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Investigating the Scientific Literacy of University Students Concerning Strengthened Greenhouse Effect / Global Climatic Change and Ozone Depletion

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Abstract: It is essential that scientists and educators have stressed the need to address the problem of scientific illeteracy for the following two reasons: because our university youth need to become "good citizens" who are in a position to make informed and more accurate decision about scientific issues that impinge on daily lives include strengthened greenhouse effect, global climatic change and ozone depletion; and because there is a need for promotes to the low level of scientific literacy of our university students concerning scientific issues. This research was conducted among 150 students to assess the "scientific literacy" of the students in the Faculty of Education in Gazi University. In the research, a survey has a 20 items which was developed by reviewing the literature was used. Significant differences were found (1) gender-related and (2) between university students attending first class and another students attending second, third, fourth and fifth classes and (3) between students whose main information source was printed media and those who relied on television.

Key words: Scientific literacy · university students · strengthened greenhouse effect · global climatic change · ozone depletion

INTRODUCTION

In this research have stressed the scientifically literate university students are seen desirable by governments and science circles and this research assessed the need to improve the universty students can then become "good citizens" who are in a position to make informed about scientific developments and more accurate decisions struggling with scientific issues. Considering of the argument that it was clearly a part of each scientist's professional responsibility to promote the public understanding of science and to realize the goal stated above, with a view to establish dimensions of existing problems of scientific illiteracy and the need to solve these problems and pointing out the missions of media and education in promoting scientifically and environmentally literate students, in this research, a scientific literacy survey about the scientific issues that impinge on daily lives, which include strengthened greenhouse effect / global climatic change and ozone depletion, was developed for university students in Geography Education Branch.

Although "scientific literacy" has a range of interpretations by many researchers [1,2], this term generally stands for "what the society ought to know about scientific issues and a range of options to tackle the causes of these issues [3].

In the United States, the United Kingdom and many other countries, governments and science circles have to emphasized the need to improve the scientific literacy and organized government-funded campaigns and research projects. The effectiveness of such organizations is related to media factors as it is in the newspapers and magazines that news are published and on televisions that productions broadcast.

In Turkey, The Scientific and Tecnological Research Council of Turkey Report [4] was published in 2005 [5]. Employing the simple quantitative survey approach, this report declared the level of scientific literacy of youth in 15-24 age group in Turkey. This survey was administrated among 1033 youth from 47 provinces, 97 administrative districts, 136 quarters and 68 villages. In this survey almost 66% of participants were from urban settlements, 34% of the sample were from rural settlements and 40% of

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respondents were graduated from a high school or university. The outcomes of this survey research were reported comparing the results related to the level of scientific literacy of their European counterparts. This report clarified 27% of our youth were fairly interested in news related to new scientific investigations and technologies and 33% of European youth whose in the same age group (15-24) were interested in news related to new scientific investigations. The developments in health and internet areas are the most interesting subjects for our youth. Environment, astronomy and humanities and social sciences leads these areas. Genetics is the least interesting area for our youth. Internet is the most interesting area for European youth. Health and other fields follow this area.

In this report, it is illuminated that Turkish youth's have little time to spend for science. They interest in scientific developments and news concerning these developments. However, they have little time to spend for reading scientific papers and discussing scientific topics with their friends. This report bemoaned the low participation level of our youth related to scientific activities, declaring that they aren't widely activities in such fields. Also it is clarified in the report that European youth whose over 15 years old were quite ahead from the Turkish youth in spending time for reading scientific papers and discussing with their friends about these topics. It is explain that the indicators of low participation level of European youth related to scientific activities and taking active role on scientific subjects. In this survey research, when a knowledge test consisted of 10 questions is applied to the Turkish youth, it is seen that 5.08% of participants answered correctly. Average ratio of correct answers for Turkish youth is 51% whereas 70% for European youth in the same age group.

While struggling with environmental problems, in societies which adopt participatory models, the policies to be followed are determined by the contributions of citizens beside the scientists. Public participation in decision making is particularly important in many of the initiatives taken to improve the public understanding of scientific literacy are widely popular. It is essential that the general public is participatory in decision making on scientific issues mitigation for the following reasons: because public need to be consulted regarding the level of risks that they are ready to accept, for instance, a consequence of climate change and because there is a need for changes to the economy, behaviour and well-being in order to mitigate possible impacts. It is unlikely that any decision that directly affects the society will have long-term support if not accepted by them [2]. Scientific issues involve difficult and controversial trade-offs and far-reaching changes in behaviour and costs e.g. increased taxes [6].

Strengthened greenhouse effect, global warming and ozone depletion are very important environmental issues facing the world today. There is proof that rapid climate change is taking place due to human activities, particularly the combustion of fossil fuels since industrial revolution. Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to observed increase in anthropogenic greenhouse gas concentrations. Rising average temperatures are likely to be faster than the rate at which ecosystems can adapt. It is likely that we will see increases in hurricane intensity and there will be an increase in frequency of warm spells, heat waves and events of heavy rainfall during the 21st century. Also it is likely that there will be an increase in areas affected by droughts, intensity of tropical cyclones which include hurricanes and typhoons and the occurance of extreme high tides [4].

Ozone (O3) is a triatomic molecule, consisting of three oxygen atoms. The highest levels of ozone in the atmosphere are in the stratosphere, in a region also known as the ozone layer between about 19 km and 50 km above the surface. Ground-level ozone (or tropospheric ozone) is regarded as a pollutant with harmful effects on health by the World Health Organization [7,8]. It is not emitted directly by car engines or by industrial operations. It is formed by the reaction of sunlight on air containing hydrocarbons and nitrogen oxides that react to form ozone directly at the source of the pollution or many kilometers down wind. On the other hand, ozone in the upper atmosphere (or stratospheric ozone) protects living organisms by preventing damaging ultraviolet light from reaching the Earth's surface. It is present in low concentrations throughout the Earth's atmosphere. In recent decades the amount of stratospheric ozone has been declining mostly due to emissions of chlorofluorocarbons (CFCs) and similar chlorinated and brominated organic molecules, which have increased the concentration of ozone- depleting catalysts above the natural background [9].

There is a great deal of evidence to show that high concentrations (ppm) of ozone, created by high concentrations of pollution and daylight ultraviolet rays at the Earth's surface, can harm lung function and irritate the respiratory system. When ozone levels are high, more people with asthma have attacks that require use of

medication. One reason this happens is that ozone makes people more sensitive to allergens, which in turn trigger asthma attacks. A statistical research of 95 large urban communities in the United States found significant association between ozone levels and premature death. The research estimated that a one-third reduction in urban ozone concentrations would save roughly 4000 lives per year [10].

Many researchers have assessed scientific literacy about greenhouse effect, global climatic change and ozone depletion. These researches in international literature have primarily been directed towards assessing general public understanding [11,12] but also of specific groups such as students in primary, secondary and higher education. Ali [13], has examined primary school children's perceptions of air pollution. Boyes and Stanistreet [1], have investigated secondary school student's scientific literacy about the global warming and ozone depletion. Lord and Rauscher [14], studied basic biological knowledge of college students. Morgan and Moran [15], examined university student's understanding the greenhouse effect and the ozone shield. Spellman, Field and Sinclair [2], assessed higher education student's knowledge of global climatic change in University College Northampton. Wilson and Henson [7], studied knowledge of global warming in US college.

No studies about "developing a scientific literacy survey about the greenhouse effect / global climatic change and ozone depletion for university students in Geography Education Branch" are found when the national literature has been searched. Çabuk and Karacaoğlu [16], determined both the environmental sensitivity of the students in the Faculty of Educational Sciences in Ankara University and their ideas about the sufficiency of the environmental education in organized education. Erten [17], assessed the attitudes and knowledge of the students about the subject of garbage reduction. Also he observed their attitudes to see if they change positively or negatively. Yilmaz *et al.* [18], examined knowledge of the secondary school and university students attending Hacettepe University, Education Faculty, Chemistry Education Branch about the environment, environmental concepts and problems.

MATERIALS AND METHODS

This research was conducted among 150 students attending Gazi University, Faculty of Education, Geography Education Branch during the 2006-2007 school year. In this research, a survey which had 20 items was developed by reviewing the literature [1,2,15,19] which was used with the aim of assessing the scientific literacy

Table 1: Survey items

Global climatic change/Greenhouse effect	Ozone depletion
1. Increasing amounts of carbon dioxide in the atmosphere contributes to strengthened greenhouse effect (True)	11. Without stratospheric ozone in the atnosphere, life on earth, as we know it, would be impossible (True)
2. Destruction of tropical rainforests in Amazon region is likely to intensify the strengthened greenhouse effect (True)	12. Midday is the ideal time to sunbathe to lessen the risk of photo- (False) aging
3. Strengthened greenhouse effect would probably lead to global warming (True)	13. To adequately protect yourself against the sun's harmful rays, experts recommend a heavy application of a sunscreen with a skin protection factor of at least 15 (True)
4. Recent observations strongly suggest that violent volcanic explosions have insignificant effect on global climate (False)	14. Greater exposure to ultraviolet radiation increases the risk of contracting skin cancer and developing sight defects (True)
5. Scientist predict that the burning of fossil fuels will enhance the strengthened greenhouse effect (True)	15. Skiing at high mountain elevations without goggles exposes the face to more intense ultraviolet radiation than sunbathing at sea level does (True)
6. If global warming occurs, it will probably have little, if any, impact on crop and timber production in Turkey (False)	16. The number of cases of skin cancer in Turkey has steadily declined over the last decade (False)
7. When climate changes, it changes in the same way everywhere on the planet (False)	17. Most scientists predict that increasing stratospheric ozone levels are result in greater human exposure to ultraviolet radiation (False)
8. Without water vapor in the atmosphere, the planet's surface would be considerably cooler (True)	18. The most serious threat to the layer of ozone in the stratosphere is from a group of chemicals, collectively known as chlorofluorocarbons (True)
9. The United State is the largest producer of greeenhouse gases in the world (True)	19. Scientists have yet to find evidence that suggest that the amount of ozone in the stratosphere over Turkey is declining (False)
10. Switching from fossil fuels to alternative energy such as solar panels (photovoltaic arrays) or geothermal energy may conribute to strengthened greenhouse effect (False)	20. Because of the long stay of chlorofluorocarbons in the atmosphere, strospheric ozone level is probably to decline for some time even after woldwide production of chlorofluorocarbons ceases (True)

of the students in the Faculty of Education in Gazi University about the strengthened greenhouse effect / global climate change and ozone depletion. The survey consisted of 10 items related to the greenhouse effect and global climate change and another 10 items related to ozone depletion (Table 1). For each item, students were instructed to answer whether they "agreed" or "disagreed". These answers therefore represent the two states "the informed" and "the misinformed". Correct scores were given "2" and incorrect scores were given "1". Instrumentation experts reviewed the survey to establish content and face validity. Some modifications were made according to the recommendations made by these experts. Using the data collected during a pilot administration (n = 150), the internal consistency and the construct validity were obtained for the survey. The final survey consisted of 20 items.

Item analysis were used for item reduction and internal consistency [20]. Item analysis consisted of the adjusted item-to-total correlation. Using the 150 participants of the research, the internal consistency assessment yielded the coefficient alpha value: .82. Split half coefficient was 0.67 (part 1: r =.66, part 2: r =.75). For study of validity of the survey, a factor analysis has been used in order to check the variety of the scientific literacy survey about the greenhouse effect / global climatic change and ozone depletion for university students in Geography Education Branch and one sub dimension has been deleted. A principle component factor analysis (PCA) and varimax rotation method performed on the data for the 20 items. As a result, 20 items with factor loading greater than .30 were found. Analysis of the items extracted one component with eigenvalues greater than 1.0; total variance explained, 58 %. 20 items corresponded to the "strengthened greenhouse effect" dimension. Factor loadings range from .30 to .71 and item-to-total correlation values range from .31 to .68.

A question asked participants to choose which media they used most to find out about actual environmental problems, printed media or television. At the end of the survey some personal details were recorded such gender and class. Details of the sample characteristics are presented in Table 2.

Findings: In this section, findings and interpretations about the characteristics of the distribution of scores were examined. Furthermore, simple statistical procedures were used to assess the significance of differences between subgroups within the sample (independent samples t-test and one-way ANOVA). Significance of results is expressed at the 95% significance level.

Table 2: Sample profile

Characteristics	
Gender	54% female ; 46% male
Class	30% 1; 17% 2; 24% 3; 18% 4; 11% 5
Source of information	58% printed media; 28% television / radio; 14% no preference

Table 3: Distribution of t-test scores on greenhouse effect and ozone depletion items

Items	N	x	S	sd	t	sig.
Greenhouse effect	150	12.29	2.08	298	3.81	significant
Ozone depletion	150	13.28	2.38			

[t(298) = 3.81, p <.01]

Table 4: Distribution of gender-related t-test scores on survey items

Gender	N	x	S	sd	t	sig.
Female	81	23.62	3.29	148	2.74	significant
Male	69	25.39	4.53			

[t(148) = 2.74, p <.01]

Overall mean scores: The rounded mean total score was 24 out of a possible 40. The modal score (39 respondents or 26% of the sample) was 22 / 40 and the median was 23 / 40.

The mean score was significantly higher for ozone items (13.28 / 20) than for greenhouse and global climatic change items (12.29 / 20) (Table 3). This finding could suggest that the effects of ozone depletion are more widely known due to the more tangible links with human health such as skin cancer, photo-aging, sight defects and respiratory infections.

Nine items, 1, 6, 7, 10, 11, 13, 16, 17 and 18, were marked correctly by over 80% of students. Item 2 refers to destruction of tropical rainforests, 37% answered incorrectly. Relatively poor scores were recorded for items 3, 14, 19 and high scores were recorded for items 6, 7, 10. Item 8 is the only statement of the 20 that refers to natural greenhouse effect, 76% answered correctly. 80% of the participants were aware of the importance of carbon dioxide that contribute to the greenhouse effect.

Influence of sample profile

Gender: Analysis of gender-related t-test results are presented in Table 4.

Table 4 indicated the significant gender-related difference in scores on survey items [t (148) = 2.74, p<0.01]. The mean score of men was significantly higher (X = 25.39) than women (X = 23.62). This finding could interpret that men are more significantly interested and concerned about environmental problems than women.

Table 5: Distribution of class-related one-way ANOVA scores on survey items

Source of variance	Sum of square	sd	Mean square	F	sig.
Between groups	267.459	4	66.865	4.587	significant
Within groups	2113.501	145	14.576		
Total	2380.960	149			

Class	N	x	S
1st	45	26.44	4.94
2nd	26	23.19	2.92
3rd	36	23.52	3.33
4th	27	23.70	3.20
5th	16	24.12	3.34
Total	150	24.44	3.99

Table 6: Distribution of main information source-related one-way ANOVA scores on survey items

Source of variance	Sum of square	sd	Mean square	F	sig.
Between groups	161.748	2	80.874	5.357	significant
Within groups	2219.212	147	15.097		
Total	2380.960	149			

Source of information	N	x	S
Printed media	87	25.22	4.33
Television / radio	42	23.85	3.30
No preference	21	22.33	2.78
Toplam	150	24.44	3.99

Class: Analysis class-related one-way ANOVA results are presented in Table 5.

Table 5 indicated the significant class-related difference in scores on survey items [F (4-145) = 4.58, p<0.01]. Analysis of LSD (Least Significant Degree) test results have shown that the significant difference in mean scores. The mean score of students attending first class was significantly higher (X = 26.44) than other students. This finding could interpret that this study sampled from students attending Gazi University, Faculty of Education, Geography Education Branch are unlikely to be considerable differences in age group but differences would exist in prior schooling and in terms of public awareness of environmental problems.

Source of information: The results have shown that students who used print media (58%) rather than television and radio (28%) as their main source of information were more likely to understand the fundamentals of the strengthened greenhouse effect, global climatic change and ozone depletion. 14% of sample expressed no preference.

Analysis main information source-related one-way ANOVA results are presented in Table 6.

Table 6 indicated the significant main information source-related difference in scores on survey items [F (2-147) = 5..35, p < 0.01]. Analysis of LSD (Least Significant Degree) test results have shown that the significant difference in mean scores. The mean score of students who used print media was significantly higher (X = 25.22) than students used television and radio (X = 23.85) as their main source of information were more likely to understand the fundamentals of the environmental problems. This finding could suggest that printed media in Turkey have been successful in promoting scientifically and environmentally literate studets and providing the widespread detailed public examination of environmental problems than television and radio.

CONCLUSIONS

Employing the simple quantitative survey approach, the following topics are assessed in this reseach by using the survey developed in prior study: Determining the scientific literacy of university students in Geography Education Branch concerning environmental issues that impinge on daily lives which include strengthened greenhouse effect, global climate change and ozone depletion, establishing dimensions of existing insufficient knowledge about actual environmental problems and pointing out the missions of media and education in promoting scientifically and environmentally literate students.

"Destruction of tropical rainforests in Amazon region is likely to intensify the global greenhouse effect" is the second item of the survey and 37% of sample answered this item incorrectly. Participants may have felt that they were not aware of this item and therefore answered accordingly. The most severe threat to the Tropical rainforests is human intervention for timber, grazing land and soybean production. In the past four decades, Amazon region's human population grow from 3 million to at least 30 million, the number of paved roads multiply from one to several dozen and thousands of square miles of tropical rain forest destroyed. In recent years, the problem has only grown worse. Large-scale cattle ranching, which first took off in the 1960s, is spreading faster than ever. Scientists say destruction of the Amazon region is a problem that should concern us all. This region not only shelters two-fifths of the world's remaining tropical rainforests, but also the single greatest repository

of biological diversity on Earth. Still, 40% is not nearly enough to sustain the fragile hydrological cycle that maintains the rainforests. Amazon Basin produces between a third and a half of its own rainfall by recycling precipitation. The spesific mechanism, called evapotranspiration, is a combination of water that evaporates from soil and plant surfaces with water vapor released through stomata, in plants' leaves. Because deforestration decreases evapotranspiration, it decreases regional rainfall.

"Switching from fossil fuels to alternative energy such as solar panels or geothermal energy may contribute to strengthened greenhouse effect" is the tenth item of the survey. This item were marked correctly by 87% of students. This finding has shown that the participants in this study were aware of the importance renewable energy sources.

The Fouth Assessment Report of the United Nations Intergovernmental Panel on Climate Change [21] strongly emphasised that substantial climate change is inevitable and we will have to adapt to this. We need both to reduce our emissions of greenhouse gases and to prepare for the impacts of climate change. This should compel all of us-world leaders, businesses and individuals-taking action on climate change that include increasing renewable energy generation and encouraging efficient energy use rather than the paralysis of fear.

"If global warming occurs, it will probably have little, if any, impact on crop and timber production in Turkey" is the sixth item of the survey. This term were marked correctly by 82% of sample. This finding could be interpreted as in the following: Since 1990 which is the starting date of global change mitigation, the researches related to climate science have increased markedly. As a result of this increase, there became worldwide improvements concerning public awareness about impacts of global warming. Related to these improvements, public understanding of global climatic changes and their impacts have increased rapidly in Turkey. There are important cases that affects on the public awareness of global climatic changes in Turkey: In 2006, the effects of characteristics special to winter season weren't occured completely, increases drought events in spring and summer months and concrete problems occured in the sector of agriculture and others. According to IPCC 2007 report [8], in the period 1990-2004, the total greenhouse gas emissions from Turkey were about 72%. The results they are predicted by climate scientists in Turkey that, during the 21st century: It is likely that there will be an increase in areas affected by droughts, in frequency of warm spells, heat waves, events of heavy rainfall in urban areas and coastal erosion especially in the Black Sea region.

It is essential that Turkey takes the lead on developing emissions reduction methods and achieves real measurable emissions reductions by pursuing proactive policies and programs that have climate benefits on global warming mitigation. Turkey signed United Nations Framework Convention Climate Change (UNFCCC) that commit to reduce greenhouse gases in 1992 (TBMM Comission Report, 2007) [5]. But, Turkey has neither signed nor ratified the Kyoto Protocol that commit to reduce the emissions of carbon dioxide and greenhouse gases, or engage in emissions trading if they maintain or increase emissions of these gases as yet due to the need of industrialization. Turkey would need to meet Kyoto targets in the period 2008-2012 when the treaty is in effect. The use of alternative energy sources, such as solar, wind, geothermal and hydro energy, is gaining increased support worldwide. These methods of energy production emit no greenhouse gases once they are up and running. Turkey have many options to purchase part or pure renewable energy. The science circles bemoaned public unreactiveness in Turkey related to unratification this treaty. Printed media in Turkey should more dominate by national newspapers that have the ability to generate a snowball effect in the discussion of environmental problems and impacts. These problems should prevail as general discussion points for several weeks, even months. Furthermore television coverage should provide the widespread detailed public examination of environmental problems.

The three external factors have the strongest influence on scientific literacy: The media, government and prevailing education system. The education system as having key responsibilities for enhancing public understanding of scientific and environmental literacy. In environmental education, employment of the problem-based active learning strategies refers to a learning situation in which students are in an active position. In active learning process, the first purpose is to transform the role of the learner from passive observer to active participant [22]. However, this is not simply a matter of participation in learning itself, but rather a learning process, which encourages the learner to take actions in various ways related to how to learn, use mental abilities, think and interpret the information which one has learned. In problem-based learning learning prosess, the learner develops problem solving abilities by using high-level cognitive and decision-making skills such as analysis,

synthesis and evaluation. In fact, due to the eclectic nature of active learning, different strategies, technics, approaches, materials, an extreme diversity in offered courses including highly specialised subject areas should be employed. There should been a movement towards more discussion-based approach rather than hard-nosed absolute correctness of approach in environmental education.

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