
An educational approach to the recycling and disposal of waste batteries

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Abstract: The aim of this study was to determine the opinions of students studying Science Teaching in Turkey regarding the recycling and disposal of waste batteries. A total of 80 volunteer, third-year students from the department of science education participated in the study. Based on the study results, it was determined that the large majority of the students had insufficient knowledge regarding the recycling and disposal of waste batteries. To change the students' views that waste batteries can be converted into batteries once again by being processing in factories, or that waste batteries can be disposed of through melting, it is necessary to increase the students' knowledge and awareness on this subject.

Keywords: Waste Batteries, Recycling, Disposal, Science Teaching Student

1. Introduction

As an indispensable part of daily life in the modern world, technology not only facilitates the lives of humans, but also alters the conditions and environment in which they live. In parallel to the developments in technology, a large variety portable devices are nowadays used in daily life, either personally or at home and workplaces. Many of the most commonly used and encountered devices in daily life – such as laptop computers, telephones, watches, cameras and TV remote controls – employ portable cells and batteries as energy source. To prevent any harmful effects on living creatures and the environment, used batteries must be collected in specific containers rather than being thrown into ordinary trash cans.

As a concept, recycling also encompasses the “reuse and utilization” of wastes. The recycling and reuse of many materials we use in our daily lives is performed differently based on considerations such as the environmental problems they cause, the related economic factors, and the cautious use of existing natural resources. Some of these everyday materials consist a large variety of different substances, and may require complex processes for proper recycling. Batteries contain both recyclable metals such as nickel, and toxic metals such as cadmium; consequently, the recycling processes of batteries need to consider both of these types of metals (1).

Due to their toxicity, their prevalence, and their physical

resistance to deterioration, waste batteries represent a significant threat for the environment and human health (2, 3). The toxicity of batteries is mainly due to their lead, mercury, and cadmium content. In addition to this, the other metals in batteries such as zinc, copper, manganese, lithium, and nickel can also pose a threat to the environment. Alkali and zinc-carbon batteries contain heavy metals such as mercury, zinc, and manganese; for this reason, it is necessary to recycle these types of batteries (4).

In case they are stored inappropriately, the toxic compounds in waste batteries may gradually seep into water sources and the ground (4). When waste batteries are thrown into bodies of water or buried into the ground, the external casing of the battery will eventually erode or become pierced, causing the heavy metals and chemicals the battery contains to mix with the surrounding water or ground. For this reason, it is necessary to collect waste batteries separately and to dispose of them in waste battery collection containers. Disposing of waste batteries in such a way, and then recycling them as necessary, not only reduces the risk of having the various chemicals inside batteries mix with the underground waters and ground in landfill areas, but also allows the efficient use of natural resources through the recycling of reusable materials within batteries (5, 6).

Waste batteries can be distinguished from one another depending on whether there are or are not rechargeable. For rechargeable batteries (NiCd, NiMh and Li-ion), there are

currently no facilities in Turkey that can recycle the valuable metals (such as nickel and cobalt) in these batteries; for this reason, such batteries are sent abroad for recycling under the supervision of the TAP Association. As the recycling of non-rechargeable batteries is not economical, they are disposed in a controlled manner by the TAP Association in solid waste storage areas constructed underground or on the surface, with no other type of waste being kept in these areas (5).

For a sustainable future, it is important for science teaching students – who will be become teachers in the future – to be aware and knowledgeable regarding the collection, recycling and disposal of waste batteries. In this context, this study evaluated and reflected in detail the views of science teaching students regarding the recycling and disposal of waste batteries. We believe that the findings of this study will contribute and provide further depth to the literature on this subject.

2. Methods

The study was conducted using the general screening model. The general screening model is a screening approach conducted on populations consisting of a large number of individuals in order to reach a general conclusion regarding the population. It is performed by screening the population as a whole, or a certain group or sample within the population (7).

The study was performed with the participation of 80 volunteer, third-year students receiving education at the Science Education Department of an Education Faculty in Turkish public university. To determine the students' views regarding the recycling and disposal of waste batteries the students were asked to answer two open-ended questions in writing. Examples of the answers provided by the students are shown below by keeping the students' name confidential and coding them as "F₁, F₂...F_n".

3. Results

The study results concerning the answers given by the students on the recycling and disposal of waste batteries are provided in two sections.

Section 1: The Recycling of Waste Batteries

The percentage distribution of the answers given by science teaching students to the question "How are waste batteries recycled?" is provided in Table 1.

Table 1. The students' views regarding the recycling of waste batteries

Student's answers	Answer Frequency f
Waste batteries can be reprocessed in factories to be converted into batteries once again	54
Batteries can be recycled	11
Waste batteries are separated into their components in factories to obtain metals	8
The metals inside waste batteries is separated and obtained by melting them with heat	5
A battery is recycled when it is recharged.	2

An evaluation of Table 1 indicates that the students were generally aware of the recyclability of waste batteries. However, many students described that waste batteries can be reprocessed in factories to be converted into batteries once again, which indicated either a lack of knowledge concerning this subject, or the fact that they confused the recycling of batteries with the recycling of packaging wastes such as plastic, glass, metal and paper. It was noted that a relatively low number of students mentioned that the metals within waste batteries could be separated and recycled. In addition, some of the students confused the concepts of recycling and recharging, and erroneously described that rechargeable batteries could be recycled by recharging them. Direct citations of the answers given by the students to this question are provided below:

"When batteries are used and spent, we throw them into battery collection containers for recycling. Waste batteries are thus collected in these containers, and then sent to factories, where they are reprocessed and converted into batteries once again" (F₁₇)

"I am certain that batteries are being recycled. However, where I live, I have not seen any recycling container for batteries" (F₁₀)

"I know that batteries can be recycled, since I have seen a number of battery recycling containers until now. However, I have no idea how waste batteries are recycled" (F₅₇)

"Many of the batteries that we use today can be recharged. Recycling batteries probably involves recharging them" (F₆₉)

"Batteries can be recycled. As batteries are composed of metals, these metals can be separated by heating them under suitable conditions" (F₇₁)

"The recycling of waste batteries is more common in developing countries. This practice is not so common in Turkey" (F₄₈)

Section 2: Disposal of Waste Batteries

The percentage distribution of the answers given by science teaching students to the question "How are waste batteries disposed?" is provided in Table 2.

Table 2. The students' views regarding the disposal of waste batteries

Student's answers	Answer Frequency f
I do not know how waste batteries are disposed	44
Waste batteries are disposed of through melting	32
Waste batteries are disposed of by being buried into the ground	4

An evaluation of Table 2 indicates that the large majority of the students did not know how waste batteries were disposed; moreover, some of students erroneously described that waste batteries were disposed of through melting, which illustrated that they lacked knowledge regarding this subject. In addition,

a limited number of students described that waste batteries were disposed of by being buried into the ground. This indicated these students' failure to consider and appreciate the fact that burying waste batteries would cause the heavy metals they contain to seep into ground and harm the environment. Direct citations of the answers given by the students to this question are provided below:

"Because waste batteries do not break down in nature, I think that they are buried into the ground" (F₃₁)

"Waste batteries are melted into a liquid at high temperatures. But I don't know how they are disposed after they are melted" (F₅₀)

"I don't know how waste batteries are processed after they are collected" (F₇₅)

"I think that batteries are disposed and eliminated by melting them at high temperature" (F₆₁)

4. Conclusions and Recommendations

Based on the study results, it was determined that the large majority of the students had insufficient knowledge regarding the recycling and disposal of waste batteries. To change the students' views that waste batteries can be converted into batteries once again by being processing in factories, or that waste batteries can be disposed of through melting, it is necessary to increase the students' knowledge and awareness on this subject. The first step of a healthy recycling system involves the sorting of waste materials at their source prior to collection. Waste batteries are not only hazardous wastes, but they are also relatively valuable items due to the reusable metals they contain. For this reason, waste batteries need to be collected in waste battery collection containers (without being thrown into ordinary trash cans or to the environment), and then sorted according to battery types; after these processes, waste batteries will undergo recycling to extract and reuse the valuable metals they contain. To increase the knowledge and awareness of students regarding the proper recycling and disposal of waste batteries, emphasis must be placed on environment-related education starting from elementary school classes, preferably by including environment classes into the curriculum. In addition to this; TAP, the authorized organization for the collection, sorting and storage of waste batteries in Turkey, places emphasis on educational activities with the aim of increasing the collection of waste batteries. In many provinces of Turkey, TAP performs seminars and presentations at elementary and secondary schools, while organizing conferences for various private and public

organizations. In addition, the TAP also cooperates with the academic staff of universities, and conducts educational activities for universities students.

The first step for ensuring a sustainable environment is raising individuals who are conscious, sensitive, and aware of environmental issues. Raising such individuals can only be achieved through the efforts of our teachers, to whom we entrust the education of future generations. Considering that a sustainable future can be achieved largely through the efforts of future teachers, it is necessary for science teaching students – who will become teachers in the future – to be both aware and knowledgeable regarding the recycling and disposal of waste batteries. For this reason, to allow science teaching students to grasp the importance of the subject of waste batteries; student-centered methods and techniques, as well as effective teaching materials, should be used in the environment-related classes which these students attend during their education. In addition, these students (as well as the general public) should be informed regarding waste batteries through the visual and written media, and measures should be taken to ensure the active participation of students into the recycling and disposal of waste batteries before these wastes have any detrimental effects on the environment.

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