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THE EFFECT OF THE KNOWLEDGE OF CORROSION ON THE PERCEPTIONS ABOUT ITS ENVIRONMENTAL EFFECTS AMONG STUDENTS FROM FACULTIES OF EDUCATION AND SCIENCE[*]

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ABSTRACT

This study was carried out to investigate the effect of the level of corrosion knowledge on the perceptions of its environmental effects among students from the Faculties of Education Department of Chemistry Teaching and Faculty of Science Department of Chemistry. The study sampled a total of 345 students studying chemistry and chemistry teaching at different Faculties of Education and Science in Turkey during the spring semester of 2014/2015. It was also tested whether there was a correlation between students' levels of corrosion knowledge and their levels of perception of environmental effects of corrosion. The results revealed a moderate, positive and significant correlation between students' levels of knowledge about corrosion and their perceptions of its environmental effects.

Key Words: Corrosion, corrosion education, level of corrosion knowledge, environmental effects of corrosion

EĞİTİM VE FEN FAKÜLTESİ ÖĞRENCİLERİNİN KOROZYON KONUSUNDAKİ BİLGİ DÜZEYLERİNİN KOROZYONUN ÇEVRESEL ETKİLERİ İLE İLGİLİ ALGILAMALARI ÜZERİNE ETKİSİ

ÖZET

Bu çalışmada eğitim fakültesi kimya öğretmenliği ve fen fakültesi kimya bölümü öğrencilerinin korozyon konusundaki bilgi düzeylerinin korozyonun çevresel etkilerini algılama düzeyleri üzerine etkisi araştırılmıştır. Araştırma 2014-2015 öğretim yılının bahar döneminde Türkiye'deki çeşitli üniversitelerin eğitim ve fen fakültelerinin kimya öğretmenliği ve kimya bölümü öğrencilerinden toplam 345 öğrenci ile gerçekleşmiştir. Eğitim fakültesi kimya öğretmenliği ve fen fakültesi kimya bölümü öğrencilerinin korozyon konusundaki bilgi düzeyleri ile korozyonun çevresel etkilerini algılamaları arasındaki korelasyona bakılmış, araştırma sonucunda elde edilen verilerden eğitim fakültesi kimya öğretmenliği ve fen fakültesi kimya bölümü öğrencilerinin korozyon konusundaki bilgi düzeyleri ile korozyonun çevresel etkilerini algılamaları arasında orta düzeyde pozitif ve anlamlı bir ilişki olduğu görülmüştür.

Anahtar Kelimeler: Korozyon, korozyon eğitimi, korozyon bilgi düzeyi, korozyonun çevresel etkileri

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1. INTRODUCTION

The term *corrosion* can be defined in many ways from different perspectives. Simply put, it is the oxidation of metals or deterioration of the materials in general or of the metals and alloys in particular due to chemical and electrochemical change or physical dissolution resulting from various environmental conditions (Üneri, 2004).

Because corrosion occurs slowly over a long period of time, it takes a long time for the consequences or effects to come out. According to some estimations, the cost of corrosion for the state is up to 3.5 – 5.0% of the Gross National Product. Moreover, there occur work accidents due to corrosion in our country, yet no adequate and informative statistical and scientific studies are conducted regarding this issue (Bildik, 2014).

There are responsibilities our universities need to take on in order to identify corrosion problems and come up with solutions for these problems. As reported by Üneri (2004), corrosion is taught as an important course at the disciplines of chemistry, metallurgical and materials engineering at 11 universities in our country. These are;

1- Ankara University, Faculty of Science, Department of Chemistry, Ankara
2- Çukurova University, Faculty of Science and Literature, Department of Chemistry, Adana
3- Dokuz Eylül University, Faculty of Engineering, Department of Metallurgical and Materials Engineering, İzmir
4- Gazi University, Faculty of Science and Literature, Department of Chemistry, Ankara
5- Gazi University, Faculty of Engineering and Architecture, Department of Chemistry Engineering, Ankara
6- Gazi University, Faculty of Education, Department of Chemistry Teaching, Ankara
7- İnönü University, Faculty of Science, Department of Chemistry, Malatya
8- Istanbul Technical University, Department of Metallurgical and Materials Engineering, İstanbul
9- Mersin University, Faculty of Science and Literature, Department of Chemistry, Mersin
10- Mustafa Kemal University, Hatay
11- Kocaeli University, İzmit
12- Middle East Technical University, Department of Metallurgical and Materials Engineering, Ankara
13- Cumhuriyet University, Department of Metallurgical and Materials Engineering, Sivas

Nearly half of these universities offer corrosion courses in their master's or doctoral degree programs and these research studies are presented and published as dissertations (Üneri, 2004).

Corrosion courses are only taught in the department of Metallurgical and Materials Engineering at Selçuk University and in the programs of Metallurgical and Materials Engineering and Chemistry Engineering at Gazi University. There are no courses under the title of corrosion provided in the department of Chemistry Teaching at Selcuk University Ahmet Keleşoğlu Faculty of Education, the department of Chemistry Teaching at Gazi University Faculty of Education, the department of Chemistry at Selcuk

University Faculty of Science, the department of Chemistry at Gazi University Faculty of Science and the department of Chemistry at Ankara University Faculty of Science, where the present research was conducted; however, corrosion is approached as an individual topic within certain courses.

It is of great importance that students of secondary education need to be instructed in what corrosion is and how it is prevented and they should also be given up-to-date examples of corrosion since it has grown in importance along with the industrialization and places a burden on the national economy. It is important for the study that students already equipped with the knowledge of corrosion make use of this knowledge throughout their university education (Şahin, Yılmaz and Morgil, 2001).

A study with high school students showed that a majority of these students had never heard of the term corrosion before and they were not familiar enough with this term. Another finding from the study was that corrosion should only be taught briefly in the teaching program (Akkaya, 2010).

In another study with university students it was found that their levels of corrosion knowledge and their attitudes toward corrosion differed significantly based on their department at university. The knowledge level and the attitudes towards corrosion were higher among the students attending corrosion lessons when compared to those not taking corrosion lessons (Eyceyurt, 2010).

Corrosion is a current issue and a problem that will always be with us. The present study therefore tried to investigate the knowledge of corrosion among teacher candidates and students from the department of chemistry and it intended to point to the existence, causes, and consequences of such a problem and how to protect from it in order to stimulate interest among students.

In 1763, the Royal Navy covered the hull of a frigate with copper sheets in an effort to prevent the accumulation of mussels that would decrease the speed of the ship. However, after a while, they discovered that the iron nails used to attach copper sheets corroded quickly and then fell off. The same year in a report presented to the British Ministry of Defence, it was told not use iron in conjunction with copper. That was when the corrosion was first discovered (Trethewey and Chamberlain, 1988).

Because corrosion occurs slowly over a long period of time, it takes a long time for the consequences or effects to come out. According to some estimations, the cost of corrosion for the state is up to 3.5 – 5.0% of the gross national product. This is estimated to be 4.5% for Turkey (www.korozyondernegi.org.tr) Moreover, there occur work accidents due to corrosion in our country, yet no adequate and informative statistical and scientific studies are conducted regarding this issue (Bildik, 2014).

Corrosion education has taken on importance as corrosion is something unwanted and leads to a variety of environmental problems as well as economic losses unless necessary precautions are taken.

As emphasized by Palmer (1995), the research studies carried out in today's information age where the knowledge is the most important power prove that education is really important to have a livable environment. It has become a necessity to cultivate environmentally-friendly individuals to ensure that the next generations live in a healthier and safer environments.

It is also known that corrosion and corrosion products do serious harm to the nature. The lack of courses about corrosion affects students' level of knowledge related to the corrosion and this has a negative effect on the perceptions regarding environmental effects of corrosion among the students studying at the departments of chemistry and chemistry teaching.

Corrosion shows itself almost in every area of the industry. Tanks, poles, vehicles, underground pipe lines, reinforcing steels, ships, tanks filed with chemicals at factories and many parts of machine that are exposed to atmospheric conditions are faced with corrosion. Due to corrosion, all these structures fall out of use sooner than expected and cause significant economic losses. It is really difficult to calculate the cost of the losses resulting from corrosion because there are also some secondary losses besides those in the materials and workforce. These can be summarized as;

Shut-down of the plant due to the breakdowns resulting from corrosion,

- Loss of the product as a consequence of pitting corrosion which leads to cavities or holes in the storage tanks or pipelines; the pollution of the environment caused by this product and the fires likely to occur if that product is a type of inflammable one,
- Contamination of the product when the dissolved corrosion products leak into the chemical substance obtained,
- Cost overrun arising from the measures (painting, covering with tin and zinc, etc.) taken to protect products against corrosion.

Replacement of a part when it is too worn to function means the shut-down of a plant and halt of the production temporarily. Corrosion is likely to lead to production loss directly (loss of petrol or water due to the holes in tanks and pipelines caused by pitting corrosion) and it might also make a product useless by contaminating it (mixture of corrosion products into the main product). Accumulation of the corrosion products on the surface decreases the heat transmission coefficient considerably and leads to low productivity (e.g. in the heating, hot water or steam plants). These are called indirect losses (Dillon 1982).

Corrosion is a slow process. Therefore, it takes a long time for the negative effects to appear. This is the main reason why corrosion is disregarded in the process of designing metal structures. In fact, corrosion is the leading factor that determines the cost of investment and production in the industry. It is estimated that on average the cost of corrosion to the economy is up to 3.5 – 5.0% of the gross national product. This is estimated to be over 4.5% for Turkey. As there is growing concern today about the environmental pollution and safety, the responsibility falling on the scientists and engineers is to develop and implement techniques that ensure the effective control of corrosion.

Corrosion mostly harms metallic materials. It causes big economic losses for every country. Corrosion, before anything else, is a threat against human life and health and its other major harmful effects can be summarised as follows;

1- As is known, for centuries copper pots and containers have been covered with tin and then used because the materials made of copper are very harmful to

human health. Breakdown or failure of some important parts on aeroplanes due to corrosion (for reasons such as corrosion fatigue and stress corrosion cracking) might lead to plane crashes and loss of lives.

2- Corrosion is the main reason for the waste of limited metal sources in the World. Every year, 1/3 of the metallic materials produced become useless to the end of the year because of corrosion. Though out-of-use metallic materials, to some degree, can be recycled as scrap metal, 1/3 of them are lost in a way that cannot be recycled, that is, go back to the nature. This means that 1/10 of the annual production of metallic materials are lost and cannot be recycled again.
3- It is not the materials only; capital, labour, energy and knowledge are lost due to corrosion as well. Production of metallic materials requires capital, labour, energy and knowledge. It leads to additional losses when these can no longer be used because of corrosion.
4- Corrosion pollutes the environment and the polluted environment accelerates metal corrosion. The parts of the metallic materials that go back to the nature pollute the environment and the polluted environment accelerates the corrosion. When the water with copper ions in it contacts a cast-iron or aluminium surface, the copper changes into metallic form and dissolve the metal (cast iron or aluminium); also it accelerates the corrosion and causes small holes or cavities in the areas where it occurs.
   The loss of metal causes the production of new materials and additional environmental pollution, thereby increasing the pollution level of atmosphere and water. Thus, in polluted environments, metals corrode faster.
5- Dissolutions that can be identified as corrosion are brought to lower levels with the development of technology.

For instance, there are greater differences between the metal dissolution described as corrosion in drug industry or nuclear power station and the corrosion of a steel structure occurring under atmospheric conditions. Under atmospheric conditions, the reduction of thickness in less than millimetres due to corrosion is considered normal, however, the corrosion is desired to be near-zero in the cooling water pipes in a nuclear power station (Yalçın and Koç 1991).

Corrosion is a deterioration process which, as a result of chemical and electrochemical reactions, first occurs on the surface and then penetrates deep into the material causing a change in the property of that material. Causing serious losses, this process is considered one of the most important wastes. On a global basis, total annual corrosion cost due to the loss of materials, energy and labour is approximately equivalent to 5 percent of the Gross National Product (GNP) (Akdoğan, 2008). For the USA, the distribution of corrosion cost in GNP is as illustrated below:

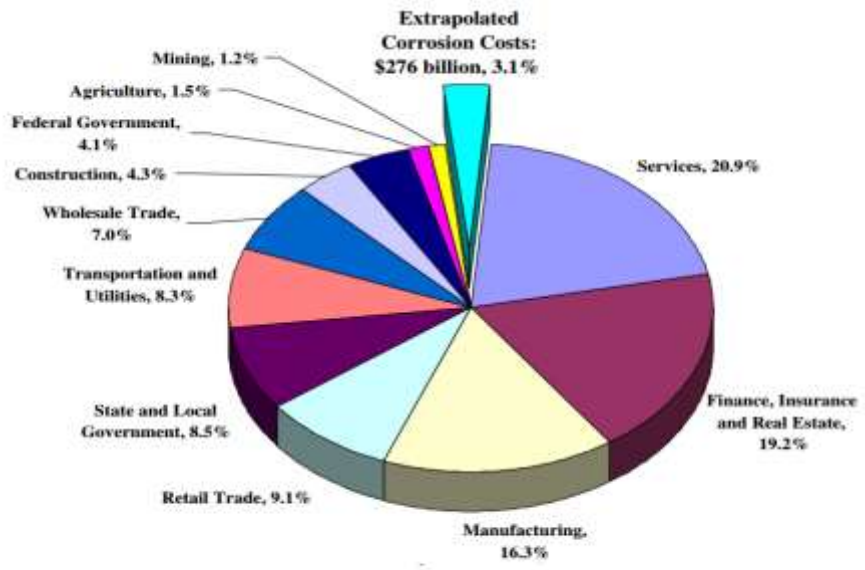

Figure 1. The percent cost of corrosion in the US GNP (Webster, 2010).

In the USA, this is equivalent to 3.1% of the GNP with a cost of $ 276 billion (Figure 1).

The total cost of the corrosion was $7.36 billion as reported in 2010 report prepared by the Department of the Navy Corrosion Prevention & Control, the US Navy. The Navy takes the first place with an amount of $3.2

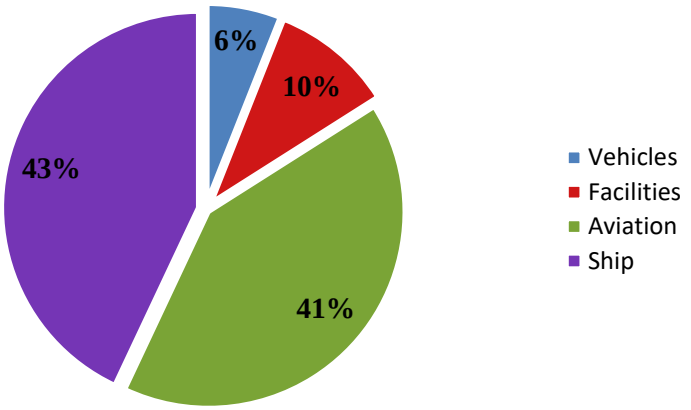

Figure 2. Proportional representation of the total cost of corrosion in US Navy (Thomas, 2010).

In the light of the date provided, it is seen that ship industry takes an important place in the fight against corrosion.

Some consequences of the corrosion could be social. These are;

Safety: Fire outbreaks, the release of toxic materials and the collapse of buildings.

Besides the financial loss, corrosion also causes severe damages with its consequences that pollute the environment and endanger human life. A study found that 67% of the buildings, which collapsed during İzmit earthquake, suffered from the damage resulting from corrosion. According to the official figures, this damage of the corrosion resulted in 58.000 deaths, 122.000 injuries and 411.000 buildings either collapses or damaged severely. It is reported that the cost of the damage due to corrosion is roughly estimated to be ₺168 billion (http://www.yalitim.net/?pid=20948).

On 22 November 2013, an oil pipeline in Chinese city of Qingdao exploded and The blast killed at least 62 people and injured 136. Eight months later, a similar explosion took place in n the southern Taiwanese city of Kaohsiung and it killed at least 32 people and injured about 321 others. Pipelines were made of steel and wore out after 20 years of use. The reason was corrosion (Victor and Leape, 2015)

Health: Contamination due to escaping products from corroded equipment or due to the corrosion product itself. For instance, Cr^{6+} ions produced by corrosion are highly toxic and carcinogenic (EL-Meligi, 2010).

Depletion of Natural Resources: Metal and the fuels used to manufacture them and the replacement of the corroded materials when they are unpleasant in appearance; these have both social and economic consequences. The contamination resulting from the leakage in the petroleum pipelines is a type of loss occurring due to corrosion and it causes the pollution of the product and environment, which is quite difficult to estimate and fix.

A study with high school students revealed that majority of these students self-reported that they never heard of, or in other words, were not familiar enough to the term *corrosion*. Another finding from the study showed that they had the opinion that the subject of corrosion should be should only be taught briefly in the teaching program (Akkaya, 2010).

Another study with university students found that their level of corrosion knowledge and their attitudes toward corrosion differed significantly based on their department at university. The knowledge level and the attitudes towards corrosion were higher among the students attending corrosion lessons when compared to those not taking corrosion lessons (Eyceyurt, 2010).

Corrosion is an occurrence that is so harmful to the human life and health and causes environmental pollution as well as financial losses. For that reason, it needs to be overcome, or at least, minimized (Sridhar, 1993, Moayed and Newman 1998). In recent years, the materials and components that do not threaten human life and have no toxic effect have become crucial in the efforts made to prevent the corrosion of metals and alloys (DeBerry 1985, Ahmad and MacDiarmid 1996, Yağan et al. 2005).

Environmental education is process that leads to responsible behaviours among individuals and groups with the intention of developing an awareness and vision about the environmental problems (KACEE, 2013). Environmental education is a lifelong, interdisciplinary approach which serves the purpose of cultivating a world population who is environmentally conscious and has knowledge, skills, attitudes, motivation, personal and social duties and responsibilities to contribute to the solution of current environmental problems and prevent the new ones (Deniş and Genç, 2010, p. 9).

In Tbilisi declaration, the objectives of environmental education were defined under five categories. These are awareness, knowledge, attitudes, skills and participation (UNESCO, 1978).

Awareness: to help individuals and social groups acquire a sensitivity to the total environment and its allied problems.

Knowledge: to help social groups and individuals gain a variety of experience in the environment and its associate problems.

Attitudes: to help individuals and social groups acquire a set of values and feelings of concern for the environment and associate problems.

Skills: to help individuals and social groups acquire the skills essential for solving environmental problems.

Participation: to provide individuals and social groups with an opportunity to be actively involved in the resolution of environmental problems (Hungerford, Bluhm, Volk and Ramsey, 1998).

Given the direct and indirect effects of corrosion on the environment, the environmental consequences of corrosion need to be emphasized at every stage of education as one of the big problems of past and future. At this point, it is essential that educators and the individuals going through an education process perceive corrosion as an environmental problem and it is approached as subject handled within the course program. Given the

environmental effects of corrosion, a strong awareness needs to be built to include corrosion in environmental education.

1.1.Purpose

The purpose of this study is to investigate whether the level of corrosion knowledge of students from the Faculties of Education Department of Chemistry Teaching and Faculty of Science Department of Chemistry has an effect on their perception of the environmental effects of corrosion.

1.2.Problem

Is there statistically a significant relationship between the level of corrosion knowledge of students from the Faculties of Education Department of Chemistry Teaching and Faculty of Science Department of Chemistry and their perception of the environmental effects of corrosion?

1.3.Sub-problems

1. What is the knowledge level of students in chemistry teaching at the education faculty and chemistry at the science faculty?
2. What is the perception of the education faculty chemistry teacher and the science faculty chemistry students about the environmental effects of corrosion?
3. Does the level of corrosion knowledge of students from the Faculty of Education Department of Chemistry Teaching has an effect on their perception of the environmental effects of corrosion?
4. Does the level of corrosion knowledge of students from the Faculty of Science Department of Chemistry has an effect on their perception of the environmental effects of corrosion?

2.METHOD

The present research study was carried out using the cross-sectional design, a type of general survey model since all of the students from the departments of chemistry and chemistry teaching couldn't be reached. Karasar (1998) defined general survey model as "a model based on surveying the whole population or a subset, sample or example drawn from this population in order to reach a general idea about the universe composed of a large variety elements". Surveys models are a study approaches that is aimed at describing a present or past situation in its existing condition (Karasar,1998).

A cross-sectional study analyses data collected from representative subsets of a population, not from the entire population since it is inaccessible, especially in the cases where the population is large (Karakaya, 2009).

2.1. Research Population and Sample

The research population included teacher candidates studying at Chemistry Teaching Programs and students from the Departments of Chemistry in Turkey. Sampling was taken from this universe through stratified sampling. In the stratified sampling method, the number of elements in the universe sub-group calculated the ratio of the number of elaman in the whole universe will go the way of choosing test (Baykal, 1999). The sample consisted of students from Department of Chemistry Teaching – Gazi University, Gazi

Faculty of Education; Department of Chemistry Teaching – Necmettin Erbakan University, Ahmet Keleşoğlu Faculty of Education; Department of Chemistry – Ankara University, Faculty of Science; Department of Chemistry – Selçuk University, Faculty of Science and Department of Chemistry – Gazi University, Faculty of Science. When the number of the chemistry teaching departments and chemistry departments at universities in Turkey are taken into consideration, there are more chemistry departments. Thus, 3 chemistry departments and 2 chemistry teaching departments consisted of the sampling of the study. The period of the undergraduate program of the chemistry teaching in the faculties of education .lasts 5 years and the period of the undergraduate program of the chemistry in the science faculties lasts 4 years. The third - grade students of the chemistry teaching departments couldn't be reached for the study because the chemistry teaching departments of the faculties of education in Turkey didn't accept any student in 2012 – 2013 educational years.

Students participated in the study were presented in Table 1 by their faculties, departments and school years.

Table 1.
Distribution of the research participants by their faculties, departments and school years.

		f	%
Faculty	N.E.U. Ahmet Keleşoğlu Faculty of Education Chemistry Teaching	54	15.7
	G.U Gazi Faculty of Education Chemistry Teaching	48	13.9
	A.U. Faculty of Science Department of Chemistry	162	47.0
	S.U. Faculty of Science Department of Chemistry	33	9.6
	G.U. Faculty of Science Department of Chemistry	48	13.9
	Total	345	100.0
Department	Chemistry Teaching	102	29.6
	Department of Chemistry	243	70.4
	Total	345	100.0
Year	1st Year	58	16.8
	2nd Year	98	28.4
	3rd Year	40	11.6
	4th Year	115	33.3
	5th Year	34	9.9
	Total	345	100.0

2.2.Data Collection Tools

The research data was collected using Corrosion Achievement Test developed by Bilir (2015), which is made up of 20-multiple choice questions and has a Cronbach's Alpha reliability coefficient of 0.76. Normality test was performed to investigate whether the scores obtained on achievement test were normal distribution or not and the value of the Shapiro-Wilk was found to be 0658.

Developed by Bilir (2015) and consisting of 26 items, The Scale of Perceiving Environmental Effects of Corrosion was the other instrument used in the study. It consisted of three sub – dimensions including "economy", "health" and "security". The internal consistency coefficients were calculated in order to analyse the reliability of the scale. Cronbach – Alpha gave the highest reliability (0.86) while Spearman – Brown and

Guttman techniques gave the lowest reliabilities (0.76 and 0.84 respectively). The fact that these values are higher than 0.70 shows that the scale has a good realibility.

2.3.Analysis of the Data

The achievement test consisting of 20 questions with multiple choices was administered to the sample. Each question has five choices and each correct response is worth 1 point while incorrect and unanswered ones are worth "0" point; in total the test is worth 20 points. Single-factor ANOVA for paired samples (repeated measures) was performed to compare the test scores that students achieved on Corrosion Achievement Test. The significance level was set at 0.05.

The Scale of Perceiving Environmental Effects of Corrosion is a Likert-type scale with 26 items and responses to items are measured on 5-point Likert rating scale; "Strongly Agree", "Agree", "Neither agree nor disagree", "Disagree" and "Strongly Disagree". The lowest possible score is 26 and the highest attainable score is 130. High scores correspond to higher levels of perceptions in relation to environmental effects of corrosion while low scores show lower levels of perception.

On the basis of test scores, the levels of perception were interpreted as follows:

130-111 very high

110-90 high

89-69 moderate

68-47 low

46-26 very low

Single-factor ANOVA for paired samples (repeated measures) was performed to compare the test scores that students achieved on The Scale of Perceiving Environmental Effects of Corrosion. The significance level was set at 0.05.

3. RESULTS AND INTERPRETATION

Corrosion Test mean scores by school year among the students of chemistry teaching were presented below in Table 2.

Table 2.
Test mean scores of students of chemistry teaching

Year	**f**	$\overline{x}$
1st Year	17	8.07
2nd Year	21	8.82
4th Year	30	7.73
5th Year	34	10.88

As seen in Table 2, for the students studying at chemistry teaching, the level of corrosion knowledge was measured to be 8.07 for first-year students, 8.82 for second-year students, 7.73 for third-year students and 10.88 for fifth-year students.

Tablo 3.
Test mean scores of students of chemistry teaching on the scale of perceiving environmental effects of corrosion

Year	f	$\overline{x}$
1st Year	17	83.84
2nd Year	21	80.86
4th Year	30	80.47
5th Year	34	84.52

As seen in Table 3, when the perceptions of the students from chemistry teaching departments towards the environmental effects of corrosion were analysed according to the years in which they attended, it was found out that the levels of perception about environmental effects of corrosion were measured to be 83.84 for first-year students, 80.86 for second-year students, 80.47 for fourth-year students and 84.52 for fifth-year students

In order to evaluate the effect of the level of corrosion knowledge on the perceptions about the environmental effects of corrosion among the students from the Faculty of Education, the data obtained from the Corrosion Achievement Test and the Scale of Perceiving Environmental Effects of Corrosion was analyzed to check for any correlation between the scores achieved on both tests. The relevant data was presented in Table 4.

Table 4.
Correlation between the perceptions about the environmental effects of corrosion and the level of corrosion knowledge among the students from the Faculty of Education

	Perceptions of Environmental Effects	Level of Knowledge
Perceptions of Environmental Effects	1	.402*
Level of Knowledge	.402*	1

The results of the correlation analysis, as can be seen in Table 4, revealed a moderate, positive and significant correlation between the perceptions about the environmental effects of corrosion and the level of corrosion knowledge among the students from the Faculty of Education, $r=.402$, $p<.01$.

The mean scores that students from the department of chemistry achieved on the Corrosion Achievement Test were given below in Table 5.

Table 5.
Test mean scores of students from the department of chemistry

Year	f	$\overline{x}$
1st Year	41	7.45
2nd Year	77	6.22
3rd Year	40	4.8
4th Year	85	6.3

As presented in Table 5, for the students studying at department of chemistry, the levels of corrosion knowledge were found to be 7.45 for first-year students, 6.22 for second-year students, 4.8 for third-year students and 6.3 for fourth-year students.

Tablo 6.
Kimya Bölümü Öğrencilerinin Korozyon Konusunun Çevresel Etkilerini Algılama Ölçeğinden Aldıkları Puan Ortalamaları

Year	f	$\overline{x}$
1st Year	41	85.66
2nd Year	77	78.40
3rd Year	40	81.35
4th Year	85	80.58

As presented in Table 6, in terms of school year, the perception levels of students from department of chemistry about the environmental effects of corrosion were found to be 85.66 for first-year students, 78.40 for second-year students, 81.35 for third-year students and 80.58 for fourth-year students.

In order to see the effect of the level of corrosion knowledge on the perceptions of its environmental effects among the students from the Faculty of Science, the data obtained from the Corrosion Achievement Test and the Scale of Perceiving Environmental Effects of Corrosion was analyzed to check for any correlation between the scores achieved on these tests. The results of correlation analysis was presented in Table 7.

Table 7.
Correlation between the level of corrosion knowledge and the perceptions of its environmental effects among the students from the Faculty of Science

	Perceptions of Environmental Effects	Level of Knowledge
Perceptions of Environmental Effects	1	.315*
Level of Knowledge	.315*	1

As presented in Table 7, a moderate, positive and significant correlation was observed between the level of knowledge of corrosion and the perceptions about its environmental effects among the students from the Faculty of Science, department of chemistry ($r=.315$, $p<.01$).

4. CONCLUSION AND DISCUSSION

As for the students studying at department of chemistry, the mean scores on the same test were found 7.45 for first-year students, 6.22 for second-year students, 4.8 for third-year students and 6.3 for fourth-year students. Similarly, students of the Faculty of Science have very low levels of knowledge of corrosion, as well.

In a study with university students, Eyceyurt (2010) also found very low levels of knowledge regarding corrosion. Given the mean scores of students from the department of chemistry and the chemistry teaching, this finding seems to be in consistent with the result of this study.

According to the results of the Scheffe test which compared pairs of group means in order to assess where the difference was, a statistically significant difference was found in favor of fifth-year students when first, fourth and fifth year students were compared. Accordingly, it was seen that fifth year students had a statistically significantly higher

level of knowledge of corrosion than first and fourth year students of chemistry teaching did.

As revealed by the Scheffe's test used to determine the direction of the differences in terms of school years, there was a statistically significant difference between first and third-year students favoring first-year ones and between fourth and third-year students favoring fourth-years. It was therefore concluded that first and fourth-year chemistry students had significantly higher levels of knowledge of corrosion, when compared to third-year students.

Considering the departments where the present study was carried out, it is seen that either there is no corrosion course available in these departments or elective corrosion courses are not preferred by students and also the subject of corrosion is taught just as a topic within another course or it is disregarded at all. Accordingly, this could be the most likely explanation for the low mean scores obtained by the students of the department of chemistry and the chemistry teaching.

The mean scores that students from the Faculty of Education achieved on the Scale of Perceiving Environmental Effects of Corrosion were found to be 83.84 for first-year students, 80.86 for second-year students, 80.47 for fourth-year students and 84.52 for fifth-years. As a result, it is seen that these students have moderate level of perception regarding the environmental effects of corrosion.

The mean scores obtained by the students from the Faculty of Science on the Scale of Perceiving Environmental Effects of Corrosion were 85.66 for first-year students, 78.40 for second-year students, 81.35 for third-year students and 80.58 for fourth-year students. Similarly, it is evident that these students also have moderate level of perception on the environmental effects of corrosion.

An investigation into the course programs of the departments where the present study was conducted shows that there is no course under the title of corrosion in these programs, and the subject of corrosion is either incorporated as a topic into another course or disregarded at all. The test scores of the students from both the Faculty of Science and the Faculty of Education appear to be the unfortunate result of this case.

It is seen that there is a moderate, positive and significant correlation between the perceptions about the environmental effects of corrosion and the level of corrosion knowledge among the students of the Chemistry Teaching in the Faculty of Education.

Similarly, a moderate, positive and significant correlation exists between the perceptions about the environmental effects of corrosion and the level of knowledge of corrosion among the students of the Department of Chemistry in the Faculty of Science.

In their study, Timur and Yılmaz (2011) reported that students' knowledge of environment increases along with the increase in their academic achievement. The existence of a moderate, positive and significant correlation between the level of corrosion knowledge and the perceptions about the its environmental effects can be interpreted as that an increase in the academic achievement of students is likely to have a positive effect on their perceptions about the environmental effects of corrosion.

This is kind of supported by students' low level of corrosion knowledge and their moderate level of perceptions about its environmental effects. Increasing the level of

corrosion knowledge will also increase their perceptions regarding the environmental effects of corrosion.

5. RECOMMENDATIONS

Corrosion is an unwanted and self-generated occurrence. It is a serious problem not only for today but for tomorrow, as well. It is therefore important that students studying in the area of science have or develop an awareness of corrosion and its consequences.

Given the living conditions of today, the presence of metals in all areas of our life makes the knowledge of corrosion more and more important. Therefore, corrosion education needs to be provided in every stage of education life, from preschool to university, where there is a formal transfer of knowledge.

It is recommended that Faculties of Education and Science that cultivate educators and scientists in this field provide corrosion education.

Corrosion should be taught as a separate course to the students of Chemistry Teaching it the Faculties of Education and to the students studying at the Department of Chemistry in the Faculties of Science since these students have lower levels of knowledge about corrosion and its effects

The study was carried out sampling 345 students from two different university departments. A more extensive research study can be undertaken with greater number of students and departments.

The research can be done in a pre- and post-test design using teaching methods intended for increasing the level of corrosion knowledge among university and secondary education students.

Corrosion education should be provided for students starting from the preschool age so that their knowledge of corrosion can be brought up to the level where it needs to be.

The number of scientific studies on corrosion need to be increased at preschool, primary and secondary school level and essential arrangements should be made by identifying shortcomings and problems faced with during corrosion education.

Activities such as field trips and observations should be encouraged at preschools, primary and secondary schools to build awareness about corrosion problem

Considering the environmental effects of corrosion and the results of the present study that found low perceptual levels on corrosion, there is a need for scientific studies to be undertaken to help every individual going through an education process develop an awareness about the environmental effects of corrosion.

Given its environmental effects, the education about corrosion should be incorporated into the lessons focusing on environment.

The issue of corrosion in Turkey can be better clarified providing that study population is expanded to involve other universities across Turkey to further solidify the research results.

The Scale of Perceiving Environmental Effects of Corrosion consists of 26 items. Various factors could be generated by increasing the number of the items.

Quantitative data collection instruments were used in the present study. Further research can be done by using qualitative instruments as well as quantitative ones.

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GENİŞ ÖZET

Korozyonun doğrudan veya dolaylı olarak çevreye etkileri göz önüne alındığında, geçmişin ve geleceğin önemli çevre sorunları arasında yer alan korozyonun çevresel etkilerinin eğitimin her kademesinde vurgulanması gereken bir problem olarak ortaya çıkmaktadır. Bu noktada eğitimcilerin ve eğitim sürecine giren bireylerin korozyonu bir çevre sorunu olarak algılamaları ve bu noktanın dersler içerisinde değerlendirildiği bir konu düzeyine çıkması gerekmektedir. Korozyonun çevresel etkileri göz önüne alındığında korozyonun çevre eğitiminin içerisine yer alması için güçlü bir farkındalık yaratılması gerekmektedir.

Bu çalışmanın amacı; eğitim ve fen fakültesi öğrencilerinin korozyon konusundaki bilgi düzeylerinin korozyonun çevresel etkilerini algılamaları üzerine bir etkisi olup olmadığı araştırmaktır.

Araştırma genel tarama modelinin, kesitsel tarama türü kullanıldı. Karasar (1998) genel tarama modelini "çok sayıda elemandan oluşan bir evrende, evren hakkında genel bir yargıya varmak amacı ile evrenin tümü ya da ondan alınacak bir grup, örnek ya da örneklem üzerinde yapılan tarama düzenlemeleri" olarak tanımlamıştır. Tarama modelleri geçmişte ya da halen var olan bir durumu var olduğu şekilde betimlemeyi amaçlayan araştırma yaklaşımlarıdır (Karasar, 1998).

Çalışma evrenini Türkiye'deki Kimya Öğretmenliği Programlarında okuyan öğretmen adayları ve Türkiye'deki Kimya Bölümü Programlarında okuyan Kimya Bölümü öğrencileri oluşturmuştur. Araştırmanın örneklemi Gazi Üniversitesi, Gazi Eğitim Fakültesi, Orta Öğretim Fen ve Matematik Alanları Eğitimi Bölümü, Kimya Öğretmenliği Anabilim Dalında (GKÖ) okuyan öğrenciler, Necmettin Erbakan Üniversitesi, Ahmet Keleşoğlu Eğitim Fakültesi, Orta Öğretim Fen ve Matematik Alanları Eğitimi Bölümü, Kimya Öğretmenliği Anabilim Dalında (NKÖ) okuyan öğrenciler, Ankara Üniversitesi Fen Fakültesi Kimya Bölümü (AKB) öğrencileri, Konya Selçuk Üniversitesi Fen Fakültesi Kimya Bölümü (SKB) öğrencileri ve Gazi Üniversitesi Fen Fakültesi Kimya Bölümü (GKB) öğrencileri oluşturmuştur.

Araştırmada veri toplama aracı olarak Bilir (2015) tarafından geliştirilen ve 20 sorudan oluşan, Cronbach-Alpha güvenirlik katsayısı 0.76 olan Korozyon Başarı Testi kullanılmıştır. Bilgi testlerinden elde edilen test puanlarının normal dağılıp dağılmadığını anlamak için homojenlik testi yapılmış, Shapiro-Wilk değeri (0.658) elde edilmiştir.

Araştırmada kullanılan diğer veri aracı da Bilir (2015) tarafından geliştirilmiş ve 26 maddeden oluşan, Korozyonun Çevresel Etkilerini Algılama Ölçeği kullanılmıştır.

Kimya öğretmenliği ve kimya bölümü öğrencilerinin korozyon konusunda bilgi düzeylerinin çok düşük olduğu sonucuna ulaşılmıştır. Eyceyurt (2010)'un üniversite öğrencileriyle yaptığı bir çalışmada da üniversite öğrencilerinin korozyon bilgi düzeylerinin oldukça düşük olduğu ortaya konulmuştur. Kimya öğretmenliği ve kimya bölümü öğrencilerinin test ortalamalarına bakıldığında yapılan bu çalışma ile paralellik gösterdiği sonucuna ulaşılmıştır.

"Eğitim fakültesi kimya öğretmenliği öğrencilerinin korozyonun çevresel etkileri ile ilgili algılamaları ne düzeydedir?" sorusuna baktığımızda 1. sınıfta öğrencileri 83.84, 2. sınıf öğrencileri 80.86, 4. sınıf öğrencileri 80.47 ve 5. sınıf öğrencileri 84.52 olduğu

görülmektedir. Bu bulgulara göre eğitim fakültesi öğrencilerinin korozyonun çevresel etkileri ile ilgili algılamaları orta düzeyde olduğu görülmektedir.

"Fen fakültesi kimya bölümü öğrencilerinin korozyonun çevresel etkileri ile ilgili algılamaları ne düzeydedir?" sorusuna baktığımızda 1.sınıfta öğrencileri 85.66, 2. sınıf öğrencileri 78.40, 3. sınıf öğrencileri 81.35 ve 4. sınıf öğrencileri 80.58 olduğu görülmektedir. Bu bulgulara göre eğitim fakültesi öğrencilerinin korozyonun çevresel etkileri ile ilgili algılamaları orta düzeyde olduğu görülmektedir. Bu bulgulara göre fen fakültesi öğrencilerinin korozyonun çevresel etkileri ile ilgili algılamaları orta düzeyde olduğu görülmektedir.

Uygulama yapılan bölümler incelendiğinde bu bölümlerde korozyon dersinin olmadığı, korozyon konusunun başka bir dersin içerisinde konu olarak işlenmektedir ya da hiç korozyon konusuna hiç değinilmektedir. Bu durum eğitim fakültesi kimya öğretmenliği ve fen fakültesi kimya bölümü öğrencilerinin testten aldığı ortalamalar incelendiğinde öğrencilerin ortalamaları ile paralellik göstermektedir.

Eğitim fakültesi kimya öğretmenliği bölümünde öğrenim gören öğrencilerin korozyon konusundaki bilgi düzeyleri ile korozyonun çevresel etkilerine karşı algılamaları arasında orta düzeyde, pozitif ve anlamlı bir ilişki olduğu görülmektedir.

Fen fakültesi kimya bölümünde öğrenim gören öğrencilerin korozyon konusundaki bilgi düzeyleri ile korozyonun çevresel etkilerine karşı algılamaları arasında orta düzeyde, pozitif ve anlamlı bir ilişki olduğu görülmektedir.

Timur ve Yılmaz (2011)'ın yapmış olduğu bir çalışmada öğrencilerin akademik ortalarının artması ile çevre bilgilerinin de arttığını görmekteyiz. Öğrencilerin korozyon konusundaki bilgi düzeyleri ile korozyonun çevresel etkilerini algılamaları arasında orta düzeyde, pozitif ve anlamlı bir ilişki olduğunun ortaya çıkması öğrencilerin akademik başarılarının artmasının çevresel etkilerini algılamalarını olumlu yönde etkileyeceği şeklinde sonuç değerlendirilebilir.

Eğitim ve fen fakültesi öğrencilerinin korozyon konusundaki bilgi düzeylerinin oldukça düşük, korozyonun çevresel etkileri ile ilgili algılamaları orta düzeyde olması bu durumu desteklemektedir. Korozyon konusundaki bilgi düzeylerinin arttırılması, korozyonun çevresel etkileri ile ilgili algılamalarını yükseltecektir.

Korozyonun doğrudan veya dolaylı olarak çevreye etkileri göz önüne alındığında, geçmişin ve geleceğin önemli çevre sorunları arasında yer alan korozyonun çevresel etkilerinin eğitimin her kademesinde vurgulanması gereken bir problem olarak ortaya çıkmaktadır. Bu noktada eğitimcilerin ve eğitim sürecine giren bireylerin korozyonu bir çevre sorunu olarak algılamaları ve bu noktanın dersler içerisinde değerlendirildiği bir konu düzeyine çıkması gerekmektedir. Korozyonun çevresel etkileri göz önüne alındığında korozyonun çevre eğitiminin içerisine yer alması için güçlü bir farkındalık yaratılması gerekmektedir.