

Measuring High School Students' Knowledge about Climate Change: A Case Study from Istanbul

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Abstract: Climate change, arguably one of the greatest environmental challenges facing humankind in the 21st century, has aroused growing interest in the public and education throughout the world. At present, there is a need to assess Turkish high school students' knowledge about climate change. The aim of this study was the exploration of Turkish secondary school students' knowledge about climate change. For this purpose, the study took place in Istanbul with the participation of 300 students receiving high school education. 14-item questionnaires were prepared and the relationship between demographic characteristics and students' level of knowledge and awareness about climate change were investigated in the study. Then, some statistical analysis were performed based on gender and study areas of the students by using SPSS® software. The results revealed that the majority of students had sufficient general information about the causes and effects of climate change but their awareness level about important issues of climate change was at the poor level. Moreover, they did not have enough practice to use their knowledge. More specifically, gender and study areas differed in some questions of the survey. The results of this study have provided enough information about the lacks of high school education about climate change.

Key words: Global warming • Awareness • High schools • Turkey

INTRODUCTION

Climate change, such as decreased access to fresh water and food and increased air pollution, has potential wide-ranging and harmful effects on human health. A major cause of climate change is the burning of fossil fuels, which release carbon dioxide (CO₂) and other greenhouse gases into the air [1]. The heat is kept because carbon dioxide (CO₂), water vapor and some other gases are relatively transparent to sunlight but not to the infrared radiation given off by the warmed Earth. This, called as greenhouse effect, was first developed in the 1820s but it was not until the 1980s that the consequences began to be taken seriously outside the scientific community [2].

The Intergovernmental Panel on Climate Change (IPCC) reports that the rise in global mean temperature between 1906 and 2005 was 0.74°C and projects average warming of up to 4.0°C, by the end of this century. One of the results of this warming will be the collapse of the Greenland and Antarctic ice sheets, leading to massive sea-level rise and disruption of ocean currents. As human

activities continue to add greenhouse gases to the atmosphere, global temperatures are expected to rise, causing the Earth's climates to change [3].

Climate change is arguably one of the greatest environmental challenges facing humankind in the 21st century [4]. So, it is vital that students learn about global warming and climate change. Teaching about them provides an understanding that is essential if future citizens are to assume responsibility for the management and policy-making decisions facing our planet [5]. Therefore, if the education is to promote a citizenry that is knowledgeable about climate change it is essential to determine what students' conceptions are about climate change.

Some studies have been conducted to examine the perceptions and attitudes of the public, students and teachers to climate change in different countries. Plotnikoff [1] examined the people's (n = 600) knowledge, attitudes and behaviors related to climate change in a province in Canada. The results showed that the awareness level of the people about climate change and related issues was about 5.7 out of 10. Adams [6]

investigated the knowledge level and perceptions of the students and the results indicated that the students had little or no scientific understanding of climate change. Similar results were found in a study conducted by Ho [7]. The conceptions of seventh-grade students (11-12 years old, 88 students) were examined about climate change. The study revealed that children's initial understandings of climate change were often confused with a range of other environmental issues and were relatively less informed about the causes of climate change than the effects.

In Turkey, studies were conducted in universities to analyze the students' perceptions towards climate change. One of the studies was conducted by Kahraman *et al.* [8] to determine the students' levels of awareness and knowledge about global warming. The findings indicated that the majority of the students had low level of awareness and knowledge about global warming. Orbay *et al.* [9] conducted a study to examine the opinions of prospective teachers (n = 220) about global warming. The opinions of the prospective teachers about global warming were evaluated relating to the questionnaire and it was observed that prospective teachers had adequate knowledge about global warming. Another study was conducted by Oluk and Oluk [10] in order to determine the university students' perceptions of green house effect, global warming and climate change. The results revealed that the students had poor knowledge and misconceptions about the causes and effects of global warming and climate change. Besides these, an important study was conducted by Bozdoğan and Yanar [11] to determine the perceptions of prospective elementary teachers (n = 68) about effect of the global warming in the next century. The results showed that almost all pre-service elementary teachers have sufficient knowledge about the global warming effects in the next century of the world. However, the results disclosed that nearly half of the preservice elementary teachers have various misconceptions about global warming.

MATERIALS AND METHODS

The aim of this study was the exploration of Turkish secondary school students' knowledge about climate change. For this purpose, a questionnaire was designed in answering three specific research questions:

- What is the students' level of knowledge about climate change?

- What are their experiences and thoughts about projects for preventing climate change?
- What is students' awareness level about important issues of climate change?

The main data collection tool was an assessment questionnaire. Based on the research questions of the study, 14-item questionnaires were prepared in three sections as follows:

- Demographic questions: This section included questions on gender and study area of the students (According to the Turkish education system, students choose their study areas in high school after finishing 9th grade. These areas are social sciences, equal area, science and foreign language.).
- Yes-no questions: In this section, seven questions were asked to learn their knowledge about climate change by choosing yes or no.
- Awareness level questions: This section focused on the awareness level of the students about important issues of climate change based on a five-point Likert scale: 1, never; 2, poor; 3, moderate; 4, familiar; 5, very familiar.

This study took place in Istanbul with the participation of 300 students receiving high school education in the 2010-2011 academic year.

The relationship between demographic characteristics and students' level of knowledge and awareness about climate change were investigated in the study. The reliability coefficient was 59% based on the factor reliability analysis of dependent variables (Cronbach's $\alpha=0.590$). In the study, descriptive statistics were used for demographic data and nonparametric test were used, including Mann-Whitney U and Kruskal-Wallis H, for the inferential statistics, as the data collected did not have a normally distributed interval variable ($p<0.05$) based on a one-sample Kolmogorov-Smirnov Z test. Throughout the study, p-values smaller than 0.05 were considered significant.

RESULTS AND DISCUSSION

Demographic Data: The demographic data indicates that, out of 300 high school students, 51.3% were female (n=154) and 48.7% were male (n=146). In this survey, 29.7% of the students were studying social sciences (n=89), 30% were studying equal area (n=90), 30.3% were studying science (n=91) and the remaining 10% were studying foreign language (n=30) (Figure 1).

Students' Knowledge of Climate Change: Remarkable results were found according to the descriptive analysis of the answers given to the questions in the first part. It was revealed that 89.3% of the students have information about the climate change and 82% know the causes and effects of climate change. Of the students, 68% have information about preventing the climate change. The questions about projects for preventing climate change indicated that 93.7% of the students have not participated in a project before but only 48% wanted to join in such a project. However, the answers of the sixth question were quite encouraging; 78% of the respondents thought that the prevention projects would be successful. The last question also revealed that 56% of the students see the effects of climate change in their life (Figure 2).

To investigate whether there was a significant difference between the gender and study areas of the students some statistical analysis were performed by using SPSS® software. Mann-Whitney U test were performed for gender analysis because the dependent variables were ordinal and variances were unequal. Analysis indicated that males and females did not differ in their knowledge about climate change ($p > 0.05$).

A Kruskal-Wallis analysis of variance indicated that, there was a statistically significant difference among the four study areas (social sciences, equal area, science and foreign language) with respect to student answers of yes-no questions on the third and fourth questions due to the fact that the p value was smaller than 0.05 ($p < 0.05$). The difference was highest on the third question with p value of 0.001. This was followed by the fourth question with p value of 0.011 (Table 1).

To determine which of the pairs of study area means were different on the third and fourth questions, post hoc Mann-Whitney tests were used to compare students' study areas on their answers in order to indicate statistical difference. The results suggested that the differences were highest on question 3 between students in foreign language ($n = 30$) and those in other three study areas. The difference between students in science (55.13, $n=91$) and those in foreign language (78.82) was the highest ($Z = -3.913, p=0.000$). This was followed by the difference between equal area (55.33, $n=90$) and foreign language (76.00) students ($Z = -3.361, p = 0.001$). The difference between students in social sciences (55.39, $n=89$) and those in foreign language (73.68) followed ($Z = -2.957, p = 0.003$) (Table 2).

Table 1: Kruskal-Wallis test results for students' answers to questions 3 and 4 based on student study areas.

Question*	Study area	Number	Mean rank	Df	X ²	p
3	Social sciences	89	151.38	3	16.455	0.001
	Equal area	90	145.83			
	Science	91	138.76			
	Foreign language	30	197.50			
4	Social sciences	89	153.26	3	11.069	0.011
	Equal area	90	155.00			
	Science	91	140.22			
	Foreign language	30	160.00			

* See Fig. 2 for questions

Table 2: Post hoc Mann-Whitney U test results comparing the students study areas with respect to students' answers to questions 3 and 4.

Question*	Study area	Number	Mean rank	U	Z	p
3	Social sciences	89	55.39	924.5	-2.957	0.003
	Foreign language	30	73.68			
3	Equal area	90	55.33	885.0	-3.361	0.001
	Foreign language	30	76.00			
3	Science	91	55.13	830.5	-3.913	0.000
	Foreign language	30	78.82			
4	Social sciences	89	94.46	3697.5	-2.043	0.041
	Science	91	86.63			
4	Equal area	90	95.48	3691.5	-2.398	0.017
	Science	91	86.57			
4	Science	91	59.02	1185.0	-2.087	0.037
	Foreign language	30	67.00			

* See Figure 2 for questions

Table 3: Mann-Whitney U test results for male and female students' level of awareness about important issues of climate change.

Question	Gender	N	Mean Rank	U	Z	P
1	Male	146	169.85	8417.0	-3.906	0.000
	Female	154	132.16			
2	Male	146	165.08	9113.5	-2.928	0.003
	Female	154	136.68			
3	Male	146	166.00	8978.5	-3.114	0.002
	Female	154	135.80			
4	Male	146	168.95	8548.5	-3.989	0.000
	Female	154	133.01			
5	Male	146	165.92	8990.5	-3.106	0.002
	Female	154	135.88			

Table 4: Kruskal-Wallis test results for students' answers to questions 1, 2, 3 and 5 based on student study areas.

Question	Study area	Number	Mean rank	Df	X ²	p
1	Social sciences	89	142.44	3	21.814	0.000
	Equal area	90	150.04			
	Science	91	176.41			
	Foreign language	30	97.17			
2	Social sciences	89	154.38	3	8.002	0.046
	Equal area	90	139.11			
	Science	91	166.51			
	Foreign language	30	124.62			
3	Social sciences	89	161.44	3	17.052	0.001
	Equal area	90	148.91			
	Science	91	160.44			
	Foreign language	30	92.67			
5	Social sciences	89	152.99	3	10.197	0.017
	Equal area	90	133.12			
	Science	91	170.46			
	Foreign language	30	134.72			

Table 5: Post hoc Mann-Whitney U test results comparing the students study areas with respect to students' answers to questions 1, 2, 3 and 5.

Question	Study area	Number	Mean rank	U	Z	p
1	Social sciences	89	80.41	3151.5	-2.654	0.008
	Science	91	100.37			
1	Science	91	68.90	646	-4.465	0.000
	Foreign language	30	37.03			
1	Equal area	90	65.96	859	-3.126	0.002
	Foreign language	30	44.13			
2	Science	91	65.15	987.5	-2.334	0.020
	Foreign language	30	48.42			
3	Social sciences	89	66.57	750	-3.717	0.000
	Science	30	40.50			
3	Science	91	67.98	730	-3.960	0.000
	Foreign language	30	39.83			
5	Science	91	64.50	1046.5	-1.984	0.047
	Foreign language	30	50.38			

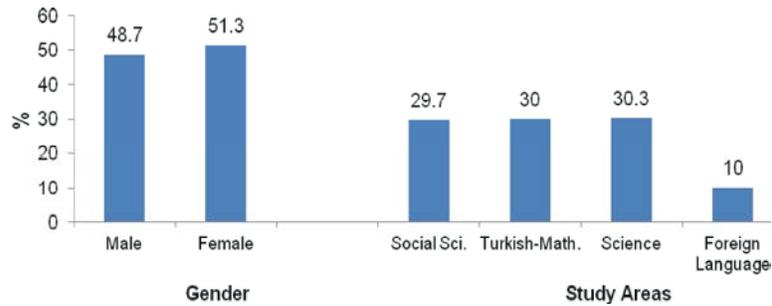


Fig. 1: Distribution of respondents by gender and study areas.

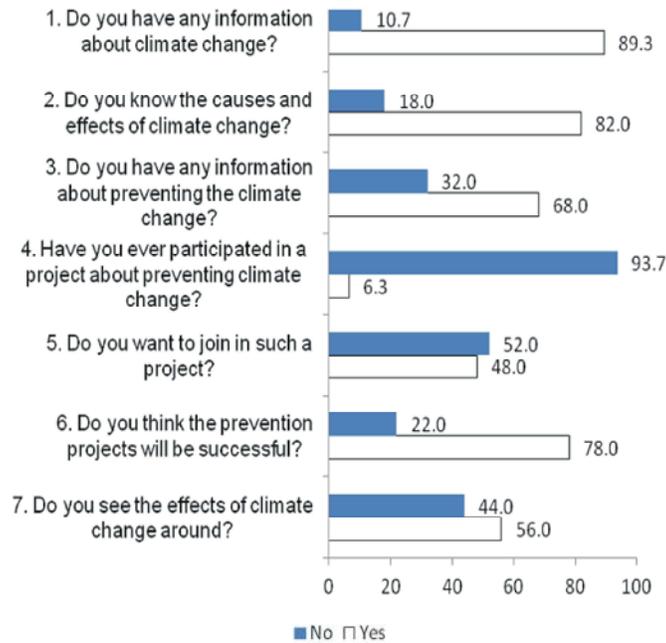


Fig. 2: Answers of the students to yes-no questions.

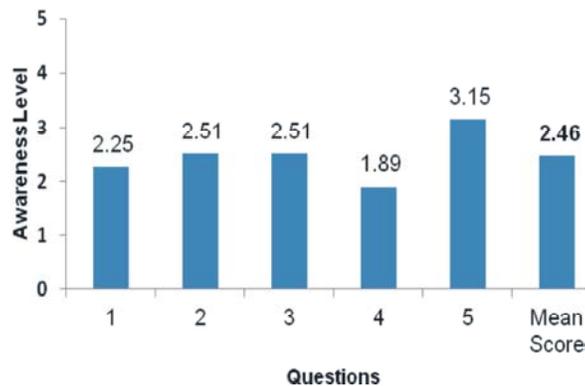


Fig. 3: Students' awareness levels about important issues of climate change.

There were also significant differences on question 4 between students in science and those in other three study areas. The mean rank of students in science was lower (86.63) than for those in social sciences (94.46) with $Z = -2.043$, $p = 0.041$. Moreover, the mean rank of students

in science was lower (86.57) than those in equal area (95.48) with $Z = -2.398$, $p = 0.017$ and lower (59.02) than those in foreign language (67.00) with $Z = -2.087$, $p = 0.037$. However, there were no differences found among other groups on the questions.

Students' Awareness Level about Important Issues of Climate Change:

According to the descriptive analysis of the answers given to the questions, the mean score for all questions was 2.46 out of 5, which corresponded to "poor". The awareness level was highest on the 5th question: "How familiar are you with the effects of globalization on climate change", with a score of 3.15. This was followed by the second and third questions: "how familiar are you with the carbon cycle in our life" and "how familiar are you with the increase of temperature since the beginning of the industrial revolution", with scores of 2.51. However, the mean score for the first statement: "how familiar are you with the increase of CO₂ since the beginning of the industrial revolution" was relatively low with 2.25. The fourth question: "how familiar are you with Kyoto Protocol" had the lowest mean with 1.89 (Figure 3).

Additional Mann-Whitney U tests were performed to determine whether gender was a significant factor in the students' awareness level about important issues of climate change. The results indicated that there were statistical differences ($p < 0.05$) between dependent and independent variables on all of the questions (Table 3).

Another additional Kruskal-Wallis analysis tests were performed to indicate whether there were differences in terms of students' study area and students' awareness level about important issues of climate change. The outcomes suggested that, there were statistically significant differences among the students in the four study areas on the questions 1, 2, 3 and 5 (Table 4).

To determine which of the pairs of study area means significantly differed with respect to students' level of awareness about important issues of climate change, post hoc Mann-Whitney tests were used. Results indicated that there were significant differences questions 1, 2, 3 and 5. On question 1, there were significant differences between students in social sciences (80.41, $n = 89$) and those in science (100.37, $n=91$) with $Z = -2.654$, $p = 0.008$; between students in science (68.90) and those in foreign language (37.03, $n=30$) with $Z=-4.465$, $p=0.000$; and between students in equal area (65.96, $n = 90$) and those in foreign language (44.13) with $Z=-2.334$, $p=0.002$. There was also a significant difference on question 2, between students in science (65.15) and those in foreign language (48.42) with $Z=-2.334$, $p=0.020$. In addition, there were also significant differences on question 3, between students in social sciences (66.57) and those in science (40.50) with $Z=-3.717$, $p=0.000$; and between students in science (67.98) and those in foreign language (39.83) with $Z=-3.960$, $p=0.000$. Moreover, there was a

significant difference on question 5, students in science (64.50) and those in foreign language (50.38) with $Z=-1.984$, $p=0.047$. However, there were no differences found among other groups on the questions (Table 5).

CONCLUSION

Analysis of the students' answers given to the questions about general knowledge of climate change indicated that the majority of students had information about climate change with its causes and effects and saw the effects of climate change in their life. An encouraging finding of this study is that almost 70% of the students who were surveyed had information about preventing the climate change. However, the rates fell below 7% for the students' participation to projects about preventing climate change. Moreover, half of these students who have not participated in a climate change project before did not want to join in such a project. This finding underscores an important problem; students have sufficient knowledge about climate change but they don't have enough practice to use their knowledge. So, there appears to be an urgent need for their knowledge to be used by mobilizing students to take action in projects. In fact, this problem is among the most urgent problems in Turkey for which all stakeholders are trying to find solutions.

The analysis of the relationship between student gender and answers did not suggest any significant difference. However, other analysis indicated that there were statistically significant differences among students by study areas with regard to questions 3 and 4. As for the third question, the largest differences were between students in foreign language and students in other three study areas. Interestingly, students in foreign language had information about question 3 (do you have any information about preventing the climate change?) more than those in other study areas. Considering the fourth question (have you ever participated in a project about preventing climate change?), the mean ranks of students in science interestingly rather low compared to other three study areas.

As for the students' awareness level about important issues of climate change, descriptive analysis of the answers revealed that the students rated their knowledge at the "poor" level with an average score of 2.46 out of 5. Their responses in this section revealed their insufficient awareness about globalization, carbon cycle, temperature and CO₂ increase and Kyoto Protocol. The responses of

the students about these issues are quite discouraging. The results showed the students had knowledge gaps in those issues and were facing urgent problems regarding their educational background. Therefore, some steps taken by authorized institutions about the curriculums can help students to fully understand the issues about climate change.

The analysis of the students' answers in this section indicated that, male students differed significantly from female students on all of the questions. According to statistics, male students had more level of awareness than female students on all issues. Other analysis showed that there were significant differences among students by study areas with regard to questions 1, 2, 3 and 5. The largest differences were between students in science and those in foreign language on question 1; between students in science and those in social sciences and foreign language on question 3. The analysis also suggested that six comparisons out of seven showed that students in science differed significantly from students in one of the other study areas.

In conclusion, this study revealed that the students surveyed had sufficient general information about the causes and effects of climate change but their awareness level about important issues of climate change was at the poor level. Although majority of the students had sufficient knowledge about preventing climate change, only 7% of them participated in such a project. Moreover, half the students did not want to take role in a project about preventing climate change. More specifically, gender and study areas differed in some questions of the survey. The results of this study have provided enough information about the lacks of high school education about climate change. These lacks give us clues regarding the directions for future works and researches in this context.

REFERENCES

1. Plotnikoff, R.C., M. Wright and N. Karunamuni, 2004. Knowledge, attitudes and behaviors related to climate change in Alberta, Canada: implications for public health policy and practice. *International J. Environmental Health Res.*, 14(3): 223-229. DOI: 10.1080/0960312042000218633.
2. Nicoll, A., 2007. Climate change. *Strategic Comments*, 13(2): 1-2. DOI: 10.1080/13567880701374855.
3. IPCC, 2007. Climate change 2007: The physical science basis. Geneva Switzerland: IPCC. Available from: http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg1_report_the_physical_science_basis.htm [Accessed 13 May 2011]
4. Schreiner, C.E., K. Henriksen and P.K. Hansen, 2005. Climate education: empowering today's youth to meet tomorrow's challenges. *Studies in Science Education*, 4(11): 3-49. DOI: 10.1080/03057260508560213.
5. Shepardson, D.P., D. Niyogi, S. Choi and U. Charusombat, 2009. Seventh grade students' conceptions of global warming and climate change, *Environmental Education Res.*, 15(5): 549-570. DOI: 10.1080/13504620903114592.
6. Adams, S., 2001. Views of the uncertainties of climate change: a comparison of high school students and specialists. *Canadian J. Environmental Education*, 6: 58-76.
7. Ho, E., 2009. Children's ideas about climate change. Unpublished phd thesis in Department of Geography and Collaborative Program in Environmental Studies, University of Toronto, 132. Available from: <http://proquest.umi.com/pqdlink?Ver=1&Exp=06-13-2016&FMT=7&DID=2008731011&RQT=309&attemp t=1&cf=1> [Accessed 15 May 2011]
8. Kahraman, S., M. Yalçın, E. Özkan and F. Aggöl, 2008. Primary teacher training students' levels of awareness and knowledge about global warming. *G.Ü. Gazi University J. Gazi Educational Faculty*, 28(3): 249-263.
9. Orbay, K., A. Cansaran and M. Kalkan, 2009. The opinions of prospective teachers about global warming. *Selçuk University J. Ahmet Kelesoglu Education Faculty*, 27: 85-97.
10. Oluk, E. and S. Oluk, 2007. Analysis of under graduated students' perceptions concerning green house effect, global warming and climate change. *Dokuz Eylül University J. Buca Education Faculty*, 22: 45-53.
11. Bozdoğan, A.E. and O. Yanar, 2010. Prospective elementary teachers' perceptions on the effect of global warming in the next century. *The Black Sea J. Sci.*, 1(2): 48-60.