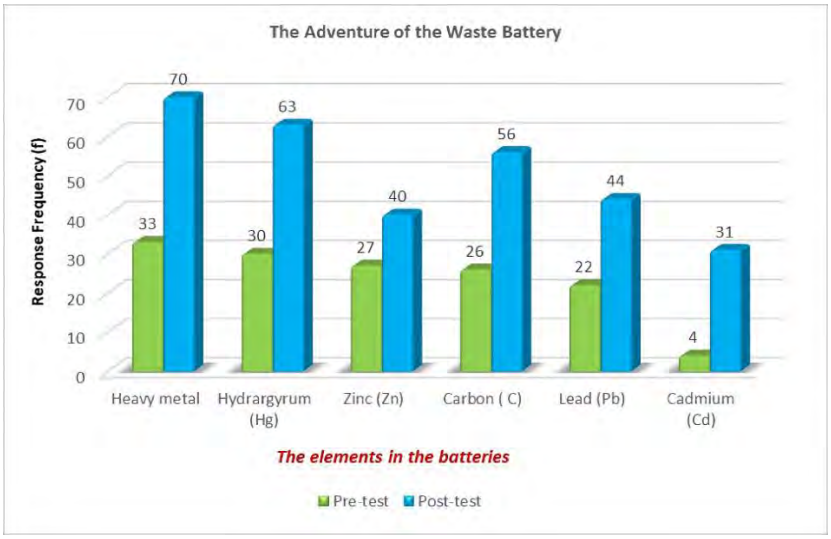



**Figure 4.** The distribution of the elements in the batteries in the pre- & post-test drawings on "the adventure of the waste battery" (Source: Authors' own elaboration)

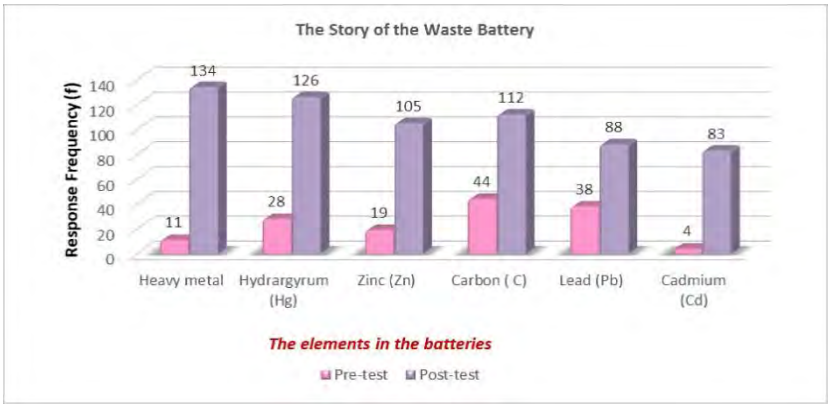



**Figure 5.** The distributions of the elements in the batteries in the pre- & post-test composition on "the story of the waste battery" (Source: Authors' own elaboration)

The distribution of the response frequencies of the usage areas of the batteries stated by the students in their drawings on "the adventure of the waste battery" and their composition on "the story of the waste battery" in the pre- and post-test are provided in **Figure 6** and **Figure 7**.

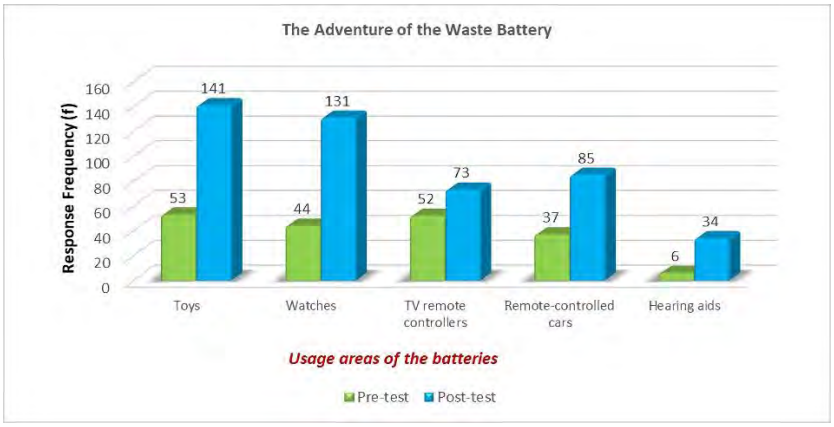



**Figure 6.** The distribution of usage areas of the batteries in the pre- & post-test drawings on "the adventure of the waste battery" (Source: Authors' own elaboration)

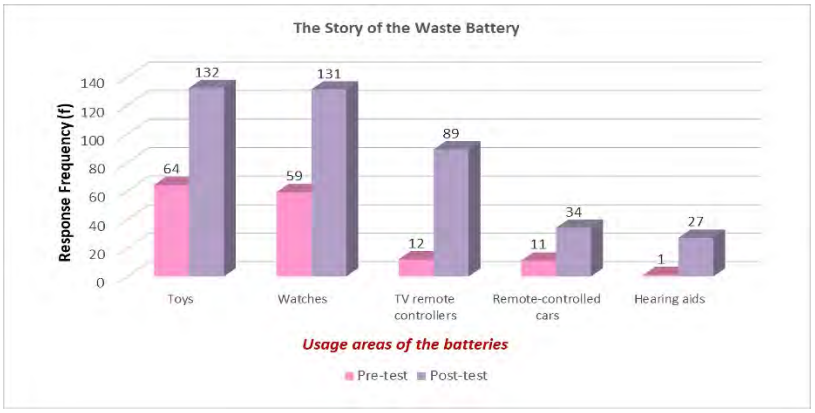



**Figure 7.** The distribution of usage areas of the batteries in the pre- & post-test drawings on "the story of the waste battery" (Source: Authors' own elaboration)

When **Figure 6** and **Figure 7** are examined, it can be seen that students stated the usage area of the batteries as toys, watches, TV remote controllers, remote-controlled cars, hearing aids, which are the items in which they use batteries frequently in their daily life, in both the pre- and post-test drawings, as well as in pre- and post-test compositions. In the post-test, it was determined that the students' awareness of the items using batteries, which they frequently encounter in daily life, increased.

The distribution of the response frequencies of the places where the waste batteries are disposed stated by the students in their pre- and post-test drawings on "the adventure of the waste battery" and their composition on "the story of the waste battery" are provided in **Figure 8** and **Figure 9**.

When **Figure 8** was examined, it was determined that the students drew about the place where the waste batteries were thrown mostly as garbage bins, sea, recycling bins, nature, and waste battery boxes in their pre-test drawings. In the post-test drawings, it was seen that the most students drew battery boxes, and a small number of students drew garbage bins and recycling bins. When **Figure 9** was examined, it was determined that, in the pre-test compositions, students expressed garbage, recycling bins, nature, waste battery boxes, and sea as where the waste batteries thrown mostly. In the post-test drawings, it was seen that the most students expressed battery boxes, and a small number of students expressed garbage bins and recycling bins.

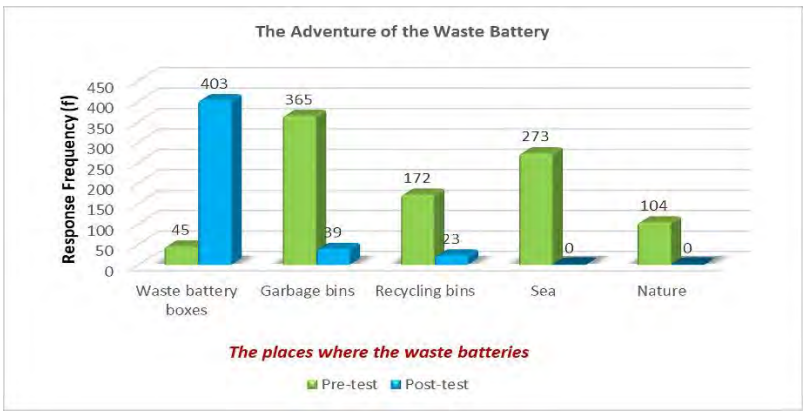



**Figure 8.** The distribution of the places, where the waste batteries are disposed in the pre- & post-test drawings on "the adventure of the waste battery" (Source: Authors' own elaboration)

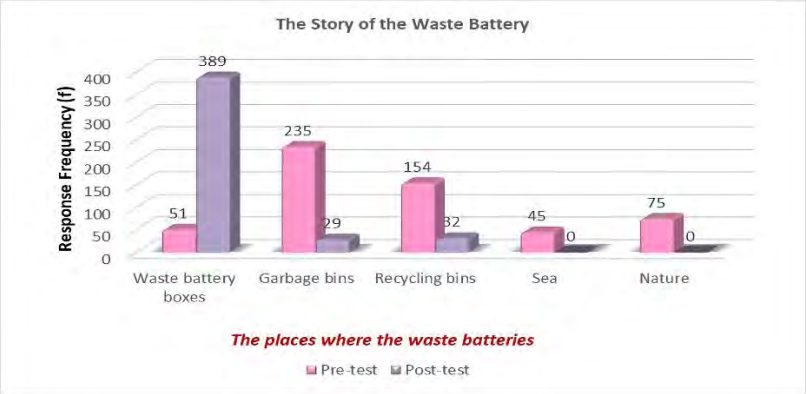



**Figure 9.** The distribution of the places, where the waste batteries are disposed in the pre- & post-test drawings on "the story of the waste battery" (Source: Authors' own elaboration)

Both the post-test drawings and the post-test compositions of the students reveal that the awareness of the students about the places where the waste batteries are disposed of has increased.

The distribution of the response frequencies of the locations of the waste battery boxes stated by the students in their pre- and post-test drawings on "the adventure of the waste battery" and their composition on "the story of the waste battery" are provided in **Figure 10** and **Figure 11**.

When **Figure 10** is examined, it can be seen that the places where the waste batteries are used in were the schools and markets in the pre-test drawings of most of the students and it was seen that fewer students drew health centers, hospitals, shopping centers, pharmacies and headman offices. In the post-test, it was determined that most of the students drew schools, markets and hospitals, some of them drew health centers and shopping centers, and a few students drew the headman offices and pharmacies. When **Figure 11** is examined, it can be seen that the places where the waste batteries are used in were the schools and markets in the pre-test compositions of most of the students, some students wrote about shopping centers, and fewer students wrote about hospitals, health centers, pharmacies and headman offices. In the post-test, it was determined that most of the students wrote about schools, markets, shopping centers, and some of them refer to health centers, hospitals and headman offices and pharmacies.

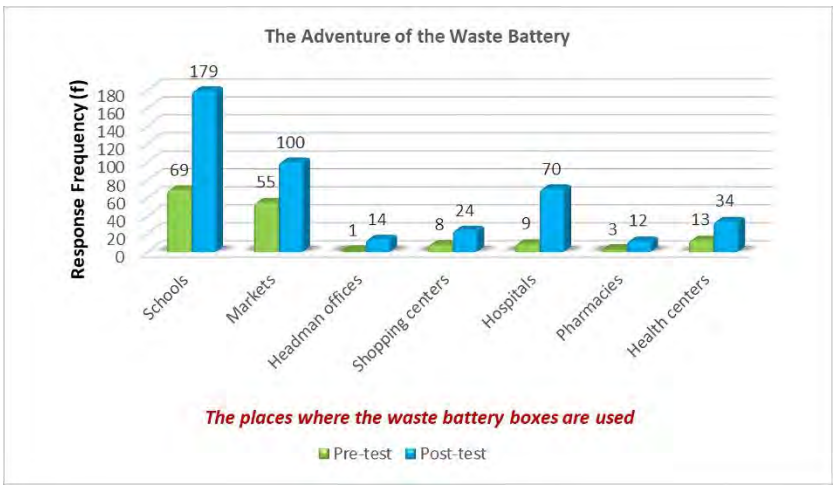



**Figure 10.** The distribution of the places, where the waste battery boxes are used in the pre- & post-test drawings on "the adventure of the waste battery" (Source: Authors' own elaboration)

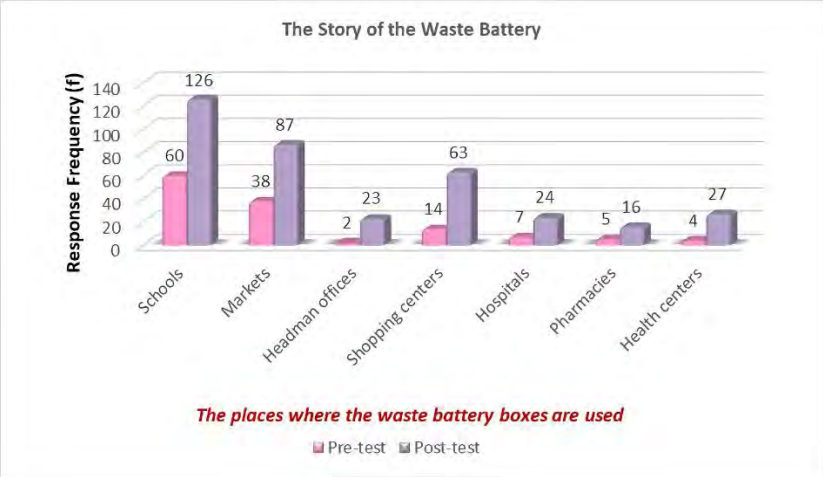



**Figure 11.** The distribution of the places, where the waste battery boxes are used in the pre- & post-test drawings on "the story of the waste battery" (Source: Authors' own elaboration)

Both the post-test drawings and the post-test compositions of the students show that students' awareness on the places where the waste battery boxes are located has increased.

The distribution of the response frequencies of the negative effects of waste batteries stated by the students in their pre- and post-test drawings on "the adventure of the waste battery" and their composition on "the story of the waste battery" are provided in **Figure 12** and **Figure 13**.

When **Figure 12** is examined, it can be seen that in pre-test the students made drawings showing the negative effects of waste batteries on the environment, flowers, living creatures, water, soil, health, vegetables and fruits, fishes, trees, and the sea. In the post-test, it was determined that most of the students made drawings showing the negative effects of waste batteries on trees, environment, flowers, soil, health, living creatures, and fish.

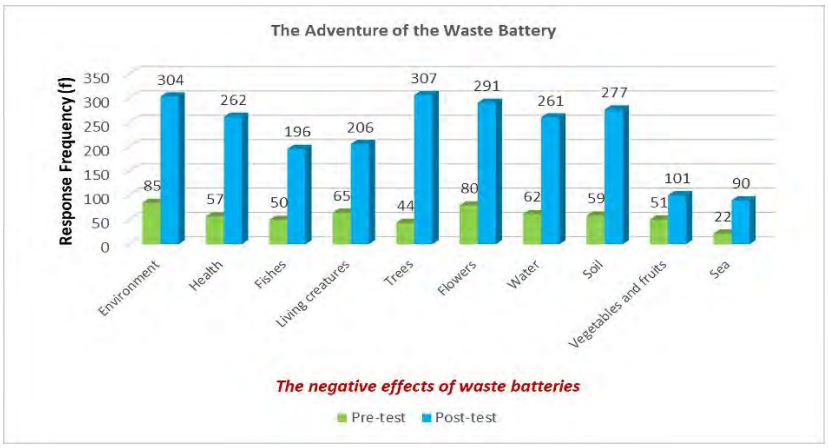



**Figure 12.** The distribution of the negative effects of waste batteries in the pre- & post-test drawings on "the adventure of the waste battery" (Source: Authors' own elaboration)

When **Figure 13** is examined, it can be seen that, in their pre-test compositions, the students wrote about the negative effects of waste batteries on the environment, living creatures, flowers, water, soil, trees, fishes, health, vegetables and fruits, and the sea. In the post-test, it was determined that most of the students wrote about the negative effects of waste batteries on the environment, trees, soil, health, living creatures, water, and fish.

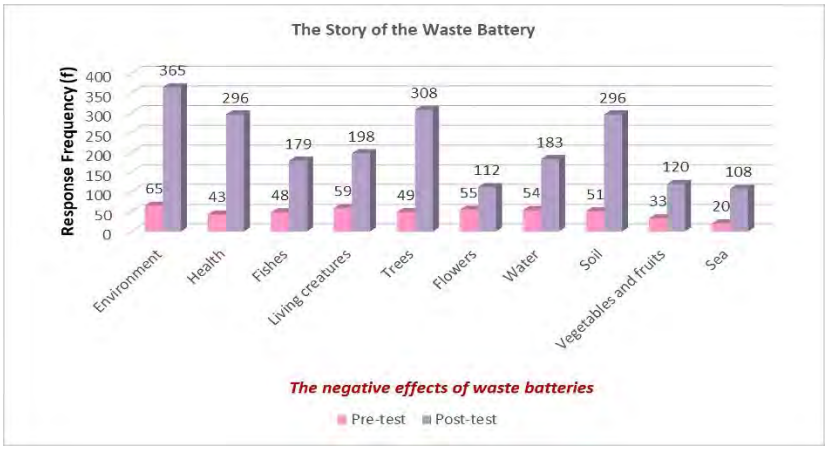



**Figure 13.** The distribution of the negative effects of waste batteries in the pre- & post-test drawings on "the story of the waste battery" (Source: Authors' own elaboration)

Both the post-test drawings and the post-test compositions of the students shows that students' awareness has increased about the negative effects of waste batteries.

The distribution of the response frequencies of the positive effects of collecting waste batteries stated by the students in their pre- and post-test drawings on "the adventure of the waste battery" and their composition on "the story of the waste battery" are provided in **Figure 14** and **Figure 15**.

When **Figure 14** is examined, it can be seen that the students made drawings showing the positive effects of collecting waste batteries on the protection of water, nature, health, trees, and soil. In the post-test, it was determined that most of the students made drawings on protection of trees, health, water, and nature.

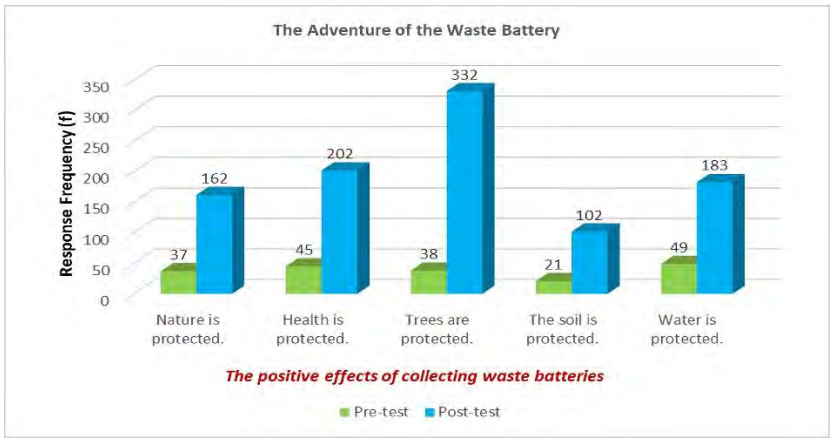



**Figure 14.** The distribution of the positive effects of collecting waste batteries in the pre- & post-test drawings on "the adventure of the waste battery" (Source: Authors' own elaboration)

When **Figure 15** is examined, it was determined that, in the pre- and post-test compositions, the students wrote about the positive effects of collecting waste batteries on the protection of nature, soil, health, water, and trees.

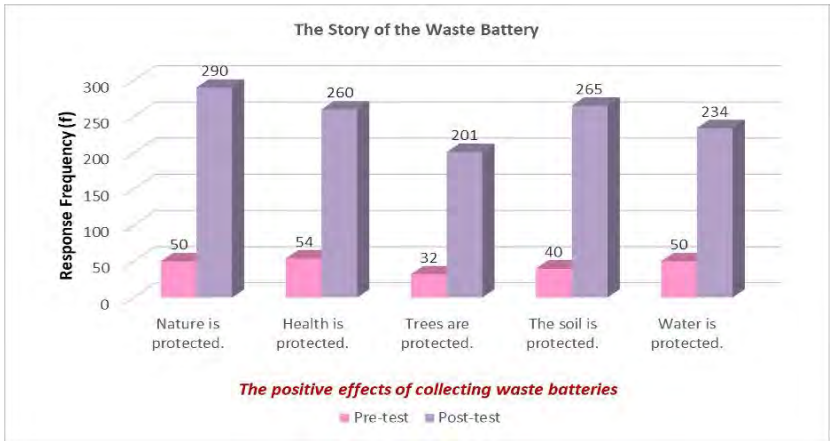



**Figure 15.** The distribution of the positive effects of collecting waste batteries in the pre- & post-test drawings on "the story of the waste battery" (Source: Authors' own elaboration)

Both the post-test drawings and the post-test compositions of the students shows that students' awareness has increased about the positive effects of collecting waste batteries.

The distribution of the response frequencies of the expressions about recycling waste batteries of students in their pre- and post-test drawings on "the adventure of the waste battery" and their composition on "the story of the waste battery" are provided in **Figure 16** and **Figure 17**.

When **Figure 16** is examined, it can be seen that, in the pre-test, most of the students made drawings of children throwing waste batteries in garbage bins and children throwing waste batteries in recycling bins. In the post-test, it was determined that most of the students drew children throwing waste batteries into waste battery bins, and some of the students drew recycling factories, TAP, and waste battery collection vehicles.

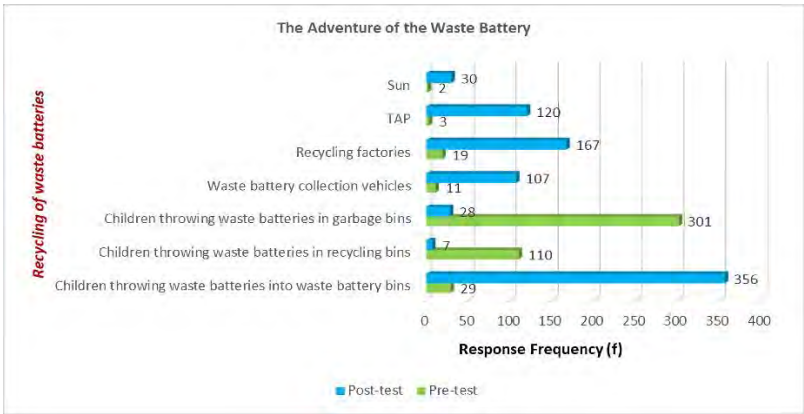



**Figure 16.** The distribution of expressions about the recycling of waste batteries in the pre- & post-test drawings on "the adventure of the waste battery" (Source: Authors' own elaboration)

When **Figure 17** is examined, it was determined that, in the pre-test compositions, most of the students used expressions about the children who throw waste batteries in garbage bins and children who throw waste batteries in recycling bins. In the post-test, it was determined that most of the students used expressions about children throwing batteries into the waste battery bins, and some of them used expressions about TAP, waste battery collection vehicles, and recycling factories.

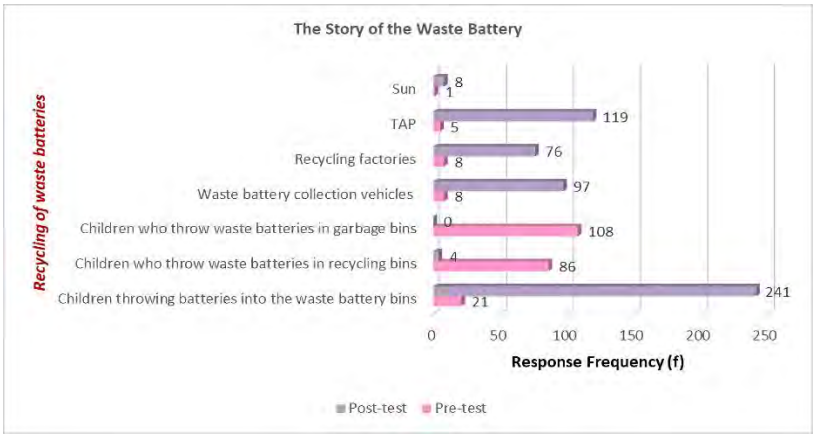



**Figure 17.** The distribution of expressions about the recycling of waste batteries in the pre- & post-test drawings on "the story of the waste battery" (Source: Authors' own elaboration)

Both the post-test drawings and the post-test compositions of the students shows that students' awareness has increased about the recycling of waste batteries.

The distribution of the response frequencies of what can be done to prevent the negative effects of waste batteries stated by the students in their pre- and post-test drawings on "the adventure of the waste battery" and their composition on "the story of the waste battery" are provided in **Figure 18** and **Figure 19**.

When **Figure 18** is examined, it can be seen that, in the pre-test, most of the students draw about not throwing waste batteries into the nature as a response to what can be done to prevent the negative effects of waste batteries. In the post-test, it was determined that most of the students drew about not throwing waste batteries into the nature, preparing brochures and posters, and shooting commercials, some of the students drew about raising public awareness about the harmful effects of waste batteries, and few students drew about establishing recycling facilities for waste batteries.

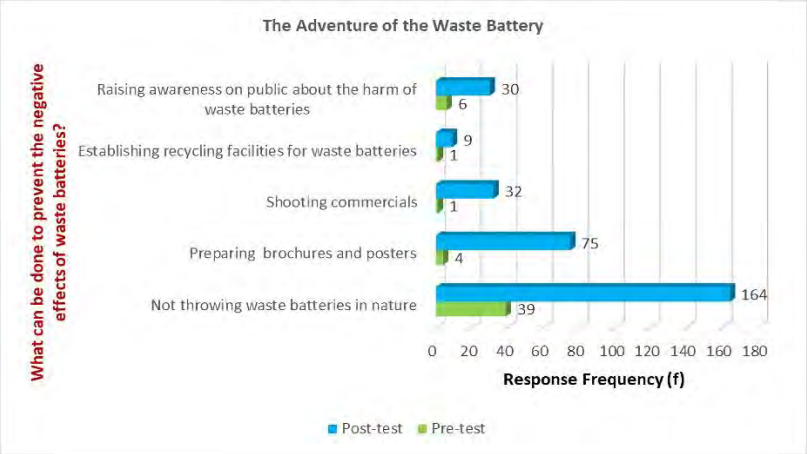



**Figure 18.** The distribution of what can be done to prevent the negative effects of waste batteries in the pre- & post-test drawings on "the adventure of the waste battery" (Source: Authors' own elaboration)

When **Figure 19** was examined, it was seen that in the pre-test compositions, most of the students stated that the waste batteries should not be thrown into the nature as an example of what can be done to prevent the negative effects of waste batteries. In the post test, it was determined that while most of the students stated that the waste batteries should not be thrown into the nature and awareness of the society should be raised about the negative effects of waste batteries, some of them stated that recycling facilities should be established for waste batteries, and brochures and posters should be prepared. It was observed that very few students considered shooting commercials.

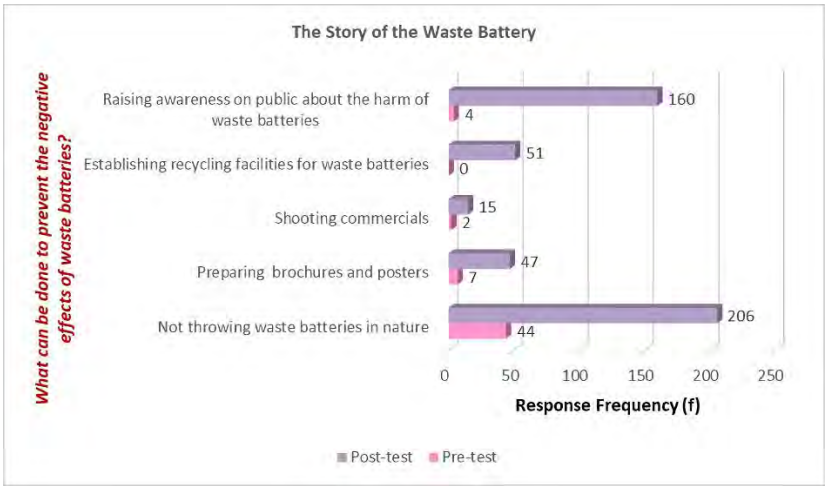



**Figure 19.** The distribution of what can be done to prevent the negative effects of waste batteries in the pre- & post-test drawings on "the story of the waste battery" (Source: Authors' own elaboration)

Both the post-test drawings and the post-test compositions of the students shows that students' awareness has increased about what can be done to prevent the negative effects of waste batteries.

The distribution of the response frequencies of the messages given by the students in their pre- and post-test drawings on "the adventure of the waste battery" and their composition on "the story of the waste battery" are provided in **Figure 20** and **Figure 21**.

When **Figure 20** was examined, it was found that most of the students did not draw anything in the pre-test. Most of the students who draw something were determined to give the messages of "throw the batteries in the box, not on the ground" and "batteries are not garbage" in their drawings. In post-test, it was determined that the messages in the drawings of most of the students were mainly; "do not ruin your life by throwing the waste batteries into the garbage cans", "throw your batteries into the waste battery box instead of on the ground", "batteries are not garbage", "throw the batteries into the waste battery box instead of garbage bins", "do not let the world's battery run out", and "do not throw batteries on ground, do not risk your life".

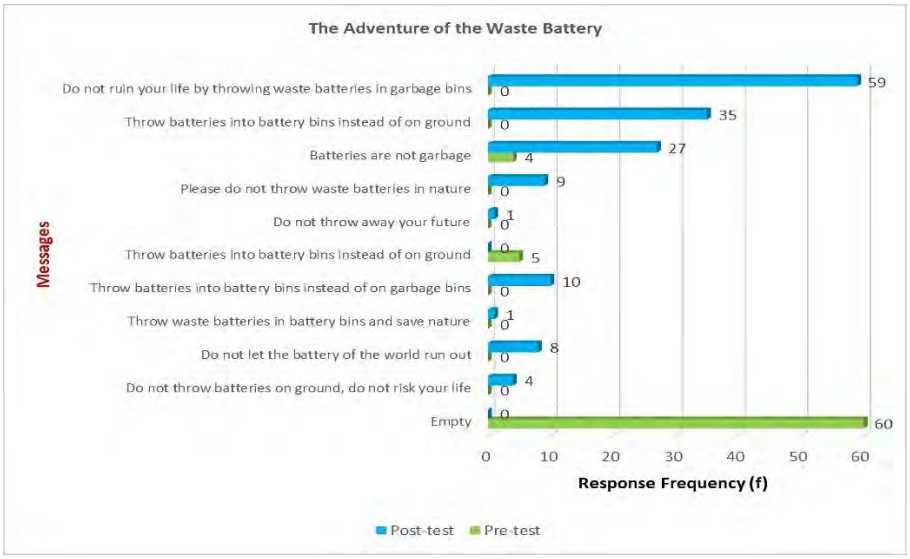



**Figure 20.** The distribution of the messages provided in pre- & post-test drawings on "the adventure of the waste battery" (Source: Authors' own elaboration)

When **Figure 21** was examined, it was determined that most of the students did not write anything in the pre-test. It was observed that the messages in the composition of the students who wrote were "batteries are not garbage" and "throw the batteries into the waste battery box, not on ground". In post-test, it was determined that the messages in the compositions of most of the students were mainly; "batteries are not garbage", "the battery of the world should not run out", "throw the batteries into the waste battery box instead of on the ground", "throw the batteries into the waste battery box instead of on the ground", "do not ruin your life by throwing waste batteries into the garbage bins".

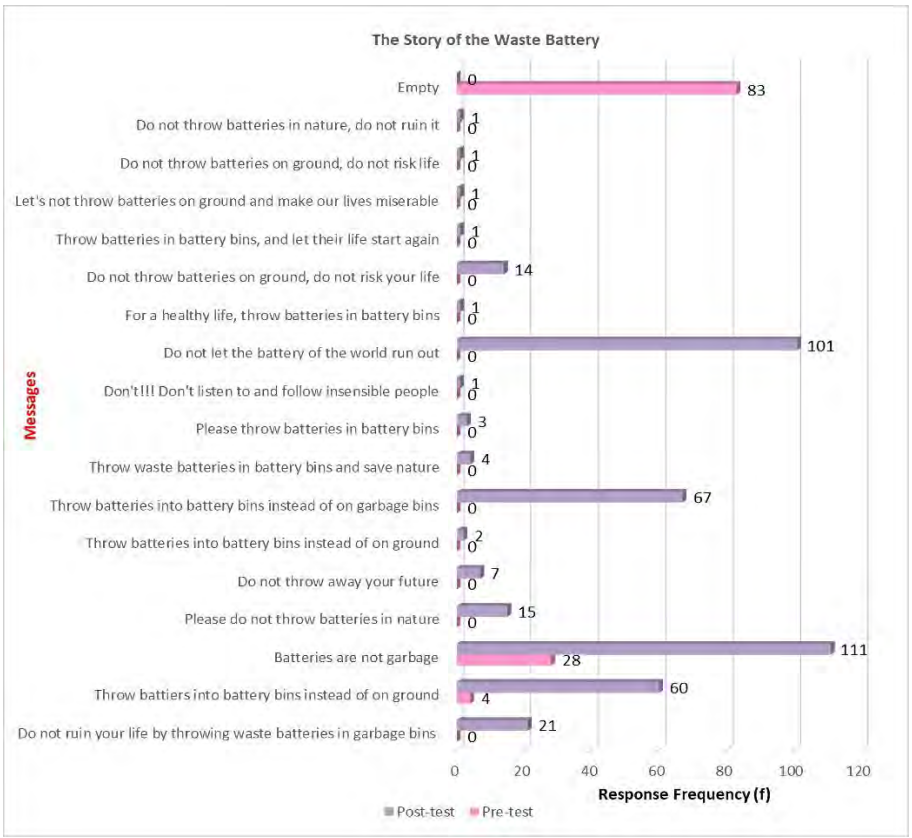
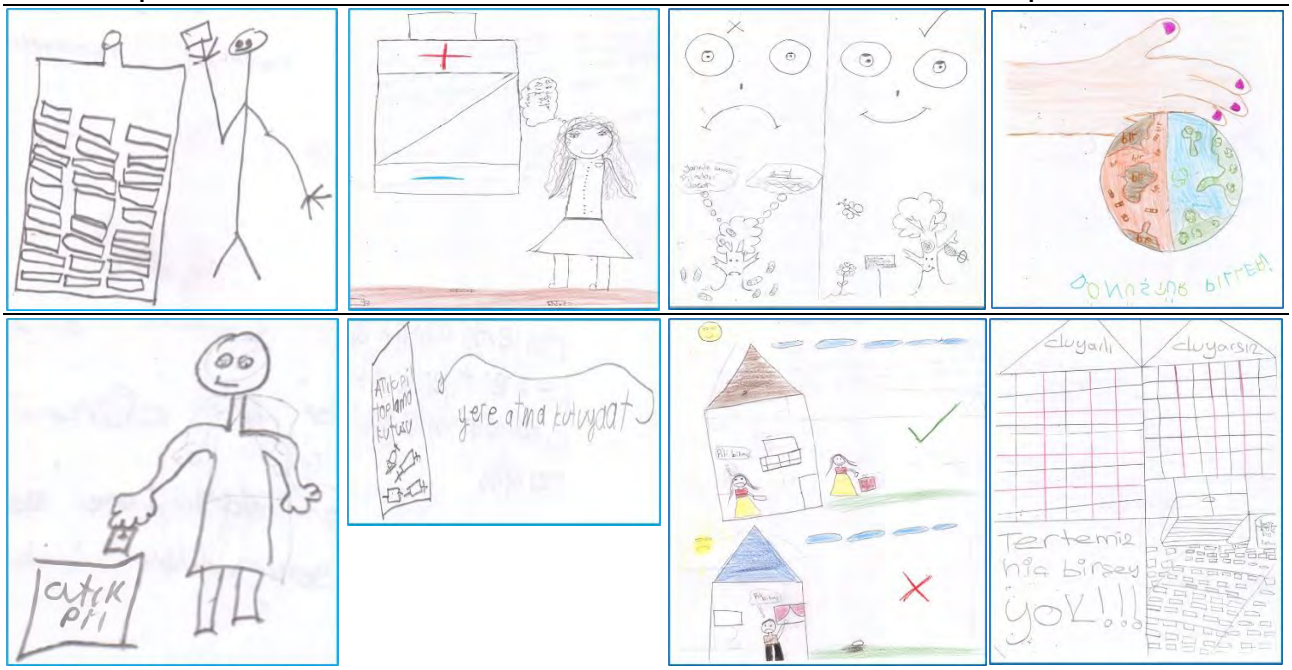



**Figure 21.** The distribution of the messages provided in pre- & post-test drawings on "the story of the waste battery" (Source: Authors' own elaboration)

Pre- and post-test examples of drawings of the students about "the adventure of the waste battery" are provided in **Table 1**.

**Table 1.** Drawing examples of "the adventure of the waste battery" in the pre- & post-test

| **The adventure of the waste battery** | |
|---|---|
| **Pre-test examples** | **Post-test examples** |
|  | |

Pre- and post-test examples of composition written by students about "the story of the waste battery" are given in **Table 2**.

**Table 2.** Drawing examples of "the story of a waste battery" in the pre- & post-test

| **The story of the waste battery** | |
|---|---|
| **Pre-test examples** | **Post-test examples** |
| **$E_{7}$:** "Batteries are actually very useful. But when thrown into the nature, those useful batteries damage our nature and natural resources. That is why we should not throw batteries into the nature." | **$E_{159}$:** "Hello, I am a battery. Until I was thrown out I was lying behind the remote control, one day after, my owner threw me out. Turns out I was dead. Then nothing would have happened if he had thrown me into the recycling bin instead of throwing me on the ground. My owner, I am calling out to you: take me out of here and throw me in where I belong." |
| **$E_{81}$:** "If there is a waste battery at home, it could harm us if we throw it out. Therefore, we should throw it in the waste battery box. If we do not throw them in the box, the batteries will not be recycled, and we will not get any more batteries." | **$E_{347}$:** "Hello I am battery, When I opened my eyes to the world, I was getting labeled in a factory. Then they sent me to the markets for the toys to work. The children loved toys very much. But my strength was running low. They threw me in the trash, but they damaged their own health instead. However, it would be more beneficial for our environment if they recycled me. This is my recommendation, recycle your used batteries. Don't ruin your life by throwing them out." |
| **$E_{254}$:** "We should not throw the batteries on the ground. If we throw the batteries on the ground, it will both damage the world and smell bad." | **$E_{502}$:** "I was a waste battery, and then my owner threw me in a trash can. Then a girl came and saw me. She talked to me until she threw me into the waste battery box and now, I was sent into my own house. I had a lot of friends there, and after that day I was very happy as a waste battery. From now on, I should say to people: Throw your waste batteries into the waste battery box." |

## CONCLUSION, DISCUSSION, AND SUGGESTIONS

It was found that the education given, and practices increased the awareness of students about the elements in the batteries, devices that operate with batteries, places where the waste batteries are thrown, places where the waste battery boxes are, positive effects of collecting waste batteries, recycling of waste batteries, negative effects of waste batteries, and what to do to prevent these effects.

The study also showed that the students emphasized in the essays that they wrote before the application that batteries should be casted down and waste batteries harm the soil and trees, and in their drawings they emphasized that waste batteries should go to waste boxes and the trees are harmed due to the damage caused by waste batteries. After the application, the students emphasized both in their drawings and essays that waste batteries should go to waste battery boxes instead of trashcan, waste batteries cause air, water and soil pollution due to the damages they cause on the environment and living creatures, waste batteries should be recycled, and the environment should be protected.

According to the results of the study, it was revealed that the teachers who received training raised awareness on students with the awareness training they provided using the relevant materials. Additionally, hanging the posters sent by TAP and placing waste battery boxes in school hallways were effective in raising and increasing the awareness of students. Thus, Cetinturk (2014) found that visual materials such as posters, banners, maps, portraits, displayed performance assignments inform students and help to raise consciousness and awareness about the relevant subjects. Moreover, the students participated in the study stated that visuals on the school walls help reinforce what was learned in the lesson, remember the forgotten parts and motivate them in the lesson. It was also found in the same study that posters on the school walls came to forefront among the materials that affect students due to the fact that they get the intended message effectively and in short time to students and their color and design features.

The information activities about recycling were reported to have contributed the most to raising awareness about recycling (Tonglet et al., 2004). Thus, Tufaner (2019) conducted a study with students of the engineering faculty to examine the contribution of recycling information and awareness on waste management and emphasized that informing studies are as important as placing recycling boxes and that informing studies should be continuous to raise awareness about recycling. He also revealed that recycling boxes were first used as regular trashcans at the beginning of the informing study, and that informing studies significantly increased the students' awareness on the fact that recyclable wastes should be collected separately. Huang et al. (2018) state that one-to-one social informing activities are increasing and persuasive on individuals with low awareness about recycling and are positive and have positive effects on the will to join in recycling among individuals who have sufficient awareness. Similarly, Aksan and Celikler (2019, 2020) revealed that awareness education that is about wastes and recycling and includes activities such as finding a slogan, preparing a poster, placing waste boxes, preparing public service ads for recycling and going to a recycling facility is effective in raising awareness and increasing the level of knowledge.

The first step to be taken to create a sustainable environment is to raise informed, conscious and aware individuals. Therefore, the subject of battery recycling should be taught with a quality environmental education starting from pre-school education to higher education programs using student-focused methods and techniques, planning suitable education activities and preparing learning environments. Thus, the must-have environmental consciousness will be raised, and individuals will realize that they are not spending time or place on environmental issues. Associations and foundations that aim to protect the environment should be promoted on visual and written media, scientific activities for both the students and society should be organized and their active participation in these activities should be ensured.

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## REFERENCES

Aksan, Z., & Celikler, D. (2019). Recycling awareness education: Its impact on knowledge levels of science teacher candidates. *International Electronic Journal of Environmental Education, 9*(2), 81-105.

Aksan, Z., & Celikler, D. (2020). Creating awareness of pre-service science teachers about sustainable development for waste recycling. *International Electronic Journal of Environmental Education, 10*(2), 147-166.

Aksan, Z., Harman, G., & Celikler, D. (2015). Evaluation through the use of drawings of the knowledge of science teacher candidates in Turkey regarding the recycling of waste batteries. *International Journal of Sustainable and Green Energy, 4*(1-2), 1-5.

Baer, R. A. (2003). Mindfulness training as a clinical intervention: A conceptual and empirical review. *Clinical Psychology: Science and Practice, 10*, 125-143. https://doi.org/10.1093/clipsy.bpg015

Bernandes, A. M., Espinosa, D. C. R., & Tenorio, J. A. S. (2004). Recycling of batteries: A review of current processes and Technologies. *Journal of Power Sources, 130*, 291-298. https://doi.org/10.1016/j.jpowsour.2003.12.026

Celikler, D., & Aksan, Z. (2015). Evaluation from an educational perspective of the effects of waste batteries on the environment. *International Journal of Sustainable and Green Energy, 4*(1-2), 12-15.

Celikler, D., & Kara, F. (2015). An educational approach to the recycling and disposal of waste batteries. *International Journal of Sustainable and Green Energy, 4*(1-2), 16-18.

Cetinturk, F. (2014). *Okul duvarlarında yer alan görsel materyallerin sosyal bilgiler öğretimindeki yerine ilişkin öğrenci görüşleri* [*Student views on the place of visual materials on school walls in social studies teaching*] [Master's thesis, Gazi University].

Christensen, L. B., Johnson, R. B., & Turner, L. A. (2015). *Research methods, design, and analysis*. Pearson Education Limited.

Fidan, T., & Ozturk, I. (2015). Perspectives and expectations of union member and non- union member teachers on teacher unions. *Eğitim Bilimleri Araştırmaları Dergisi* [*Journal of Educational Sciences Research*], *5*(2), 191-220. https://doi.org/10.12973/jesr.2015.52.10

Huang, Y., Tamas, P., & Harder, M. (2018). Information with a smile–Does it increase recycling? *Journal of Cleaner Production, 178*, 947-953. https://doi.org/10.1016/j.jclepro.2018.01.006

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice, 10*(2), 144-156. https://doi.org/10.1093/clipsy.bpg016

Kabat-Zinn, J. (2005). *Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness*. Bantam Dell.

Kansu, Y., & Tuysuz, C. (2009). Atık pillerle ilgili ortaöğretim öğrencilerinde çevre bilincinin oluşturulması [Creating environmental awareness among secondary school students about waste batteries]. *Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü Dergisi* [*Journal of Suleyman Demirel University Graduate School of Natural and Applied Sciences*]*, 13*(2), 123-127.

Kierkegaard, S. (2007). EU battery directive, charging up the batteries: Squeezing more capacity and power into the new EU battery directive. *Computer Law & Security Report, 23*, 357-364. https://doi.org/10.1016/j.clsr.2007.05.001

Malkoc, H. (2011). *Sınıf öğretmeni adaylarının çevre sorunlarına yönelik tutumlarının ve bilişsel farkındalık becerilerinin incelenmesi* [*Examination of primary school teacher candidates' attitudes towards environmental problems and their cognitive awareness skills*] [Master's thesis, Gazi University].

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. SAGE.

Nogueira, C. A., & Margarido, F. (2007). Chemical and physical characterization of electrode materials of spent sealed Ni–Cd batteries. *Waste Management, 27*, 1570-1579. https://doi.org/10.1016/j.wasman.2006.10.007

Patton, M. Q. (2002). *Qualitative research and evaluation methods*. SAGE.

Siegel, R. D., Germer, C. K., & Olendzki, A. (2009). Mindfulness: What is it? Where did it come from? In F. Didonna (Ed.), *Clinical handbook of mindfulness* (pp. 17-35). Springer. https://doi.org/10.1007/978-0-387-09593-6_2

TAP. (2018). *Taşınabilir Pil Üreticileri ve İthalatçıları Derneği (TAP)* [*Portable Battery Manufacturers and Importers Association (TAP)*]. https://www.tap.org.tr/egitim-ve-bilinclendirme/egitim-sunumlarimiz/

Tonglet, M., Phillips, P. S., & Read, A. D. (2004). Using the theory of planned behavior to investigate the determinants of recycling behaviour: A case study from Brixworth, UK. *Resources, Conservation and Recycling, 41*, 191-214. https://doi.org/10.1016/j.resconrec.2003.11.001

Tufaner, F. (2019). Geri dönüşebilir atıkların toplanması konusunda yapılan bilgilendirme çalışmalarının toplama verimine katkısının araştırılması [Investigation of the contribution of the information studies on the collection of recyclable wastes to the collection efficiency]. *İklim Değişikliği ve Çevre* [*Climate Change and Environment*]*, 4*(1), 33-40.

Uzunoglu, S. (1996). Çevre eğitiminin amaçları, uğraşı alanları ve sorunları [The objectıves of envıronmental education and its research fields and problems]. *Ekoloji Çevre Dergisi* [*Ecology Environment Journal*]*, 6*(21), 7-12.

Yavuz, C. I., Acar Vaizoglu, S., & Guler, C. (2013). Hayatımızdaki piller [Batteries in our lives]. *Sürekli Tıp Eğitimi Dergisi* [*Journal of Continuing Medical Education*]*, 21*(6), 19-25.

Yildirim, A., & Simsek, H. (2011). *Sosyal bilimlerde nitel araştırma yöntemleri* [*Qualitative research methods in the social sciences*]. Seckin Publishing.

Yilmaz, A., Aksan, Z., & Celikler, D. (2016). The views of science teacher candidates regarding the collection, recycling and disposal of waste batteries. *International Journal on New Trends in Education and Their Implications, 7*(3), 79-86.