International Journal on New Trends in Education and Their Implications
July 2016 Volume: 7 Issue: 3 Article: 09 ISSN 1309-6249

THE VIEWS OF SCIENCE TEACHER CANDIDATES REGARDING THE COLLECTION, RECYCLING AND DISPOSAL OF WASTE BATTERIES

Prof. Dr. Ayhan YILMAZ
Hacettepe University
Faculty of Education
Deparment of Science and Mathematics Education
Ankara- TURKEY

PhDc. Zeynep AKSAN
Ondokuz Mayıs University
Faculty of Education
Department of Elementary Science Education
Samsun- TURKEY

Assoc. Prof. Dr. Dilek ÇELİKLER
Ondokuz Mayıs University
Faculty of Education
Department of Elementary Science Education
Samsun- TURKEY

ABSTRACT

The aim of this study was to investigate the views of science teacher candidates regarding the collection, recycling and disposal of waste batteries. The study was conducted with a total of 92 fourth-year science teacher candidates attending the education faculty of a public university in Turkey. Study data were collected using five open-ended questions regarding the collection, recycling and disposal of waste batteries, and analyzed using the descriptive analysis method. It was determined that 57 of the teacher candidates participating to the study did not have any views or knowledge regarding the institutions and organizations in Turkey responsible for the collection, recycling and disposal of waste batteries. In addition, 79 of the teacher candidates described that current activities in Turkey for the collection of batteries are inadequate, while 85 of the teacher candidates noted that public service announcements through the visual and printed media, as well as posters and informative programs, regarding batteries might help increase people's level of awareness on this subject. Another noteworthy result of this study was that all of the participating teacher candidates expressed the importance of raising environmentally-conscious individuals by including the subject of waste battery management into educational programs/curricula at all levels of education.

Keywords: Science teacher candidate, waste batteries, recycle.

INTRODUCTION

The environmental problems caused by human disregard towards nature, the widely-held belief that nature is only a resource and living space for human use, and increasing population and industrialisation are disrupting

natural ecological balances. In parallel to the developments in technology engendered by industrialisation, various portable devices intended for personal have become popular, and are now widely used in both homes and workplaces. These devices use portable batteries or cells as energy source.

Batteries are considered as hazardous wastes whose improper disposal leads to significant problems. Hazardous waste is a collective term referring to materials in solid, liquid, gas or sludge form that are dangerous for human health and the environment (Suk, 2008). As batteries are widely used, the problem caused by waste batteries, a hazardous waste, is also very significant (Yavuz, Vaizoğlu & Güler, 2013).

Since they are disposed in very large numbers and contained toxic materials, waste batteries pose an important threat to human health and the environment (Bernandes et al., 2004; Kierkegaard, 2007). Since batteries contain toxic metals such as lead, mercury (Bartolozzi, 1990) and cadmium, as well as reusable metals such as nickel, recycling processes for batteries must take into account these different metals (Nogueira, 2007).

Batteries can be divided into two groups as rechargeable and non-rechargeable batteries. In Turkey, there are currently no facilities which can recycle the precious metals (such as nickel and cobalt) extracted from rechargeable batteries (NiCd, NiMh and Li-ion). For this reason, these batteries can be sent abroad under the supervision of the Portable Batteries Manufacturers and Importers (TAP) Association for recycling. The recycling of non-rechargeable batteries, on the other hand, is not economical, which is why they are disposed by the TAP Association by being stored in solid waste storage areas built aboveground or underground according to mono-storage principles (i.e. one type of waste stored in one particular area) (TAP, 2014). Ensuring the disposal of used batteries in a way that would result in minimal harm for human health and the environment is essential for preserving the environment. This requires individuals efforts as well as public regulations (Yavuz, Vaizoğlu & Güler, 2013).

Since science teacher candidates will actively take part as teachers in the education system in the future, ensuring that these teacher candidates are knowledgeable regarding the collection, recycling and disposal of waste batteries is of vital important for a sustainable future. In this context, we believe that the present study will help reflect in the detail the different opinions of science teacher candidates regarding the recycling and disposal of waste batteries, and thus contribute and provide further depth to the literature on this subject.

METHODS

The study was conducted with 92 fourth-year science teacher candidates attending the Education Faculty of a public university in Turkey. The study was performed using a scanning model, and the opinions of the teacher candidates regarding the collection, recycling and disposal of waste batteries were recorded using an assessment tool with five open-ended questions. The study data were analysed using the descriptive analysis method. The names of the teacher candidates were kept confidential by using codes such as “F1, F2…Fn.” Direct citations of the answers given by the teacher candidates are provided in the Results section of the study.

RESULTS

Table 1 shows the frequency distribution of the answers provided by the teacher candidates to the question “Write down the institutions and organisations in Turkey responsible for the collection, recycling and disposal of waste batteries.”

Table 1: Frequency Distribution of the Teacher Candidates' Answers to Question 1

Answers	Answer Frequency (f)
No idea	57
Collection of Waste Batteries	
The Municipality	8
TAP	7
Ministry of Environment and Urban Planning	5
ÇEVKO	4
Ministry of National Education	4
Ministry of Forestry and Water Affairs	3
Ministry of Health	2
Recycling and Disposal of Waste Batteries	
TAP	10
Ministry of Environment and Urban Planning	3
TEMA	2
Yeşilay	1

The Table above indicates that 57 of the teacher candidates had no opinion about the institutions and organisations in Turkey responsible for collecting, recycling and disposing waste batteries. According to the study results, some of the teacher candidates believed that the municipality, TAP and the Ministry of Environment and Urban Planning are responsible for the collection of waste batteries. In addition, some of the students believed that the ÇEVKO foundation is responsible for collecting waste batteries, which was interesting observation. Some the teacher candidates described that the recycling and disposal of waste batteries is the TAP association's responsibility. Another interesting observation in this study was that some of the teacher candidates thought that the Yeşilay and TEMA associations were in any way involved in the recycling and disposal of waste batteries.

Table 2 shows the frequency distribution of the answers provided by the teacher candidates to the question "At what stages of your education did you receive classes covering the subject of waste batteries? In you opinion, during which stages of education should this subject be included into the curriculum?"

Table 2**:** Frequency Distribution of the Teacher Candidates' Answers to Question 2

Answers	Answer Frequency (f)
Middle School	
Sixth grade Science Class	3
High School	
Campaigns on waste battery collection	2
University	
"Special Topics in Chemistry" course during Third-Year	92
"Chemical Wastes and Environmental Pollution" course during Fourth-Year	44
At Every Stage of Education (Preschool, Elementary School, Middle School, High School and University)	92

The results on this Table indicate that all of the students taking part in this study learned a certain amount of information about waste batteries through the "Special Topics in Chemistry" course they received in university. On the other hand, teacher candidates who have taken the elective course "Chemical Wastes and Environmental Pollution" have acquired more detailed and comprehensive knowledge on this subject. Direct citations of the answers provided by the teacher candidates are given below:

- I only learned a little bit about waste batteries during the Special Topics in Chemistry course I received during my third year in university. However, it was during the elective course named Chemical Wastes and

Environmental Pollution, which I took during my fourth year, that I learned a lot more detailed information on the subject (F62).
- In high school 10th grade, I took part in a battery collection campaign organised by the school; however, at the time, I had no idea about the types of batteries I was supposed to collect (F23).

All of the teacher candidates described that the subject of waste batteries should be included into the curriculum at all levels of education - starting from pre-school and at elementary school, middle school, high school and university levels - either as a separate course in itself or as the content of another course.

Table 3 shows the frequency distribution of the answers provided by the teacher candidates to the question "Do you believe that the activities conducted in Turkey for the collection, recycling and disposal of batteries are adequate?"

Table 3: Frequency Distribution of the Teacher Candidates' Answers to Question 3

Answers	**Answer Frequency (f)**
Not adequate	**79**
Society at large is not knowledgeable about the collection of waste batteries.	63
Batteries are thrown into trash cans	56
Students lack enough knowledge on this subject	49
Waste battery collection containers are not widespread	43
Ordinary trash is thrown into battery collection containers.	36
The Municipalities activities on this subject are inadequate	28
There are no facilities in Turkey for recycling waste batteries.	19
Adequate	13

According to the Table above, 79 of the teacher candidates taught that the activities conducted in Turkey for the collection, recycling and disposal of waste batteries are inadequate. The reason they cited included the generally lack of knowledge within society about waste batteries; the lack of knowledge among students on this subject; and the tendency to throw waste batteries into ordinary trash cans. Some of the students even said that people tend to throw ordinary trash into battery collection containers, which is a noteworthy observation. Direct citations of the answers provided by the teacher candidates are given below:
- No, I don't think they're adequate, because in our country, people still throw waste batteries into the trash (F16).
- In place I live, I often look inside battery collection containers, and see regular trash in them instead of batteries. Unfortunately; children, adolescents and adults all lack knowledge about waste batteries. (F36).
- In recent years, the TAP association has been promoting the collection of waste batteries by organising waste battery collection campaigns in school. However, these efforts are not enough. This is because these campaigns in schools lack any cooperation with municipalities, which I think is actually necessary for ensuring that these reach a larger number of people and gain a broader scope. In addition to this, these campaigns should not just focus on the collection of waste batteries, but also tell about their harms and hazards. In other words, both students and society should be informed [about the threats posed by waste batteries (F51).
- In recent times, I believe there have been some positive developments about the collection of waste batteries (F87).

Table 4 shows the frequency distribution of the answers provided by the teacher candidates to the question "What is the importance of the visual and printed media with regards to the collection, recycling and disposal of waste batteries?"

Table 4: Frequency Distribution of the Teacher Candidates' Answers to Question 4

Answers	Answer Frequency (f)
They raise social awareness	85
They draw attention to battery collection points	72
They encourage people to collect waste batteries	51
They help announce campaigns to broader audiences	46
They inform people about where and how they are supposed to delivered waste batteries.	40
They draw attention to the harms caused to the environment by waste batteries.	37

Results in the Table above indicate that the teacher candidates considered the visual media (public service announcements, TV programs, documentaries, animations, cartoons and videos) and the printed media (newspapers, magazines, books) as having a notable effect in raising social awareness about the collection, recycling and disposal of waste batteries. In addition, they also emphasised that the visual and printed press could draw attention to where and how waste batteries should be collected, and help increase the amount of waste batteries being disposed. Direct citations of the answers provided by the teacher candidates are given below:

- Public service announcements can inform about the recycling of waste batteries, and tell where waste batteries can be collected (F24).

- Everybody watches TV. Public service announcements, cartoons and animations can inform and draw the attention of every group within society. The printed media, on the other hand, could be used to inform people who prefer to read (F5).

- Public service announcements are especially important on this subject. In addition, printed materials such as journals and boobs may also help raise awareness (F71).

- In our country, people think of batteries as trash, whereas in fact they are not. Posters and informative materials on waste batteries could be placed at the stops of mass transportation vehicles such as buses and tramways, are be published through journals and magazines (F49).

Table 5 shows the frequency distribution of the answers provided by the teacher candidates to the question "What should be done to increase the collection of waste batteries?"

Table 5: Frequency Distribution of the Teacher Candidates' Answers to Question 5

Answers	Answer Frequency (f)
Courses on waste batteries should be provided at every level of education, and course content on this subject should be more comprehensive	89
Contests with prizes should be organised to promote the collection of waste batteries.	77
Public service announcements as well as informative brochures and posters should be prepared	74
Informative TV and radio programs should be broadcast	70
Municipalities must distribute a large number of waste battery containers, and ensure that they are regularly collected (at schools, hospitals, airports, shopping malls, etc.)	70
Conferences and seminars must be organised	68
Informative activities and presentations must be performed at schools	52
Preschool children should be encouraged to collect waste batteries through games and rewards	43

Cartoons must describe the harms of waste batteries and encourage their collection	38
Machines which give a reward in return for waste batteries must be used more widely.	21
Legal penalties or fines should be imposed on people who throw waste batteries into ordinary trash containers	17
Project assignments should be given	12
Scientific articles should be written on the subject	5

According to the results in the Table above, most teacher candidates were of the view that the collection of waste batteries could be increased by including the subject of waste batteries into course content in schools; by organising contests were rewards; by raising awareness through the visual and printed media; and by increasing the number of waste battery collection containers and ensuring that hey are regularly collected by municipalities. In addition, some of the teacher candidates also noted that children could be habituated to collected waste batteries by using machines (similar to vending machines) which give sweets or gifts in return for waste batteries. Another interesting observation was that some of the teacher candidates recommended the use of legal penalities or fine against people who throw waste batteries into regular trash containers. A small number of students also stated that scientific articles on the harms and hazards of waste batteries will draw attention to this issue and promote the collection of waste batteries. Direct citations of the answers provided by the teacher candidates are given below:

- I believe that conferences are an effective means [for raising awareness]; in fact, I learned a lot from the speech of an expert from TAP who came to our faculty within the frame of a research we were conducting. I later shared many of the things I learned there with the people (F91).

- Children should be informed about waste battery collection starting from pre-school. In addition, we might also think about machines in which you "throw a waste battery to get a sweet;" these machines could be placed in shopping malls and schools, or they might give gifts instead of sweets (F2).

- Batteries must a written warning on them saying "Do not dispose in a trash can." Or new batteries might be given in return for flat batteries (F75).

- Every year, entertaining events and projects should be organised through cooperation between the school and parents (F65).

RESULTS AND DISCUSSIONS

The study results indicated that the number of students with no opinion or knowledge about the institutions and organisations responsible for the collection, recycling and disposal of waste batteries was fairly high. This was possibly due to the fact that the promotional activities and announcements of these institutions and organisations have not reached the larger masses, or because the teacher candidates are not sufficiently aware of the importance of this subject. Teacher candidates who stated that the responsible institutions and organisations are the municipalities, the TAP and the Ministry of Environment and Urban Planning provided the correct answers. In fact, the TAP Association is the only organisation authorised by the Turkish Ministry of Environment and Urban Planning with the separate collection, transportation, storage and disposal of waste batteries, and has been conducting its activities since 2004. In addition, municipalities are also authorised in collecting waste batteries. The ÇEVKO Foundation, on the other hand, is an organisation established to ensure the recycling of packaging wastes in Turkey. As such, neither ÇEVKO nor the TEM and Yeşilay Associations are authorised in collecting waste batteries. Some of the students still assumed that these foundations and associations also deal with the collection of waste batteries, which was probably because they lacked sufficient knowledge about their actual purposes.

The study results also revealed that only three of the teacher candidates had received any courses on waste batteries in middle school; this indicates that the subject of waste batteries is not sufficiently covered during secondary education in middle schools. At high school, two of the teacher candidates had participated to battery collection campaigns, although these campaigns provided no information about the environmental harms of waste batteries, or about the processes these batteries would undergo. This suggests that the

information provided in high schools on waste batteries is very inadequate. All of the science teacher candidates participating to the study described that the course entitled "Special Topics in Chemistry," which they received during their third year, provide some general yet limited information about the harms of batteries. On the other hand, it was observed that students who took the course entitled "Chemical Wastes and Environmental Pollution" during their fourth year had much better knowledge about the collection, recycling and disposal of waste batteries. For this reason, to raise environmentally-friendly and conscious generations, it is important to provide such courses to students starting from their preschool education, and also during their university education (depending on the department they are studying). This will allow children to learn from an early age that waste batteries should be thrown into waste collection containers rather than ordinary trash cans.

The fact that waste batteries are thrown in trash cans, while ordinary waste are thrown into waste battery containers, indicates that there is a serious issue about the understanding and implementation of waste battery collection practices. The source of this issues appears to be the general lack of knowledge and awareness within society and among students of all levels of education about waste batteries. In their study on third-year science teacher candidates, Çelikler and Aksan (2015) demonstrated that the large majority of students throw waste batteries into trash cans and lack adequate knowledge about the recycling of waste batteries and their effects on the environment. To resolve this issue, efforts should focus on raising the level of knowledge of all age groups on this subject through the visual and printed media, and through classes taught in school. In addition, awareness on waste batteries could also be enhanced through conferences and seminars organised with the contributions of municipalities and the TAP association, and attended by subject expert; by ensuring that waste battery containers are more widespread and collected more regularly; or by enabling people to send waste batteries directly to the TAP Association. The study of Çelikler and Aksan (2015) described that certain students used ordinary trash cans for disposing waste batteries mainly because waste battery containers are not widely found.

A reward and sanction system could be utilised to encourage people to collect waste batteries in the proper locations (i.e. without throwing them in trash cans), or to take them to the proper storage locations for disposal; this would help promote desirable behaviors, while also preventing undesirable ones.

Batteries are used in many different areas of our lives. It is therefore imperative to raise the awareness of individuals on the collection, recycling and disposal of waste batteries, which constitute a form of hazardous waste. In a study performed by Çelikler and Kara (2015), some of the third-year students in the science education department described that waste batteries are processed in factories to make batteries once again. Such statements reflect that many students lack proper or adequate knowledge on this subject, and that they equate the recycling and disposal of batteries to the recycling and disposal of packaging wastes such as plastic, glass, metal and paper. In addition, most of the students in the said study did not know how waste batteries are destroyed, or assumed that they are destroyed through melting, which also points to a significant lack of knowledge on the subject. Another study by Aksan, Harman and Çelikler (2015) determined that most science education students were unable to properly and completely illustrate with drawings the recycling processes of waste batteries through drawings.

The first step towards a sustainable environment is the raising of conscious, sensitive and knowledgeable individuals. For this reason, it is essential to provide students a comprehensive environmental education starting from the pre-school period, and all the way up to their higher education programs. Such environmental education should be provided by using student-centred methods and techniques; by planning suitable educational events and activities, and by creating quality learning environments. Such education will help foster among students the necessary awareness and knowledge towards nature, thus helping raise individual who think about the future, and who are aware that environmental problems are not limited in time or space. Associations and foundations working on the protection of the environment should also be promoted through the visual and printed media, while events should also be organised towards students at all levels and the society at large to ensure their active participation to environmental efforts and activities.

International Journal on New Trends in Education and Their Implications
July 2016 Volume: 7 Issue: 3 Article: 09 ISSN 1309-6249

IJONTE's Note: This article was presented at 7th International Conference on New Trends in Education - ICONTE, 13- 15 May, 2016, Antalya-Turkey and was selected for publication for Volume 7 Number 3 of IJONTE 2016 by IJONTE Scientific Committee.

BIODATA AND CONTACT ADDRESSES OF AUTHORS

Ayhan YILMAZ, is a Professor in Secondary Science and Mathematics Education at Hacettepe University, Turkey. She received her Ph.D.(1996) in Chemistry from Ankara University. Her main research interests are students' conceptions of science, misconceptions in chemistry and science education, and environmental education.

Prof. Dr. Ayhan YILMAZ
Hacettepe University
Faculty of Education
Deparment of Science and Mathematics Education
Ankara- TURKEY
E. Mail: ayhany@hacettepe.edu.tr

Zeynep AKSAN, PhD Student in Department of Science Education, Faculty of Education, Ondokuz Mayıs University, Turkey. She received her MS (2011) in Science Education from Ondokuz Mayıs University. Her academic interest areas are science education and environmental education.

PhDc. Zeynep AKSAN
Ondokuz Mayıs University
Faculty of Education
Department of Elementary Science Education
Samsun- TURKEY
E. Mail: zeynep.axan@gmail.com

Dilek ÇELİKLER, Associate Professor in Department of Science Education, Faculty of Education, Ondokuz Mayıs University, Turkey. She received her Ph.D.(2003) in Chemistry from Kafkas University. Her academic interest areas are chemistry and science education, and environmental education.

Assoc. Prof. Dr. Dilek ÇELİKLER
Ondokuz Mayıs University
Faculty of Education
Department of Elementary Science Education
Samsun- TURKEY
E. Mail: dilekc@omu.edu.tr

REFERENCES

Aksan, Z., Harman, G., & Çelikler, 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.

Bartolozzi, M. (1990). The recovery of metals from spent alkaline–manganese batteries: a review of patent literature. *Resources, Conservation and Recycling*, 4, 233–240.

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.

Çelikler, 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.

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

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.

Nogueira, C.A., & Margarido, F. (2007). Chemical and physical characterization of electrode materials of spent sealed ni–cd batteries. *Waste Manag*; 27:1570–1579.

Suk, W.A. (2008). *Hazardous waste: Assessing, detecting, and remediation*. In: Ed. Wallace R.B. Public health and preventive medicine, 15th edition USA: Mc Graw Hill,;901-908.

Taşinabilir Pil Üreticileri ve İthalatçilari Derneği (TAP) (2014). *Atık pillerin toplanması ve bertarafı*. Genel Eğitim Sunumu.

Yavuz, C.I., Acar Vaizoğlu, S., & Güler Ç. (2013). Hayatımızdaki Piller. *Sürekli Tıp Eğitimi Dergisi (STED),* 21(6), 19-25.