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DETERMINATION OF HIGH SCHOOL STUDENTS' VIEWS ON ELECTRONIC WASTE POLLUTION[i]

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Abstract:
The purpose of this study is the determination of the science teacher candidates' views on electronic waste pollution. The participants of the study were determined with a purposive sample which enables researcher to choose the ones who are believed to find to solutions to the problems of the researcher. Total 144 high school students from different type school are participated to study during the 2016-2017 academic year. Data were collected open-ended questions which developed by the researchers. Students were answered the related seven open ended questions in almost one hour. The qualitative data obtained from the study were analyzed using a phenomenological method. According to results of the study, it was determined that students are not sufficiently knowledgeable about the electronic waste, sources of electronic waste, evaluating of electronic devices. It was recommended that teachers candidates need to be aware of this issue.

Keywords: electronic waste, science education, teacher candidates, environmental pollution

1. Introduction

The concept of waste was defined for the first time in our country's regulations, in the Environment Law dated 1983 and numbered 2872 as "*harmful substances thrown out or dropped into the environment as a result of any activity*" (Cited by Gündüzalp, Güven,

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2016). With the rapid development of technology, the start of the use of new products in many areas varying from production to transportation, from communication to education has changed our consumption habits and, as a result of the increased consumption and the diversification of wastes, there has appeared a need for redefining "wastes" (wasted electrical and electronic equipment, The Turkish Regulation on the Control of Waste Electrical and Electronic Equipment, Municipality Implementation Guidance, 2016).

Since many electrical and electronic equipment, which have become indispensible in our daily life, continuously undergo development and renovation, they have turned into very short-time consumer goods and hence the concept of electronic waste have entered in our lives.

According to the United Nations Environment Program (UNEP-2007), e-waste is defined as unwanted electrical and electronic equipment which have become worn out or completed their lives in various ways. According to another definition, electrical and electronic devices and equipment having not been in use and/or completed their lives (TVs, computers, printers, telephones, modems, fax machines, photocopy machines, monitors, printed circuit cards, integrated circuits, medical devices, etc.) are disposed by product-owners. These wastes composed of electronic devices/equipment are shortly described as "*electric-electronic waste (e-waste)*" (Yazıcı, Deveci, 2011). Although there is not a certain accepted scope for e-waste, the broken, cracked, irreparable equipment used for data processing, telecommunication, work, entertainment or home are generally included in this group (İnce, 2011). If these definitions are taken into account, e-waste was used for device or equipment which have completed their lives or become worn out. However, today, based on the developing technology, the limits of needs, desires and likes have broadened. Now, people do not wait for a device, such as a mobile phone, to complete its life or wear out, but instead, they replace it with an upper or newer model in a short time. Moreover, cheapening of technological devices has made them easily and quickly accessible in every area changing from education to communication today. Depending on this, the content of the definition of e-waste as broadened.

When we look at the examples of electronic waste, we encounter a very wide range as the following (Çiftlik et al., 2009).

- Big household goods (refrigerator, washing machine, oven, air conditioning, etc.);
- Small house appliances (vacuum cleaner, toaster, bathroom scale, hair dryer, etc.);
- Information and communication equipment (computers, telephones, printers, fax machines, etc.);

- Consumer equipment (video cameras, musical instruments, radio, TV, etc.);
- Lighting equipment (fluorescent lambs, etc.);
- Electrical and electronic equipment (electric drill, sewing machine, lathe, gardening tools, etc.);
- Toys, entertainment and sports equipment (electric train, video games, sports equipment, etc.);
- Medical devices (dialysis equipment, analysis equipment, etc.)
- Monitoring and control instruments (thermostats, heat regulators, detectors, etc.);
- Automats (ATMs, vending machines, etc.);

It is clear that all the electrical and electronic tools, devices mentioned here have made our lives easier. However, today, the basic equation in meeting human requirements is based on the fact that there are limited resources against limitless human needs and lack of knowledge of until when we can meet our needs with resources already in use without problems (İnce, 2011).

When it is looked from this perspective and the growing world population is taken into account, e-waste is regarded as one of the most important global problems of today and the future. Moreover, it is evaluated as the most dangerous within the waste category.

WEEE is one of the waste kinds increasing in the quickest way all over the world. WEEE composes 5-8% of the total waste in the world. The amount of WEEE, which was 33,8 million tons across the world in 2010, increased by annual average of 5,5% and reached the level of 41,8 million tons in 2014. According to the UNU, 2015 report, it is observed that most WEEE occurs in the branches of big white appliances and small house appliances. WEEE amounts may show important changes according to countries' economic and social levels (The Turkish Regulation on the Control of Waste Electrical and Electronic Equipment, Municipality Implementation Guidance).

When we look for an answer to the question "*Why is the subject of e-waste so important and update?"*, we encounter a situation which is different from other kinds of waste. For, while, on the one hand, these kinds of waste threaten the lives of living things seriously, on the other hand, they are seen as potential resources because of containing important metals. E-wastes contain about 60 different elements, some of which are valuable and some of which are harmful (Namias, J., 2013). For example, the presence of such metals as Cu, Fe, Ni, Hg, Pb, Cd, Al, etc. and especially valuable metals such as Au, Ag, Pd, etc. in e-wastes have caused e-wastes to be described as the minerals of the future (Yazıcı, Deveci, 2011).

In this case, there are things which all the countries should do in general and every individual in particular. Since both e-wastes are valuable economically and they

can threaten the environment and human health after they become wastes, it is necessary that they should be processed by plants which are expert in the matter and have established their technical sub-structure for waste utilization and put into humanities' service again (İnce, 2011). These procedures are performed via the methods of recycling, recovery or reuse. Recovery is the collection of wastes for the purpose of obtaining a new product by applying such processes as reusing, generating energy or performing physical or chemical procedures. However, recycling is the process of turning wastes into raw material or a new product by applying physical and chemical processes to them (Kaya, Sözeri, 2007).

As it is seen from those which were mentioned above, every individual in a society seems to be the source of both the problem and the solution. In that case, what should we do against this important problem? Or what kind of a contribution can we make to solve problems? It is clear that the procedure of raising society's awareness towards this should be started primarily via education, that's to say, teachers, preservice teachers and students. For, education to be given by starting from young ages will make our students behave more consciously about this subject. When various previous are examined, it is observed that there are not many studies on this subject. In a study made with various preservice teachers, it was determined that the preservice teachers were not knowledgeable enough about the problem of e-waste (Çalış, Ergül, 2015).

In a study by Liang and Sharp (2016), the knowledge levels of the young people in China, Laos and Thailand in relation to the effects of e-wastes on the environment tried to be determined depending on gender and various age groups and it was found that especially the young people under the age of 17 had insufficient knowledge and it was mentioned that designing education programs for this purpose was necessary. In a study investigating into the knowledge and awareness levels of the university students in relation to e-waste in Ghana, Edumadze, Cudjoe and Edumadze (2013) reached the result that the majority of the students had never heard about the concept of e-waste and did not have enough knowledge about the effects of e-wastes on the environment and human health.

In a study entitled "*Proposal for the Integration of Electronic Waste Management into the Teaching Program of Elementary Schools*", Jager (2015) emphasizes the necessity of equipping young students with necessary values, attitudes, knowledge and skills in relation to how e-wastes should be managed and giving them training about how e-wastes should be managed by putting forward the importance of guaranteeing a healthy and sustainable future for everybody.

In a study made with 250 students by taking various variables into account and entitled "*Investigation into Elementary Students' Electronic Waste Awareness and*

Environmental Attitudes", Ercan and Bilen (2014) reached the result that the students had insufficient or incorrect knowledge about e-waste.

In a study investigating into the awareness levels of the students of the Information Technologies College in relation to e-waste management, Chen, L.F. and Yee, H.W. (2011) determined that the students were not ready for this situation.

In the study, since the concept of electronic waste appears before us as an update and growing problem today, it was aimed to investigate into the knowledge and awareness levels of young people composing an important part of the society about this subject. For this reason, determination of high school students' opinions about electronic waste pollution composed the purpose of the study.

2. Method

2.1 Research Model

In the study, the phenomenographic method, one of the qualitative research methods, was used. The aim of phenomenographic studies is to define different ways of humans' experiencing, interpreting or conceptualizing a certain aspect of a phenomenon or a fact (Çepni, 2014). Phenomenographic studies are interested in what people perceive, understand or experience in relation to phenomena which they encounter in the universe in which they live. In phenomenographic studies, definitions which individuals make in relation to any phenomenon are associated with appropriate categories (Çekmez, Yıldız, & Bütüner, 2012).

2.2 Sample

The sample of the study was composed of a total of 144 10th and 11th grade students from the Science High School, the Anatolia High School and the Vocational High School in the 2016-2017 educational year. The distribution of the students according to the schools and classes was given in Table-1.

Table 1: Distribution of students by school and class

High School Type	**Class Level**	
	10. class	**11. class**
Science High School	23	26
Anatolia High School	33	28
Vocational high School	14	20
Total	70	74

2.3 Data Collection Tools

The pieces of data were collected via the open-ended questions prepared by the researchers and given below.

1. Have you ever heard of the concept of electronic waste?/ What do you know about this concept?
2. In your opinion, what can be the sources of electronic waste?
3. What effects do you think electronic waste pollution has on human health and the environment?
4. How do you evaluate your end-of-life electronic appliances?
5. What do you think about the results of electronic waste pollution in the next 50 years? 6. What substances may electronic wastes contain?
6. What do you think may cause the occurrence of electronic wastes?

2.4 Validity and Reliability

Attention was paid to the inclusion of all the stages, which are necessary to achieve validity and reliability in phenomenographic studies. Validity tried to be achieved by selecting a heterogeneous sample group and paying attention to the inclusion of the possibility of making generalizations and presentation of the methods applied in the study and the results of the study clearly and completely (Akerlind, 2002: Cited by Çekmez, Yıldız, Bütüner, 2012). Saljö (1988: Cited by Çekmez, Yıldız, Bütüner, 2012) bases the reliability of a phenomenographic study on a high consistency between the categories which different studies created. In this respect, in terms of reliability, the obtained data were evaluated by two different researchers, and as a result of the comparison of the codes and the categories, a high level of consistency was observed.

2.5 Data Analysis

The sheets including seven open-ended questions were handed out to the students and the students were asked to answer the questions in written. The answering procedure took about an hour. Hence, the obtained data were arranged and coded and then the coded statements were arranged again according to their similarities and differences and transformed into themes and, finally, tables including the themes, codes and the frequency of the students' saying the codes were created. After arranging the obtained data, the percentage-frequency tables were formed. In order to support the data in the created percentage-frequency tables, some direct quotations were included from some of the high school students' opinions. Since the high school students' own sentences were directly quoted, each student was given a code name such as S_1, S_2, ….

3. Findings and Discussion

The findings of the study investigating the high school students' opinions about electronic waste pollution were explained in the following table.

1. In the evaluation made for the question "*What do you know about the concept of e-waste?*", eight answer categories were determined and these categories were given in Table 2.

Table 2: Percentage-frequency table for the concept of E-waste

Question	Answers	Science High School		Anatolia High School		Vocational High School	
		10. class	11. class	10. class	11. class	10. class	11. class
		f %	f %	f %	f %	f %	f %
What do you know about the concept of e-waste?	* Disposal of all electrical-electronic devices / garbage	3 13	5 19	- -	7 25	- -	5 25
	* Technology obsolete and end of life devices	7 30	15 58	16 48	14 50	5 36	10 50
	* Hazardous radiation matter for health	3 13	2 8	3 9	2 7	1 7	4 20
	* Non-recyclable / long-lasting substances	1 4	3 12	1 3	- -	2 14	5 25
	* Harmful substances	2 9	5 19	2 6	4 14	4 29	8 40
	* Battery	5 22	8 31	4 12	1 4	2 14	2 10
	* Domestic / Industrial wastes	2 9	- -	4 12	- -	4 29	- -
	* I don't know	6 26	1 4	8 24	2 7	- -	- -

When Table 2 was examined, it was observed that almost half of the students enrolled in three different high schools defined the concept of e-waste as "*old-fashioned and end-of-life electronic appliances*". While the rate of the 10th grade students who stated not

knowing about the concept of e-waste in three high schools was in the interval of 24-29%, it was observed that the rate of the 11th grade students stating not knowing about it was lower in the Science High School and the Anatolia High School. However, in the vocational high school, there were no students stating not knowing in both classes.

The opinions of some of the high school students in relation to the question are as follows.

- S1: *"E- waste occurs as a result of unconsciously disposal of electric or electronic appliances which we use into the environment."*
- S13: *"E- wastes are appliances which are worn out or whose upper model has come onto the market."*
- S27: *"As many electronic appliances produced thanks to the technology, which is the biggest necessity of our age, get worn out, broken or, from time to time, replaced with a new one, devices which we have extra in our hands are called e-waste."*
- S32: *"E-waste is the disposal of some materials which we use such as battery, etc. in an uncontrolled manner and substances seeping into the environment poison the nature."*
- S50: *"E-waste is the waste of end-of-life electrical and electronic appliances."*
- *S79: "E-waste is the substance giving harm to human health."*
- S139: *"E-wastes are very dangerous substances giving great harm to the environment and do not disappear easily as long as they remain in the environment."*

2. In the evaluation made for the question "*What can be the sources of e-waste?"*, nine answer categories were determined and these categories were given in Table 3.

Table 3: Percentage-frequency table of electronic waste sources

Question	Answers	Science High School		Anatolia High School		Vocational High School	
		10. class	11. class	10. class	11. class	10. class	11. class
		f %	f %	f %	f %	f %	f %
What can be the sources of e-waste?	*Information and telecommunication	11 48	17 65	17 52	21 75	7 50	13 65
	* Large household goods	- -	6 23	3 9	13 46	1 7	7 35
	* Small household appliances	3 13	4 15	3 9	13 46	1 7	7 35
	* Battery, battery	- -	16 62	9 27	8 29	11 79	15 75

	* Lighting	-	2	1	2	1	3
		-	8	3	7	7	15
	* Electronic games/	-	-	2	5	-	2
	Toys	-	-	6	18	-	10
				-			
	* Medical device	-	2	-	2	-	2
		-	8	-	7	-	10
	* Radioactive element	2	3	-	-	-	-
	/Heavy metals	9	12	-	-	-	-
							-
	* I do not know	-	-	5	-	2	-
		-	-	15	-	14	-

When Table 3 was examined, it was observed that the 10th and the 11th grade students of the three high schools emphasized, in great rates, the information and communication devices, battery and accumulator as the sources of e-waste. These were followed by big and small household appliances, lightening equipment, electronic games/ toys and medical devices.

The opinions of some of the high school students in relation to the question are as follows.

- S44: "*All unused computers, televisions, telephones, etc. and waste batteries."*
- S29: "*All electrical devices such as dishwasher, washing machine, vacuum cleaner, toaster, information and communication tools and lightening tools."*
- S24: "*Storable energy sources in general, mainly battery and accumulator; since they cannot be subjected to the reuse procedure, they are sources of waste*."
- S126: "*Big and small kitchen utensils, games/toys, lightening equipment, mobile phones, battery, accumulator."*

3. Based on the answers given by the high school students to the question "*What kinds of harms does electronic waste pollution do to human health and the environment?"*, eight categories appeared and the results were presented in Table 4.

Table 4: Percentage-frequency table of e-waste pollution for the harms of human health and environment

Question	Answers	Science High School		Anatolia High School		Vocational High School	
		10. class	11. class	10. class	11. class	10. class	11. class
		f %	f %	f %	f %	f %	f %
What kinds of harms does electronic waste pollution do to human health and the environment?	* Heavy metals; soil, water, air pollution.	9 39	16 62	3 9	7 25	- -	7 35
	* Ecological equilibrium	9 39	5 19	6 18	3 11	2 14	- -
	* Causes image contamination	5 22	5 19	10 30	9 12	- -	12 60
	* Causes various diseases and cancers	14 61	16 62	16 48	23 82	10 71	20 100
	* Economic damage causes	- -	2 8	- -	3 11	- -	- -
	* Causes time loss	- -	- -	- -	2 7	- -	- -
	* No damage	- -	- -	- -	3 11	- -	- -
	* I do not know.	- -	- -	4 12	- -	2 14	- -

When Table 4 was examined, it was observed that, in relation to the damages of e-waste pollution, a great majority of the high school students (all of the vocational high school 11th grade students) stated that e-wastes cause various illnesses and cancer. This was followed by these answers "*Since they contain heavy metals, they cause soil, air and water pollution"; "They break the ecological balance and cause visual pollution".* A few students mentioned about the economic damage and waste of time. The opinions of some of the high school students in relation to the question are as follows.

- S14: *"E- wastes affect human and environmental health by emitting radiation."*

- S25: "*E- wastes give harm to humans in terms of both economic and health aspects. A telephone bought as an extra gives damage both to our budget and health by emitting radiation*."
- S36: *"Heavy metals pollute soil, air and water."*
- S47: "*Since they dissolve in nature in a very long time, these substances cause environmental pollution and cause visual pollution."*
- S125: "*… Since e-wastes dissolve in nature in a very long time, there appears a throng of wastes."*

4. Based on the answers given by the high school students to the question "*How do you evaluate your end-of-life electronic appliances?*", six categories appeared and the results were presented in Table 5.

Table 5: Percentage-frequency table for electronic goods that lose function

Question	Answers	Science High School		Anatolia High School		Vocational High School	
		10. class	11. class	10. class	11. class	10. class	11. class
		f %	f %	f %	f %	f %	f %
How do you evaluate your end-of-life electronic appliances?	* Give for recycling	8 35	10 38	10 30	12 43	2 14	16 80
	* Sell to junkman	4 17	10 38	4 12	6 21	2 14	4 20
	* Throw a rubbish	2 9	7 27	13 39	7 25	3 21	1 5
	* To Repair	1 4	1 4	5 15	- -	5 36	13 65
	* I do not know how to evaluate	13 57	9 35	6 18	6 21	4 29	4 20
	* No recycling bin my around	- -	3 12	- -	- -	- -	1 5

As it is seen in Table 5, while 80% of the vocational high school 11th grade students stated sending their end-of-life electronic appliances for recycling, the rate of the Anatolia and Science high school 11th grade students stated sending their end-of-life electronic appliances for recycling is about 40%. Moreover, a great majority of the vocational high school 11th grade students stated repairing their end-of-life electronic

appliances or using their parts in other devices. The rate of the participant students stating not knowing how to evaluate their end-of-life electronic appliances was very high, too.

The opinions of the high school students in relation to the subject are as follows:

- S23: *"... I leave electronic wastes in recycling bins."*
- S39: *"… We throw them away or keep them in store."*
- S47: *"… I sell them in the second hand market or give them to waste pickers."*
- S107: *"… I check if they can be repaired; if not, I take out the part(s) which I can use later."*

5. Based on the answers given by the high school students to the question "*What do you think about the results of electronic waste pollution in the next 50 years?",* six categories appeared and the results were presented in Table 6.

Table 6: Percentage-frequency table for the results of the e-waste pollution in the next 50 years

Question	**Answers**	**Science High School**		**Anatolia High School**		**Vocational High School**	
		10. class	**11. class**	**10. class**	**11. class**	**10. class**	**11. class**
		f	**f**	**f**	**f**	**f**	**f**
		%	**%**	**%**	**%**	**%**	**%**
What do you think about the results of electronic waste pollution in the next 50 years?	* The lifetimes of people is shortened	9	10	3	7	-	6
		39	38	9	25	-	30
	* Environmental pollution increases more	7	14	19	13	5	6
		30	54	58	46	36	30
	* Damages the nature	6	11	3	3	-	10
		26	42	9	11	-	50
	* Radiation increases	1	-	1	1	-	3
		4	-	3	4	-	15
	* People become conscious	-	9	3	9	-	2
		-	35	9	32	-	10
	* Environmental pollution is reduced	-	1	6	2	9	8
		-	4	18	7	64	40
	* I do not know	5	-	-	-	-	-
		22	-	-	-	-	-

When Table 6 was examined, it was observed that the students drew attention to the fact that, in the next 50 years, the environmental pollution will increase more and shorten lifetimes by causing cancer and other illnesses due to radiation. This was followed by the opinions that heavy metals will give harm to the nature and the environmental pollution will decrease in the future since humans will get more conscious about the subject.

The opinions of the high school students in relation to the subject are as follows:

- S48: *"… Electronic wastes pollute the environment a lot and this affects human health negatively. People can die early; cancer cases may increase."*
- S49: *"… Since technological wastes will increase, if humans do not get conscious, the nature will be damaged greatly."*
- S87: *"… If people get conscious, they can benefit from wastes, but if wastes are not recycled, there will remain nothing called environment 50 years later ... "*
- S33: *"… If e- wastes continue to increase in 50 years, the radiation they emit to the environment will be a big threat to the nature and human health."*
- S39: *"… Genes of living things will be disordered because of exposure to radiation and the order of ecosystem will be spoilt."*

6. Based on the answers given by the high school students to the question "*What substances may e-wastes contain?"*, five categories appeared and the results were presented in Table 7.

Table 7: Percentage-frequency table of which substances contain e-waste

Question	**Answers**	**Science High School**		**Anatolia High School**		**Vocational High School**	
		10. class	**11. class**	**10. class**	**11. class**	**10. class**	**11. class**
		f	**f**	**f**	**f**	**f**	**f**
		%	**%**	**%**	**%**	**%**	**%**
What substances may e-wastes contain?	* Metals / Heavy metals	9 39	10 38	6 18	24 86	3 21	14 70
	* Radioactive substances	3 13	10 38	- -	4 14	- -	- -
	* Glass, plastic	6 26	2 8	7 21	- -	- -	3 15
	* Toxic chemicals	3 13	10 38	4 12	2 7	- -	- -
						11 79	6

	* I do not know	5 22	8 31	22 67	2 7		30

When Table 7 was examined, it was observed that a great majority of the vocational and Anatolia high school 11th grade students stated their opinions in the direction of the fact that electronic wastes contain harmful and heavy metals. This opinion was followed by radioactive substances, poisonous chemicals, and toxic substances. Especially the rate of the 10th grade students stating not knowing was rather high.

The opinions of the high school students in relation to the subject are as follows:

- S148: "*… e-wastes contain dangerous elements such as lead, mercury, phosphor and zinc, most of which are heavy metals.*"
- S120: "… They contain heavy metals like lead and radioactive substances"
- S83: "*… They may contain radioactive and toxic substances which have effect on the nature for a long time.*"

7. The answers given by the high school students to the question "*What do you think may cause the occurrence of e-wastes?*" were presented in Table 8.

Table 8: Percentage-frequency table for causes of e-waste occurrence

Question	**Answers**	**Science High School**		**Anatolia High School**		**Vocational High School**	
		10. class	**11. class**	**10. class**	**11. class**	**10. class**	**11. class**
		f **%**	**f** **%**	**f** **%**	**f** **%**	**f** **%**	**f** **%**
What do you think may cause the occurrence of e-wastes?	* Rapid development in technology	2 9	8 31	1 3	6 21	1 7	- -
	* Insufficient information / unconscious use	13 57	5 19	22 67	13 46	3 21	10 50
	* Inability to recycle information	5 22	14 54	8 24	7 25	1 7	11 55
	* Poor quality product	- -	- -	- -	- -	4 29	5 25
	* I do not know	4 17	- -	2 6	2 7	4 29	3 15

When Table 8 was examined, it was observed that a great majority of the high school students put forward such reasons as unconsciousness related to electronic devices, insufficient knowledge about recycling, rapid technological development and products of poor quality as the reasons for the occurrence of e-wastes. Of the high school students, S80, S84, S107 and S109 made the following explanations in relation to the question.

- S80: *"… e-wastes occur because of people's being unconscious about the subject of recycling ..."*
- S84: *"… e-wastes occur because of our incorrect and unconscious use of technology ..."*
- S107: *"… due to such reasons as launching products of poor quality to the market, inappropriate use and firms' not caring the environment but their profit ..."*
- S109: *"… because of rapid consumption, hunger for technology …"*

4. Conclusion and Suggestions

In this study aiming to determine the high school students' opinions about electronic waste pollution, the students were firstly asked about the concept of e-waste. A great majority of the students defined the concept of e-waste as tools and devices with outdated technology or have become out of use. This was followed in order by such definitions as rubbish, bad for health, radioactive substance, non-recyclable/not disappearing for a long time and substances damaging the environment. While there were no vocational high school students not having had any idea about the subject, the rate of the Anatolia and Science high school students who had no idea about the subject was about 30%. It is considered that the students enrolled in the electric program of the vocational high school were more knowledgeable about the subject as it was required by their shop classes. In a study made by Edumadze, Cudjoe and Edumadze (2013) with 1154 university students enrolled in various faculties, while only 6,2% of the students stated the problem of e- waste as the most important environmental problem, 54.2% of them stated not having any foreknowledge about the problem of e-waste.

Secondly, the students were addressed the question "*What can be the souces of e-waste?*". A great majority of the students emphasized information and communication tools as the sources of e-waste. When we evaluated the results, we saw that the definitions made by the students in relation to the sources of e-waste were mostly related to items which the students frequently used in their daily lives and, in terms of scope, the information and communication tools which included some of the definitions of sources given in the literature.

Since developments in information and communication tools are in their field of interest, they focused on this group as sources of e-waste. In the above-mentioned study

of Edumadze, Cudjoe and Edumadze's (2013), while 66% of the same students showed computers and 13% of them showed mobile phones as the sources of e-waste, 58% of them stated that their mobile phones were not a source of e-waste. In our study, very few of the students described such sources as consumer equipment, lightening equipment, electrical and electronic tools, toys, entertainment and sports equipment, medical monitoring and control devices and automats as the sources of e-waste.

Thirdly, the question "*What kind of damages do you think e-waste pollution has on human health and the environment?"* was addressed to the students. 69% of the students stated opinions in relation to the fact e-wastes will give harm to human health and, for this reason; illnesses such as cancer and the like will increase. In fact, all of the vocational high school 11th grade students stated this opinion. 30% of the participant students stated that since e-wastes contain heavy metals, they will contaminate soil and water, cause environmental pollution and break the ecological balance. This result overlaps those of the study made by Liang and Sharp (2016) in China, Laos and Thailand with the aim of determining the knowledge levels of various age groups in relation to the effects of e-wastes on the environment according to gender and various age groups. In the study, especially the young people under 17 had insufficient knowledge about this subject. Again, in the same study, Edumadze, Cudjoe and Edumadze (2013) found that only 32,7% of the students gave the answer "yes" to the question "*Do e-wastes have any harmful effects on the environment and human health*?" In this study, too, it was observed that our students' knowledge levels in relation to the harmful effects of e-wastes on the environment were in line with the results of the above-mentioned study.

Fourthly, the question "*How do you evaluate your end-of-life electronic appliances?*" was addressed to the students. When the answers were examined, it was observed that although most of the students were knowledgeable about the concept of recycle, this rate was higher in the vocational high school students. Despite this, it was not at the desired level. Similarly, while the knowledge of reuse mostly developed in the vocational high school 11th grade students, very few of the other students mentioned about this concept. The vocational high school students used these statements for the end-of-life electronic devices: "*I try to repair; if I cannot repair, I take out useful parts in it and evaluate them in another device.*" In the name of vocational high schools, this result is satisfying. When we looked at the other results, we encountered such statements as "*I sell them to junk dealers/waste pickers*" and "*I throw them away*". The number of students who stated not knowing how to evaluate them was non-ignorable high. Especially, in the science high school, the highest rate was reached. This result makes us consider that the students became distanced from social problems and solutions in the process of preparing for university. The result that similar results were obtained in the vocational

high school, too, appears as a thought-provoking one. In a study with 200 university students, Wright (2011) reached the result that recycle behaviors were generally directly related to the knowledge of recycle. It is observed that the results of the study support this finding, though more in the vocational high school students.

Fifthly, the question "*What do you think about the results of the e-waste pollution in the next 50 years*" was addressed to the students. A great majority of the students stated that e-wastes will give harm to the environment and the human, the environmental pollution will increase more and due to radiation and illnesses, people's lifetimes will shorten. Although the number of students who were optimistic about the future was low, these students stated that this awareness in people will increase and, as a result of this, the environmental pollution will decrease. As an eye-catching result, compared to the other high school students, the vocational high school students had more difficulty in making deductions about the future.

Sixthly, the students were addressed the question "*What substances do e-wastes contain?*" 46% of the students stated that they contained heavy metals. The most-frequently mentioned heavy metals were lead and mercury. It was observed that the students did not mention the other heavy metals and never mentioned most of the metals. Edumadze, Cudjoe and Edumadze (2013) reached in their study the finding that 87.9% of the students had no knowledge about the harmful metals in e-waits at all. The existence of radioactive substances and poisonous chemicals in e-wastes was among the other answers. Another finding was that, in the vocational and Anatolia high schools, the number of students giving the answer "*I do not know*" was very high.

Seventhly, the students were addressed the question "*What do you think may cause the occurrence of e-wastes?"* 46% of the students showed people's having insufficient knowledge about how to use electronic tools and devices or using these tools and devices unconsciously, 13% of them showed the rapid development in technology and 32% of them showed insufficient knowledge of recycling as reasons for the occurrence of e-wastes. However, the importance of product quality, one of the main reasons, was mentioned only by the vocational high school students.

Since the e-waste problem is a current and gradually increasing problem, it is continuously brought to the agenda and it emphasizes the necessity of making students be more knowledgeable of it and of giving this training to them at younger ages. For these reasons, by making necessary additions to the related course contents at our schools, students, teachers, families, shortly every part of the society should be made aware of this problem and steps should be taken towards finding solutions to this important problem of our age

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- Laboratory Facilities Of Primary Schools And A Study On Teachers' Attitudes And Skills
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