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## COMPARING CHEMISTRY STUDENT TEACHERS' CONCEPTIONS TOWARD OZONE LAYER: TURKEY AND GERMANY SAMPLES

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### Abstract

This study is aimed to analyze conceptions of student teachers who receive education from Turkey and Germany, toward ozone layer by comparing them according to several variables. Sample of the study is composed of 78 student teachers of chemistry who received education in three universities from three different cities in Turkey and 72 student teachers of chemistry who received education in different universities of Hessen and Baden-Württemberg States of Germany in 2012-2013. This research, which was carried out in order to detect student chemistry teachers' levels of conception toward environmental chemistry, is a descriptive research carried out with comparative study method. To collect data, open-ended questionnaire which was composed of four questions and likert scale about ozone layer was used. SPSS 17,0 package program was used to analyze data. No meaningful statistical differences detected between the ranks of student teachers (101 female and 68 male) depending on the gender based on Mann-Whitney U analyze results( $U=3425,000$ ;  $p=0,977$ ;  $p>,05$ ) which was applied in order to determine whether there were any meaningful differences between male and female student teachers' questionnaire ranks or not. When results of Mann-Whitney U which was applied in order to detect were analyzed, it was seen that there was a meaningful difference between students' questionnaire ranks depending on the country in which they received education( $U=3,425,000$ ;  $p=0,977$ ;  $p>,05$ ).

**Key Words:** Ozone Layer; Conception; Student Teachers; Teacher Education

## KİMYA ÖĞRETMEN ADAYLARININ OZON TABAKASINA YÖNELİK KAVRAMLARININ KARŞILAŞTIRILMASI: TÜRKİYE ALMANYA ÖRNEĞİ

### Özet

Bu Çalışmanın amacı, Türkiye ve Almanya'da eğitim gören kimya öğretmen adaylarının ozon tabakasına yönelik kavramsal anlama düzeylerinin karşılaştırılmasıdır. Çalışmanın örneklemini 2012-2013 eğitim-öğretim yılında Türkiye'nin farklı Bölgelerinde bulunan üç üniversitenin öğretmenlik programında öğrenim gören 78 Kimya öğretmen adayı ve Almanya'da Hessen ve Baden-Württemberg Eyaletlerinde farklı üniversitelerde öğretmenlik programında öğrenim gören 72 kimya öğretmen adayı oluşturmaktadır. Öğretmen adaylarının

çevre kimyasına yönelik kavramsal düzeylerini belirlemek amacıyla yapılan bu araştırma, mevcut bir durumu betimlemeye ve buna bağlı olarak değişkenlerin (cinsiyet ve eğitim aldıkları ülke) birbiriyle ne seviyede ilişkili olduğunu belirlemeye yönelik olması nedeniyle genel tarama özelliği taşıyan tarama modelinde betimsel bir çalışmadır. Bu çalışmada Ozon Tabakası ile ilgili kavramların öğretmen adayları tarafından algılanma düzeylerinin belirlenmesi amacıyla Selvi (2007) tarafından hazırlanan likert tipi anket ve dört sorudan oluşan açık uçlu anket kullanılmıştır. Verilerin istatistiksel analizi için SPSS 17,0 paket programı kullanılmıştır. erkek ve bayan öğretmen adaylarının anket puanları arasında istatistiksel olarak anlamlı bir farklılık olmadığı görülmektedir ( $U = 3425,000$ ;  $p = 0,977$ ;  $p > ,05$ ). Mean ranks dikkate alındığında erkek öğretmen adaylarının bayan öğretmen adaylarına göre istatistiksel başarılar bakımından daha yüksek bir ortalamaya sahip oldukları söylenebilir. Fakat bu farkın istatistiksel olarak anlamlı bir fark için yeterli olmadığı söylenebilir. öğretmen adaylarının anketten aldıkları puanlarının bulundukları ülkelere göre ise anlamlı bir farklılık gösterdiği görülmektedir ( $U = 3425,000$ ;  $p = 0,977$ ;  $p > ,05$ ). Mean ranks dikkate alındığında Alman öğretmen adaylarının Türk öğretmen adaylarına göre istatistik başarılar bakımından daha yüksek bir ortalamaya sahip oldukları açıkça görülebilir.

**Anahtar Kelimeler:** Ozon Tabakası; Kimya Öğretmen Adayları; Öğretmen Eğitimi

## 1. INTRODUCTION

In today's education system, rather than giving the existing data, teaching how to reach data and thus, developing students' mental abilities and problem solving strategies are aimed. Education of chemistry plays the most important role in providing these abilities. The aim of the education of chemistry is to provide students with the capability of handling and analyze the universe and the environment they live in. Students' adaptation to life requires the capability of observation of the environment they live in and making cause and effect connections between the events. Students who have this ability, are also have the capability of making objective and right decisions about various cases and situations. One of the most important subjects that chemistry education engages with is the environment education.

In recent years, parallel to the deformation of ecosystem and environmental cases, the importance of environment education has increased. When the bad effects of global environment problems on world balance are taken in to consideration, creating awareness about these problems is essential. People give reactions according to their perceptions about the environmental problems that threaten them. If their perceptions are wrong, their attempts to save the environment would fail. This is the reason why it is extremely important to raise generations who can perceive environmental problems correctly, sensitive to the environment, and can behave responsibly. One of the most important places where people can be aware of environment is educational institutions. In educational institutions, adequate environmental data should be given to students (Palmer, 1998; Bradley, Waliczek & Zajicek, 1999; Soran et al., 2000; Barraza, 2001; Loubser, Swanepoel & Chacko, 2001; Hsu, 2004; Strife, 2010). It is considered that in order to find a solution for the environmental problems, first individuals should be aware of the problem and with the help of their experiences, they should make

suggestions. From this aspect, it can be declared that preconceptions are important while solving problems. Being known that Preconceptions are considerably effective on learning; preconceptions and if exists, misconceptions should be detected. If students have misconceptions about the reasons for environmental problems, they will make false suggestions, and because of this, they will not be able to find effective ways to solve the global environmental problems. Among World's most effective environmental problems, global warming as a result of increasing greenhouse gases, ozone depletion and it's affects, and acid rain which threatens the life on earth can be named (Bozkurt & Koray, 2002; Bozkurt & Aydoğdu, 2004; Brown, 2000). The most effective one among these environmental problems is ozone depletion.

Ozone layer filters the ultraviolet rays that come from sun and can have bad affects for life on earth (Keleş, 1997). Resulting from the ozone depletion, the more ultraviolet ray reach to the earth, the more it endangers humanity and biologic life (Cordero & Clayton, 2001).

It is observed in former researches that students from various ages have misconceptions about ozone layer (Kaya, 2009; Bozkurt, & Kaya, 2008; Michail, Stamou, & Stamou, 2007; Selvi, 2007; Papadimitriou, 2004; Groves & Pugh, 2002; Khalid, 2003; Boyes & Stanisstreet, 1999; Meadows & Wiesenmayer, 1999).

In general, individuals have inadequate knowledge about the subject of ozone layer despite their worries about environmental issues including ozone layer (Meadows & Wiesenmayer, 1999). Thus, the possibilities of understanding the problem and finding a solution are limited.

When researches are analyzed, it is seen researches that include current environmental problems are very few. From this aspect, it is obviously important to detect and correct students' preconceptions and misconceptions about current environmental problems starting from primary schools and different levels of high schools. Key point in this progress is the teacher (Gayford, 2002; Sail, 1999). For this reason it can be implicated that it is fairly important for teachers to have adequate knowledge of field during the formal education process. Because great majority of students' misconceptions are the results of teachers' preconceptions and misunderstandings about the context of the lessons they are teaching (Pardo & Portoles, 1995)

Therefore, detecting possible misconceptions or alternative concepts of student teachers about basic items, and searching for ways to correct these in further progress, is essential in order to change students' attitudes toward the context being taught. This is the reason why teacher training institutions go under so much responsibility. It is crucial for student teachers who receive education in these institutions to be trained sufficiently in terms of both field information and their professional education fields.

When EU countries and Turkey are analyzed in terms of teacher training programs, various differences are observed. Two basic models are applied in teacher training programs. These are the concurrent model and consecutive model. While a student

simultaneously studies both the field, and the ways of teaching in the ‘concurrent’ model, in the ‘consecutive’ model, a teacher first obtains a qualification in field subjects and then studies teaching. It is seen that second model is used wider in EU countries that were analyzed. In Germany, there are differences between states in terms of teacher training programs as a result of state-governed education system.

Courses of Chemistry Teaching program and contexts of practical courses in Turkey and EU countries that are analyzed are different from each other. In Germany and England student teachers have to take less field-related courses during their education program than in Turkey. In Turkey, more field related courses, have negative effects on students’ development in certain subjects. Also, there are differences between countries in terms of practical education. When selected countries are compared, it is seen that the biggest difference is teacher education between Germany and Turkey. Thus, in this research, the aim is to make a comparison between these two countries.

Recently, practical education is carried out in Turkey under the title of faculty-school cooperation that was implemented by Higher Education Council and Ministry of Education in 1998 (YÖK 1998). Practical education program was developed with ‘school experience’ and ‘teaching practice’ instructions which were prepared by Education Faculties in accordance with the general arrangements of Higher Education Council, and planned with clear definitions of the activity process. Also, in 2006, certain changes were made in practical education in Education Faculties’ programmes by HEC. According to the last arrangement, there are two basic practical courses in preservice teacher education: School Experience and Teaching Practice (YÖK, 2008).

In Germany, teacher education is composed of two training components: first level is the education process in faculties, and the second level is the internship. After teacher candidates complete their education in faculty, they attend 1<sup>st</sup> State Examination (*I. Staatsexamen*). After they succeed this exam, they manage to assign as a teacher after they complete their two-year internship program and succeed in 2<sup>nd</sup> state examination. (Daschner & Drews, 2007; Turan, 2005). According to this system, practical education can be divided into two sections: in the teacher training institution, and during the internship process.

In Turkey, it can be mentioned that practical education processes developed structurally. On the other hand, it is hard to imply that principles in instructions of school experience and teaching practice, and also in the arrangements related to internship are properly put into practice. This is the reason why practical education is still problematic in Turkey (Silay & Gök, 2004; Kuşuoğlu, 2005; Paker, 2005). In Germany, active teaching practice is given more importance in curriculum when compared to Turkey.

In Germany, especially in teacher training during internship, teacher candidates have very long term active teaching practice. In Turkey however, active practice is limited with one semester and instead of taking full responsibility of the assigned classroom, teacher candidates go through this procedure under the supervision of the

classroom teacher. Consequently, duration of active teaching practice may differ depending on the number of teacher candidates in the practice group and advisor's attitude. Although active practice three times a week is required according to program, in fact, for various reasons, practices were far fewer. This fact results in ineffectiveness and uselessness of the most basic items of practical education.

Thus, detecting misconceptions of Student Teachers of Chemistry (STC), (Student Teacher(s) of Chemistry in Germany (SCTG,) and Student Teacher(s) of Chemistry in Turkey (SCTT)), and seeking for solutions to these misconceptions in next stages, are essential in order to change students' approaches positively.

### **Purpose**

Purpose of this research is to analyze STCs concepts contrastively from the aspects of different variations towards the chemistry of environment. Research questions are shown below:

1. Do STCs' concepts towards the chemistry of environment show any meaningful variety according to gender?
2. Do STCs' concepts towards the chemistry of environment show any meaningful difference related to the country they live in?
3. On which level are the STCs' concepts related to the chemistry of environment?

## **2. METHOD**

### **Model of the Research**

This research, which was done to detect the conceptual level of STCs' towards the chemistry of environment, is a descriptive study in terms of specifying an existing condition and based on that detecting the relationship level between variables (gender and the country they receive education in). When the research is analyzed from the aspect of contrastive education, according to contrastive education; all the dimensions in education system are framed with horizontal approach because of being put together with the variables which belong to that time period, and detecting the differences. This research can be given the named as 'contrastive education research' based on the environment which it is applied in, 'field research' because of the field under research and it's special frame, and 'basic research in terms of usage, aim, level and function.

#### **a) Universe and Sample**

Universe of the study is all the Chemistry teacher candidates in Turkey and Germany. Sample of the study is composed of 78 student teachers of chemistry who received education in three universities from three different cities in Turkey and 72 student teachers of chemistry who received education in different universities of Hessen and Baden-Württemberg States of Germany in 2012-2013. All of the teacher candidates from Turkey completed the practice program and were about to be graduated. 46 of teacher candidates in Germany succeeded in 1<sup>st</sup> state exam(I. Staatsexamen), and

continuing 3<sup>rd</sup> and 4<sup>th</sup> semesters of two-year teaching practice program. Other 26 teacher candidates in Germany finished teaching practice program, passed the 2<sup>nd</sup> state exam (II. Staatsexamen), and qualified to assign as a teacher.

Gender distribution of STCs and countries in which they receive education are given in Table-1.

**Table 1. Gender Distributions of STCs According to the Countries They Receive Education in and Sampling Rate**

Country		Turkey	Germany	Total
Women	N	57	44	101
	%	33,7	26	59,7
Men	N	40	28	68
	%	23,7	16,6	40,3
Total	N	97	72	169
	%	57,4	42,6	100

When Table-1 is analyzed, it is seen that STC sample group is composed of 101(59,7%) women, and 68(40,3%) men. This fact shows that the majority of this sample group is women.

### Collecting Data

In this study, likert scale and open-ended questionnaire composed of four questions are used which were prepared by Selvi (2007) in order to understand student teacher's level of perception in ozone layer. In open-ended survey SCT's questions are based on the scientific information about ozone layer, the effects of ozone depletion on human life and our planet, reasons of ozone depletion, and how did they get these information. This survey was used in order to support and analyze the results of likert scale in detail. Also, this survey was applied before Likert scale to influence student teachers'. The reliability parameter of Likert scale which had 21 questions, are estimated  $\alpha=.65$  by Selvi(2007). The survey is applied to Student Teachers of Chemistry in Turkey (STCT) without any change. Also the survey is translated from Turkish to German by a chemistry teacher in Germany. The survey was first analyzed by the linguists and the masters of the subject field. After necessary alterations are made, the survey is applied to the students from various levels at university to set an example, and used after each question was remediated based on understandability. Reliability parameter of the test is estimated  $\alpha=.70$  with the help of the data gathered from German sample group.

Scale is composed of three sub-scales and 21 questions: seven about preconceptions, seven about the reasons of the ozone depletion, seven of them about the consequences of the ozone depletion. In scale, each question has five choices as: 'strongly agree', 'agree', 'neutral', 'disagree', and 'strongly disagree'. Gathered data were coded form 5 to 1 for correct statements and from 1 to 5 for incorrect statements. The

maximum rank is 105(21x5), the minimum rank is 21 (21x1) from the scale.

#### b) Analysis

To analyze data, SPSS 17,0 package program is used. While analyzing the scale, data are explained through average ( $\bar{X}$ ), standard deviation (S), frequency (f) and percentage (%) values in tables. In statistical analysis are based on 0,05 significance level.

To detect whether data shows normal distribution or not, Kolmogorov-Smirnov test results are analyzed and it is proven that data do not show normal distribution. According to Kolmogorov-Smirnov test results, it is detected that ranks of student teachers of chemistry from scale do not show normal distribution on the 0,05 significance level. As a result, analysis will be based on non-parametric tests. Mann-Whitney U test is applied on the results of survey

### 3. FINDINGS

#### Distribution of STCs' Ranks of Questionnaire Related to Ozone Layer

General Distribution of STCs Ranks from questionnaire is given in Table 2

**Table 2. General Distribution of the Ranks of STCs From Scientific Attitude Scale:**

Country	N	Mini- mum Rank	Maxi- mum Rank	Mean Rank	S.D.
TURKEY	97	58	81	67,54	5,09
GERMANY	72	74	101	91,68	4,93
SUM	169	58	101	79,61	5,01

The maximum Rank of the STCTs is 81, minimum rank is 58, mean rank is 67,54, standard deviation is 5,09. Maximum rank of STCGs (German student teachers of Chemistry) is calculated 101, minimum rank is calculated 74, mean rank is calculated 91,68, standard deviation is calculated 4,93.

#### Findings of Questionnaire In Terms of Gender and Countries They Receive Education From.

In Table 3, results of Mann-Whitney U analysis, which is applied in order to detect whether there is a difference between ranks of STCs related to gender, are shown. In graphic 2, the variability graphic is given according to gender and grade.



**Table 3. Results of Mann-Whitney Test According to Gender**

Gender	n	Sum of Ranks	Mean Rank	U	Z	p*
Male	68	5789,00	85,13	3425,000	-,029	,977
Female	101	8576,00	84,91			
Sum	169					

\*  $p > 0,05$

When Mann-Whitney U results are analyzed, it is seen that there is not a statically meaningful rank difference between male and female STCs ( $U = 3425,000$ ;  $p = 0,977$ ;  $p > 0,05$ ). When mean ranks are analyzed, it can be declared that male STCs are statistically more successful than Female STCs. On the other hand, this difference is not enough for a statically meaningful difference.

**Table 4. Mann Whitney U test Results according to the country they receive education in**

Country	n	Sum of Ranks	Mean Rank	U	Z	p*
Turkey	97	4771,00	49,19	18,000	-11,053	,000
Germany	72	9594,00	133,25			
Sum	169					

\*  $p < 0,05$

When the results in Table 4 are analyzed, it is seen that there is a meaningful difference between STCs' ranks according to the country in which they receive education. ( $U = 3425,000$ ;  $p = 0,977$ ;  $p > 0,05$ ). When mean ranks are analyzed, it is obvious that GSTCs have higher mean rank than TSTCs in terms of statistical success.

#### Test Results Related To Ozone

When mean rank of SCTTs answers to the questions related to their preconceptions of ozone layer are analyzed, only 44% of STCTs have adequate preconceptions about the subject, approximately 28% of them did not answer these questions This means that they do not have preconceptions. Other STCTs on the other hand, have incorrect information. This result is in accordance with the other findings of the studies made in literature (Kaya, 2009; Bozkurt, & Kaya, 2008; Michail, Stamou, & Stamou, 2007; Selvi, 2007; Papadimitriou, 2004; Khalid, 2003; Boyes & Stanisstreet, 1999; Meadows & Wiesenmayer, 1999). When STCG's Results from Likert Test are analyzed, it is detected that majority of STCGs (93%) have adequate level of general knowledge. On the other hand, 6% of STCGs have inadequate knowledge about ozone, and 1% of STCGs have an alternative concept about the subject. It can be declared that there is no difference between test questions when they are examined one by one.

When these data is taken into consideration, it can be declared that teacher education in Germany is remarkably successful about this subject. The result is the same in the answers they give in open-ended questionnaire.

STCG 11:

*"Ozone (O<sub>3</sub>) is an unstable molecule composed of three oxygen atoms. Ozone layer which is forms a very thin layer of atmosphere, belongs to stratosphere. It is the layer that protects World from harmful rays of sun."*

STCG 68:

*"Ozone is found in two separate layers of atmosphere (troposphere, stratosphere). Ozone which is in stratosphere layer is 90% of the whole ozone in atmosphere. This layer is called ozone layer. Ozone layer protects livings by filtering harmful radiation of ultraviolet rays."*

STCG 52:

*"Ozone layer is in stratosphere which is 10-50 km above Earth's surface. Ozone layer blocks short-wave sun rays from reaching world. These rays are dangerous for livings."*

STCG 18:

*"It is the layer in upper stratosphere. Ozone layer absorbs rays like ultraviolet, which are harmful. This is very important for life, because ultraviolet rays are harmful. Ozonosphere takes its' name after ozone gas in it."*

STCG 32:

*"Especially ozone with oxygen, absorb ultraviolet rays, which come from sun, in stratosphere layer, and deprive the torrid effect of these rays by preventing them from reaching the earth."*

STCG 62:

*"Ozone gas (O<sub>3</sub>), consists as a result of the reaction which happens between oxygen gas and oxygen atoms. This gas is an important component of stratosphere which is approximately 15 km. s above Earth's surface."*

STCG 72:

*"Ozone layer is the layer that is composed by ozone gas and found in the higher levels of atmosphere. The most important role of this layer is to protect us from harmful rays of sun which are called ultraviolet (UV) rays. Ozone layer stands as a filter to protect Earth from these harmful rays that reach our world."*

When STCGs' answers are analyzed, it is seen that except from the two STCGs, there are no other STC mentioning about tropospheric ozone. On the other hand, most of them gave coherent answers with scientifically correct information in

terms of defining ozone and ozone layer. Data from likert scale are compatible with open-ended questionnaire. This situation indicates that STCG have adequate knowledge about this subject.

Besides, 80% of STCTs think that ozone layer is composed of various gases and great majority of them thinks that ozone depletion results in  $O_2$  gas for humanity. While 9 of the STCGs are choosing 'neutral' for this question, one of them gave an incorrect answer. It is detected that these STCGs did not mention anything related to this subject. Likely, majority of STCTs thinks that ozone layer protects earth from acid rains. This situation is the same with the answers which STCTs give in open ended questionnaire.

STCT's 8 answer in questionnaire related to ozone layer:

*"I think it is important because it has various gases in it, covers the earth and it is a layer that protects Earth from sun rays, and it contains essential gases for life".*

STCT 12:

*"One of the layers of our world. It protects World from harmful rays of the Sun. Because it contains various gasses it reflects harmful sun rays back."*

STCT 67:

*"A layer that is composed of various gases, covers our World and prevents harmful rays from reaching our world. Ozone depletion causes acid rain."*

STCT 65:

*"Ozone layer is the layer which covers our world outside. It protects our world from harmful sun rays and acid rains. It stabilizes the temperature of our world. It is composed of various gasses and layers..."*

STCT 82:

*"Ozone layer is a mix of gasses which covers the World and protects it from harmful sun rays."*

STCT 32:

*"Ozone layer is a mass of air. It is composed of various gasses. Ozone depletion is  $O_3$  transformation to  $O_2$ ."*

STCT 58:

*"Ozone Layer: The layer in the Atmosphere, and it contains ozone gases, prevents harmful UV rays from reaching World."*

STCT 42:

*"Ozone layer is composed of various gases. Increasing amount of these gases cause the depletion of ozone layer and  $O_2$  increases."*

STCT 97:

*"It is the layer which is composed of various gases and which protects earth from UV rays and keeps it warm. Depletion of Ozone, is the increasing O<sub>2</sub> resulting from various causes. It protects World from acid rain.*

STCT 3:

*"It is a layer of Atmosphere. It is a layer which is composed by various gasses. It blocks the bad effects of Sun and protects Earth from acid rains, keeps Earth warm."*

STCT 7:

*"It is composed of oxygen atoms. It is above the stratosphere. Blocks harmful ray of Sun. prevents acid rains from reaching the world, and keeps the earth warm."*

STCT 52:

*"The layer which is composed of various gasses in atmosphere and blocks harmful rays of sun is called Ozone layer. In time, as a result of the various effects in world, gasses in the layer would become sparse, and ozone depletion begins. This means ozone depletion."*

Great majority of both groups gave either incorrect answers, or selected 'neutral' answer to the 4<sup>th</sup> question of the questionnaire: 'tropospheric ozone is harmful for human health'. None of the STCTs mentioned about tropospheric ozone in open-ended questionnaire. It is also important data that despite 60% of STCGs gave correct answers to this question, they did not mention about it in open-ended questionnaire. Thus, it is thought that SCTs in both groups do not have adequate scientific information about tropospheric ozone.

The other misconception which is widely seen in STCTs, is the thought of ozone layer protecting world from acid rains. Majority of STCTs selected 'definitely agree' for the 7<sup>th</sup> question of likert scale: 'ozone layer protects world from acid rains'. Also they used supportive expressions in open-ended questionnaire. With this data, it can be interpreted that approximately 65% of STCTs have alternative concepts about this subject. Specific examples towards students' answers are given below.

STCT 28:

*"...ozone depletion causes acid rains."*

STCT 67:

*"...one of the bad effects of ozone depletion is acid rain. Acid rains occur as a result of ozone depletion."*

STCT 19:

*"...ozone depletion results in greenhouse effect; greenhouse effects cause acid rains."*

STCT 30:

*"...ozone depletion causes greenhouse effect; greenhouse effect causes*

*acid rains. This is the reason why ozone depletion causes the increase in acid rains."*

STCT 14:

*"As a result of ozone depletion, greenhouse effect occurs in world, heat of the world increases, as a result of these, acid rains occur."*

When these answers and similar answers of STCTs are analyzed, it is seen that STCTs have alternative concepts about the relationship between ozone depletion and greenhouse effect. It is considered that students' confusion about ozone depletion and tropospheric ozone may have caused this alternative concept.

When mean rank of the test questions about the causes of ozone depletion are taken into consideration, it is seen majority of teachers in both groups gave the correct answers to the questions about the right reasons of ozone depletion. Particularly, when STCGs' answers are analyzed one by one, it is seen that their answers to the questions about ozone depletion are in accordance with data gathered from the test in which student teachers' preconceptions are questioned. From STCGs, student teachers who have inadequate preconceptions, give either incorrect or neutral answers to the questions about the reasons of ozone depletion. When the answers of STCTs to likert scale questions are analyzed, it is seen that they are significantly successful at the questions about the reasons of ozone depletion. This means, student teachers mostly gave correct answers to the questions about the reasons of ozone depletion which contain CFCs, volcanic eruptions, artificial fertilizers, and some pesticides. On the other hand, none of the STCTs mentioned about the effects of artificial fertilizers and some pesticides on ozone depletion. This fact is considered as an evidence of inadequate conceptions that STCTs have. Also STCTs mostly gave incorrect answers to the 9<sup>th</sup> and 10<sup>th</sup> questions of the questionnaire which are scientifically incorrect. This situation indicates that STCs are confused greenhouse effect and ozone depletion. STCs think that emissions resulted from cars and greenhouse effect cause ozone depletion. The same situation can be also observed on the questions in which preconceptions about ozone depletion is questioned. When STCTs' answers to the open-ended questionnaire are analyzed, this situation is clear. This result is in accordance with the other researches made in literature (Kaya, 2009; Bozkurt, & Kaya, 2008; Michail, Stamou & Stamou, 2007; Selvi, 2007; Papadimitriou, 2004; Boyes & Stanisstreet, 1999; Meadows & Wiesenmayer, 1999).

Data of STCTs' answers in open-ended questionnaire about ozone depletion:

STCT 97:

*"Ozone depletion is a result of various chemical gasses. CFCs in particular, exhaust of cars, gasses of artificial fertilizers are very effective."*

STCT 3:

*"CFCs used in perfumes, deodorants and in coolers, are the most effective gasses on ozone depletion. Besides, gasses of exhausts, greenhouse*

*effect, and agricultural mismanagement cause ozone depletion."*

STCT 47:

*"CFCs in various coolers we use, toxic gasses released from factories, gasses from car exhausts, and perfume, cause the depletion of ozone."*

STCT 52:

*"There are several factors that cause ozone depletion. These are the gases which are used in fire extinguishers, CFCs in our daily used materials such as perfumes and coolers, coal consumption or CO and CO<sub>2</sub> released from car exhausts."*

STCT 12:

*"The most important reason of ozone depletion is CFCs in coolers and perfumes we use in our daily life. Increasing greenhouse gasses also cause ozone depletion."*

STCT 67:

*"CFCs which are the components of the materials we use at home such as perfume and deodorant, cause ozone depletion. Also fuels we use and toxic gases from car exhausts cause ozone depletion."*

STCT 28:

*"As a result of the reaction between ozone and CFCs, CO and CO<sub>2</sub>, O and O<sub>2</sub> emerge. For this reason, we should be careful about the production and the consumption of the materials we use in our daily life."*

STCT 65:

*"Ozone depletion is resulted from different reasons. The most important of these is CFC gases. Fuels we use at home and gases from cars are some the other important reasons."*

STCT 7:

*"Ozone depletion is caused by CFCs that is inhaled by perfumes, deodorants, and electrical materials we use and damage in our everyday life. Also, increasing greenhouse effect is the other important factor of ozone depletion."*

STCT 72:

*"The most important causes of ozone depletion are CFCs that are caused by deformation of old coolers and sprays we use. Also air pollution, and emission of cars and usage of fuel cause ozone depletion."*

When these answers of STCTs are taken into consideration, it is obvious that they gave the correct answers about CFCs related to ozone depletion. Also, some STCTs mention about fertilizers, pesticides and volcanic eruptions. This situation indicates how shallow the STCTs' concepts related to subject are. Also great majority of STCTs are confused about the reasons of greenhouse effect with ozone depletion, and have the misconception of greenhouse gases cause ozone depletion.

However, STCGs are thought to have adequate knowledge about this subject. They mentioned about all the other scientific reasons except from volcanic eruptions in their answers to the open-ended questionnaire. Examples from some STCGs' answers are given below:

STCG 33:

*"Chlorofluorocarbon (CFC) gasses which are produced for various purposes deplete ozone layer and as a result of this, environment and human health is badly affected."*

STCG 45:

*"...ozone depletion is the result of emission of chemical catalysts and its' components which are used in fridges that have CFCs, air conditioners, deodorants, fertilizers and materials like these. These harmful gasses and chlorine components can reach ozone layer due to vertical movements in atmosphere."*

STCG 56:

*"...because some gasses we release are harmful for ozone layer. These gasses compose a chemical reaction with ozone gas that forms ozone layer. We call these harmful gasses CFC. Use of these gasses is banned in our country, and most countries around the world. On the other hand, deodorants, insecticides, shaving foams which are produced in pressurized metal boxes, also have these gasses in them."*

STCG 67:

*"Chlorofluorocarbons (CFCs) are used generally in production of air conditioner systems, refrigerators, and foam productions (for beds). Haloalkane is used in fire extinguishers. Methyl bromide is used as insecticide for agriculture."*

STCG 51:

*"The most important factors that cause ozone depletion are, the gases used widely in coolers and deodorants, and emission of the planes' jet engine gases. These gases are named Chlorofluorocarbons and presents Chlorine (Cl), fluorine(F), and carbon(C) elements in terms of its' components."*

STCG 9:

*"Ozone depletion is caused by CFCs. These gases are used primarily in coolers, various sprays, agricultural insecticides and fertilizers."*

STCG 18:

*"These gases (abbreviated as CFCs) are mostly stable under normal conditions. Thanks to their stability, these gases are not biologically dangerous. However, because they have low density, they can reach upper layers of atmosphere. CFCs that reach atmosphere, lose their stability when they meet sunlight with high energy level. Chlorine, fluorine*

*and carbon gases which are very reactive gases, separate from each other and form a compound with oxygen, which forms ozone layer and as radioactive as these gases."*

When answers of STCs in both groups to the questions related to the effects of ozone depletion on human life and on our planet are analyzed, it is clear that there is a big difference between two groups. Answers of STCGs to these questions are parallel with their answers to the other questions. When 16<sup>th</sup>, 17<sup>th</sup>, and 18<sup>th</sup> questions of the questionnaire are analyzed, it is seen that 94% of STCGs gave correct answers to 16<sup>th</sup> question, 93% to the 17<sup>th</sup> question, and 92% to the 18<sup>th</sup> question. This situation indicates that STCGs have clear conceptions about the problems may have caused by ozone depletion. Also, when scientifically incorrect informations at the end of the test are analyzed, it is seen that STCGs gave the correct answers to these questions. When answers of STCGs to the open-ended questionnaire are analyzed, it is also seen that there are no scientifically incorrect answers similar to these. This situation is also seen when answers of STCGs to the open-ended questionnaire are analyzed.

STCG 22:

*"UV rays may cause sun burns, skin cancer, may cause damage to eyes, and may weaken people's immune system. UV rays are not only dangerous for our health, but also they may cause negative effect on the environment. They may cause the decrease of agricultural production, and affects fish population by breaking food chain in sea."*

On the other hand, when STCTs' answers are analyzed, most of them agreed with the scientifically incorrect information about ozone layer. Particularly 55% of STCT gave wrong answer to the 15<sup>th</sup> question, 25% could not give an answer; and 45% of STCT gave wrong answer to the 20<sup>th</sup> question and 15% of them could not give an answer. Both questions are about the problems that are caused by greenhouse effect. The same results can be reached when their answers to the open-ended questionnaire are analyzed.

STCT 72:

*"Ozone depletion is a big loss for us and our planet. Harmful rays of sun may cause permanent damages on human body. It may cause skin cancer, may have bad effects on our eyes, and cause various diseases. It has various effects on our planet too. If ozone becomes depleted, world would become warmer, global warming would increase, glaciers melt, and water famine would happen."*

STCT 48:

*"Ozone depletion affects human health badly. Sight problems, skin cancer and because of harmful rays of sun, serious illnesses are seen on skin. Global warming would increase and life would be affected badly".*

STCT 65:

*"What makes our World a livable place is the ozone layer. It protects*



*our body from harmful sun rays. If ozone becomes depleted, skin cancer and sight disorders would increase and balance of the nature would be broken. Heat from sun to earth would increase. This causes decrease of ice in the World."*

STCT 42:

*"With ozone depletion, skin cancers sight disorders and various diseases can be seen. Climate changes, melting glaciers and increase of temperature can be seen. Besides, life would be affected badly"*.

STCT 82:

*"As a result of ozone depletion, harmful rays of sun would reach the earth. It causes increasing temperature. Skin cancers and sight disorders would increase. As a result of increasing temperature, glaciers would become smaller."*

When STCTs' answers to the 19<sup>th</sup> and 21<sup>st</sup> questions of the questionnaire are analyzed, it is seen that 65% of the STCT gave wrong answer and 25% of them could not answer; to 21<sup>st</sup> question, 35% of them gave the correct answer but 27% could not answer. This situation indicates that STCTs have alternative conceptions like water pollution causing ozone depletion and gases in atmosphere leaking to space. But when answers to the open-ended questionnaire of STCTs are analyzed, except from few, are detected not to mention about subjects like these. One interpretation of these results is that except from a few, they could not acquire these alternative concepts. That is, STCTs do not have adequate knowledge about these subjects. When STCT faced to these questions in likert survey, instead of leaving the questions without answering, they choose to answer without thinking whether it is correct or not. Quotations of the similar answers of STCTs to the open-ended questionnaire are given below:

STCT 3:

*"With ozone depletion, harmful rays start to come to earth. By that, world becomes warmer, glaciers begin to melt, and livings' shelters would be badly affected. Water and air pollution would increase, and livings in sea would die. Ozone depletion causes skin cancer and sight disorders of people."*

STCT 41:

*"...the increase of ozone depletion cause air and water pollution, and these cause the death of livings in sea and imbalance of ecosystem."*

#### **4. RESULTS AND SUGESTIONS**

1. No meaningful statistical differences detected between the ranks of student teachers (101 female and 68 male) depending on the gender based on Mann-Whitney U analyze results( $U = 3425,000$ ;  $p = 0,977$ ;  $p > ,05$ ) which was applied in order to determine whether there were any meaningful differences between male and female student teachers' questionnaire ranks or not. This result indicates that gender is not an

important factor in related subject.

2. When results of Mann-Whitney U which was applied in order to detect were analyzed, it was seen that there was a meaningful difference between students' questionnaire ranks depending on the country in which they received education ( $U=3,425,000$ ;  $p=0,977$ ;  $p>,05$ ). When mean ranks were taken into consideration, it is obvious that STCG had higher mean rank than STCT in terms of statistical success. This situation is an important result to show how effective the practical education in teacher education program. From this aspect, teacher education programmes in Turkey should be revised and practical education must be given more importance.

3. When mean rank of SCTTs answers to the questions in which their preconceptions about ozone layer were analyzed, it was detected that they did not have preconceptions or they had alternative conceptions. This result is in accordance with the findings of other studies in literature. (add literature). When STCG's Results from Likert Test were analyzed, it was detected that majority of STCGs (93%) had adequate level of general knowledge. This result indicates that when STCG and STCT are compared, STCG are relatively successful.

4. 80% of STCTs mentioned that ozone layer is composed of various gases and great majority of them mentioned that ozone depletion results in  $O_2$  gas for humanity. While 9 STCG marked 'neutral', one of them gave an incorrect answer to this question. It is detected that these STCG did not mention anything related to this subject when their answers to open-ended questionnaire were analyzed. Likely, majority of STCTs thought that earth is protected from acid rains by ozone layer. This situation is the same with the answers which STCT gave in open ended questionnaire. The other misconception which was common for STCT, was the thought of ozone layer protecting world from acid rains. Majority of STCT selected 'definitely agree' for the 7<sup>th</sup> question of likert scale: 'ozone layer protects world from acid rains'. Also they supported these expressions with their answers to open-ended questionnaire. From this data, it can be inferred approximately 65% of STCTs had alternative concepts about this subject. When STCG's answers were analysed, it was seen that they did not have any alternative concepts related to this subject.

5. When mean rank of the answers to the questions about the causes of ozone depletion, are taken into consideration, it was seen that majority of teachers in both groups gave correct answers to the questions toward the real reasons of ozone depletion. Particularly, when STCG's answers were analyzed one by one, it was seen that their answers to the questions about ozone depletion were in accordance with data gathered from the test in which student teachers' preconceptions were questioned. From STCG group, student teachers who had inadequate preconceptions gave either incorrect or neutral answers to the questions about the reasons of ozone depletion. When the answers of STCT to likert scale questions were analyzed, it was seen that they were significantly successful at the questions toward the reasons of ozone depletion. This means, student teachers mostly gave correct answers to the questions about the reasons

of ozone depletion which contain CFCs, volcanic eruptions, artificial fertilizers, and some pesticides. On the other hand, none of the STCTs mentioned about the effects of some pesticides and artificial fertilizers on ozone depletion. This fact is considered as an evidence of inadequate conceptions that STCTs had. Also STCTs mostly marked incorrect answers to the 9<sup>th</sup> and 10<sup>th</sup> questions of the questionnaire which were scientifically incorrect. This situation indicates that STCTs confused greenhouse effect and ozone depletion. STCTs thought that ozone depletion is caused by emissions resulted from cars and greenhouse effect. The same situation can also be observed on the questions in which preconceptions about ozone depletion is questioned. When STCTs' answers to the open-ended questionnaire were analyzed, this situation is obvious. This result is in accordance with the other researches made in literature (Kaya, 2009; Bozkurt, & Kaya, 2008; Michail, Stamou & Stamou, 2007; Selvi, 2007; Papadimitriou, 2004; Groves & Pugh, 2002; Khalid, 2003; Boyes & Stanisstreet, 1999; Meadows & Wiesenmayer, 1999; Boyes & Stanisstreet 1993). This situation shows that giving more importance to environmental education in Turkey is sufficient. Thus, it is suggested to emphasize environmental education in every level of chemistry education more, and to associate chemistry with common problems.

6. When answers of STCTs in both groups to the questions related to the effects of ozone depletion on human life and on our planet were analyzed, it was clear that there was a big difference between two groups. Answers of STCG to these questions were parallel to their answers to the other questions. This situation indicates that STCG had clear conceptions about the problems which are likely to be caused by ozone depletion. Also, when scientifically incorrect informations at the end of the test were analyzed, it was detected that STCG gave correct answers to these questions. When answers of STCG to the open-ended questionnaire were analyzed, it was also detected that there were no scientifically incorrect answers similar to these. This situation was also seen on answers of STCG to the questions in open-ended questionnaire. On the other hand, when STCT's answers were analyzed, it is seen that most of them agreed with the scientifically incorrect information about ozone layer. They confused greenhouse effect with ozone depletion in these questions as they did on the other questions of the questionnaire.

7. When STCT's answers to the 19<sup>th</sup> and 21<sup>st</sup> questions of the questionnaire were analyzed, it was detected that STCT had alternative conceptions like ozone depletion and gas leak from atmosphere to space is caused by water pollution. But when STCTs' answers to the open-ended questionnaire were analyzed, most of them were detected not mentioning about these subjects. One interpretation of these results is that except from a few, they could not acquire these alternative concepts.

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