

An Evaluation of Environmental Responsibility and Its Associated Factors: Reflections from PISA 2006

Ayhan Kürşat Erbaş *
Gaye Tuncer Teksoz **
Ceren Tekkaya ***

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Abstract

Problem statement: Contemporary global environmental problems have highlighted the importance of acting responsibly towards natural resources and the environment. The role of science education in shaping how people interact with the environment, therefore, has gained importance. The science education community has responded to this challenge by helping citizens develop responsibility for environmental issues. Accordingly, "scientific literacy and the environment" was one of the research areas in the Programme for International Student Assessment (PISA) 2006. We attempted to examine patterns in Turkish students' environmental responsibility and to expose relationships between student responsibility for environmental issues and socio-demographic variables. We did this by assessing scientific literacy and evaluating an environmental database for Turkey in the context of PISA 2006. Specifically, the current study examined the extent to which Turkish students' economic, social, and cultural status; school activities; parents' sense of responsibility and optimism regarding environmental issues and gender predicted their perceived responsibility towards the environment.

* Corresponding Author: Assoc. Prof. Dr. Middle East Technical University, Faculty of Education, erbas@metu.edu.tr

** Assoc. Prof. Dr., Middle East Technical University, Faculty of Education, gtuncer@metu.edu.tr

*** Prof. Dr., Middle East Technical University, Faculty of Education, ceren@metu.edu.tr

Purpose of Study: This study evaluated students' responsibility towards the environment and the relationship between perceived responsibility and several background variables, utilizing Turkish data obtained from the Programme for International Student Assessment (PISA) 2006.

Methods: Canonical correlation analysis (CCA) was used to examine the association between dependent and independent variables.

Findings and Results: The findings suggested that 15-year-old Turkish students' responsibility towards the environment varied with respect to such socio-demographic variables as gender; economic, social and cultural status; availability of school activities related to environmental topics and parental sense of responsibility for and optimism about environmental issues. Among these, although the association was negative, parental level of optimism regarding environmental issues explained the greatest amount of variation in student responsibility towards the environment. This was followed by parental sense of responsibility for environmental issues.

Conclusions and Recommendations: The overall picture disclosed by this study is one in which economic, social and cultural status (ESCS) is the primary feature shaping awareness and responsibility toward the environment. It is important to note that this result was obtained by sampling 15-year-old students in Turkey, where there is no strategy for environmental education. That is to say, if we were to gather background data on environmental awareness and responsibility in Turkey (although these would be below the OECD average), and if we were to identify how this awareness and responsibility have shaped the country's economic, social and cultural status, which differs by region, then we might be able to make plans to develop a tendency toward environmental consciousness. Such change would be important for the developing world. Being pessimistic about low ESCS coincides with low environmental awareness and responsibility, but alternative means to ameliorating this situation can be found by addressing national and even regional factors.

Keywords: Environmental awareness, environmental responsibility, environmental sustainability, Programme for International Student Assessment, socio-demographic variables

Evidence that science education shapes how people interact with the environment comes at a time when global environmental challenges, such as climate change and biodiversity, have never been greater. Research in the field has been oriented toward integrating environmental issues into school curricula since environmental education was accepted as a tool for environmental protection in the 1970s (Brundtland, 1987; United Nations [UN], 1992; United Nations Environment Program [UNEP], 1972). Efforts towards this end have helped educators recognize

that personal and social awareness, as well as concern regarding the quality of the natural environment, is at the heart of environmental protection (Shen & Saijo, 2008). Within this context, researchers from a variety of cultures have paid significant attention to the identification of socio-demographic variables that are associated with student attitudes towards environmental issues (e.g., Dietz, Kalof, & Stern, 2002; Eisler, Eisler, & Yoshida, 2003; Negev, Sagy, Garb, Salzberg, & Tal, 2008; Olli, Grendstad, & Wollebaek, 2001; Schultz & Zelezny, 1999; Shen & Saijo, 2008; Stern, Dietz, & Kalof, 1993; Zelezny, Chua, & Aldrich, 2000). Available studies, however, reveal inconsistent results. For example, examining the effect of parental occupation and education on sixth grade students' environmental knowledge, concern and behavior in Australia, Holdsworth and Boldero (1996) found that parental education level was related to student environmental concern. They reported that the effect of parental education level was stronger on boys than on girls. Furthermore, a study of Lebanese high school students by Makki, Abd-El-Khalick, and BouJaoude (2003) revealed that students had favorable attitudes towards the environment and yet lacked knowledge bases for environmental issues. They found that student environmental knowledge was positively correlated with parental education level, as well as student attitudes towards the environment, affect, beliefs and behavioral commitments. In a recent study, Chu et al. (2007) investigated the variables that influence Korean students' environmental literacy and found that these students tended to have higher levels of environmental literacy if their parents had university degrees. The authors concluded that children's levels of environmental literacy and associated variables were related to characteristics of Korean culture, society and school curricula. In regard to the effects of socio-economic status on student environmental concern, Worsley and Skrzypiec (1998) reported that students of lower socio-economic status were likely to be more supportive of environmental exploitation and scientific solutions to environmental problems than were other students. Negev et al. (2008) assessed 6th- and 12th-grade Israeli students' environmental literacy and found no relationship between knowledge and behavior. Ethnicity and socioeconomic status, however, were found to be moderately related to environmental literacy, while the presence of an adult who mediated a child's relation to nature was strongly associated with environmental attitudes and behavior and weakly linked to knowledge. Negev et al. showed that ethnic and socioeconomic characteristics were moderately related to Israeli students' environmental literacy and claimed that the intended goal of environmental education in Israel had not been achieved. Evans, Brauchle, Haq, Stecker, Wong, and Shapiro (2007), on the other hand, found that although adults' educational levels and political values were associated with their environmental attitudes and behaviours, parental attitudes and behaviours were not related to children's attitudes and behaviours.

The studies cited above focused mainly on the socio-demographic factors affecting environmental concern and the attitudes of individuals in developed countries. These studies tell us that cultural differences and differences in socio-economic structures have a major impact on students' environmental responsibility. Little work, however, has been done on the relationships between various socio-demographic characteristics and environmental concern in the developing world.

Moreover, although environmental issues have been of considerable interest to Turkish researchers in recent years (e.g., Alp, Ertepinar, Tekkaya, & Yilmaz, 2008; Taskin, 2009; Tuncer, Ertepinar, Tekkaya, & Sungur, 2005; Tuncer et al., 2009; Yilmaz, Boone, & Andersen, 2004), no study has been conducted to reveal the current status of Turkish students' responsibility towards the environment, using a sample representative of the whole country. The present study, therefore, aims to fill this gap and extend the findings of previous studies by utilizing a large data set obtained from PISA 2006. As a developing nation with a growing economy, great political and geographical importance and valuable natural resources, Turkey must construct a sustainable future. Therefore, we expect our study to contribute to research covering general problems in environmental education, as well as specific issues related to student environmental awareness, optimism, sense of responsibility for environmental issues and sustainable development. Our findings may also contribute to understandings of how people in different cultures and of different genders handle environmental problems. Thus, the following question guided this study: How well do Turkish students' economic, social, and cultural statuses; school activities; gender and parents' sense of responsibility and optimism regarding environmental issues predict their perceived responsibility towards the environment, as measured by PISA 2006?

Method

Participants

The Turkish data in PISA 2006 were collected from 4,942 fifteen-year-old students (2,290 girls and 2,652 boys) in 160 schools that included 7th (n = 23), 8th (n = 93), 9th (n = 2007), 10th (n = 2671) and 11th (n = 148) grade classes across 51 cities in 7 geographical regions.

Instruments

The Programme for International Student Assessment (PISA) is a comprehensive and rigorous international programme that assesses student performance and collects data on student, family and institutional factors that can help explain variations in performance, included aspects of environmental science and geoscience. Along with assessing literacy in certain subject areas, PISA 2006 collected contextual data through three questionnaires: A student questionnaire (StQ), a parent questionnaire (PaQ) and a school questionnaire (ScQ). A 30-minute questionnaire (i.e., StQ) covering the following aspects was administered to participating students: Student characteristics, family background, student views on science, student views on the environment, student views of science-related careers and student self-reported views on classroom time, teaching and the learning of science. The school questionnaire (i.e., ScQ) was filled out by school principals and covered the following: Structure and organization of schools, staffing and management, school resources, accountability and admission practices, teaching and environmental issues and career guidance. Furthermore, a 10-minute mandatory questionnaire (i.e., PaQ) was administered to one or both of the parents or other primary caregiver(s) of the students tested. It covered the following: Parental reports on school and science learning, parental views on the environment, annual spending on children's

education and parental background. While PISA was not designed specifically to assess environmental science and geoscience, out of the 108 questions used in the PISA 2006 science assessment, 24 were related to environmental science (of these, 14 focused on geoscience). This study, which focuses on how students performed when answering PISA science questions that were related to environmental science and geoscience, therefore, used Turkish students' responses on the environmental science and geosciences section of PISA 2006 to assess their environmental responsibility and associated factors. The environmental science questions on PISA 2006 spanned most of the criteria identified in the PISA 2006 framework for assessing "scientific literacy and environment". Of these 24 questions, 6 were related to natural resources, 10 were related to the environment, 5 were related to hazardous waste and 3 were related to the frontiers of science and technology. Furthermore, 11 questions (46%) were related to social context, 13 (54%) to global context, 10 (67%) to explaining phenomena scientifically and 8 (33%) to giving scientific references. The seven constructs (with related PISA 2006 indexes and sources of related data) considered under the PISA 2006 "scientific literacy and environment" theme were as follows (OECD, 2009a, p. 56):

- i. Student awareness of environmental issues—ENVAWARE (StQ),
- ii. Student sense of responsibility for environmental issues—ENVPERC (StQ),
- iii. Student environmental optimism—ENVOPT (StQ),
- iv. Responsibility for sustainable development—RESPDEV (StQ),
- v. School activities to promote environmental learning—ENVLEARN (ScQ),
- vi. Parental sense of responsibility for environmental issues—PQENPERC (PaQ),
- vii. Parental environmental optimism—PQENVOPT (PaQ).

Measures and variables

Two sets of data were utilized in this study (see Table 1). The first, the *responsibility towards the environment set*, included measures of pupils' scientific literacy, environmental awareness, level of concern and optimism about environmental issues and personal feelings of responsibility. The second set, the *background set*, included variables that were thought to possibly affect the variables in the first set. Details of these indices are given below and in Table 1.

Awareness of environmental issues: Pupils' beliefs regarding their own levels of knowledge about environmental issues (Table 1) constituted the *index of students' awareness of environmental issues* (ENVAWARE) (OECD, 2007, pp. 340).

Level of concern for environmental issues: Pupils' levels of concern about environmental issues, presented in Table 1, constituted the *index of students' level of concern about environmental issues* (ENVPERC) (OECD, 2007, pp. 340).

Optimism regarding environmental issues: The *index of students' optimism about environmental issues* (ENVOPT) was created using pupils' responses about their

optimism regarding the development, over the next 20 years, of the problems associated with environmental issues (Table 1) (OECD, 2007, pp. 340).

Responsibility for sustainable development: The *index of students' responsibility for sustainable development* (RESPDEV) was created by combining pupils' levels of agreement with the statements presented in Table 1 (OECD, 2007, pp. 340-41).

Economic, social and cultural status: As noted by the OECD (2007, p. 333), the economic, social and cultural statuses or socio-economic backgrounds of students have been described by the *PISA index of economic, social and cultural status* (ESCS), which was constructed to represent broad aspects of students' family and home backgrounds, as well as parents' occupational status. Principal component analysis was carried out to derive factor scores, as the student scores on the ESCS index are standardized, so that the OECD mean for the ESCS index is 0 and the standard deviation is 1. The reliability of the ESCS index was reported to range from 0.52 to 0.80 across participating countries (OECD, 2007, p. 333).

Parents' level of concern for environmental issues: The *index of parents' level of concern for environmental issues* (PQENPERC) was created using parents' (of 15-year-old pupils) levels of concern about the environmental issues presented in Table 1 (OECD, 2007, p. 346):

Parents' optimism regarding environmental issues: The *index of parents' optimism regarding environmental issues* (PQENVOPT) was created using the optimism shown by the parents of 15-year-old pupils regarding the development, over the next 20 years, of the problems associated with the environmental issues presented in Table 1 (OECD, 2007, p. 347).

School activities for learning environmental topics: The *index of school activities for learning environmental topics* (ENVLEARN) was created by combining school principals' responses as to whether their schools had organised any of the following activities, to provide opportunities to students in the 8th and 9th grades (i.e., Turkish modal grades for 15-year-olds) to learn about the environmental topics presented in Table 1 (OECD, 2007, p. 344).

Table 1

"Scientific Literacy and Environment" Theme - PISA 2006

Index	Measuring items in the surveys	Cronbach's alpha
Responsibility towards environment set		
Student awareness of environmental issues – ENVWARE	<ul style="list-style-type: none"> i) the increase of greenhouse gases in the atmosphere ii) the use of genetically-modified organisms iii) acid rain iv) nuclear waste v) the consequences of clearing forests for other land use 	0.72
Student sense of responsibility for environmental issues – ENVPERC	<ul style="list-style-type: none"> i) air pollution ii) energy shortages iii) extinction of plants and animals iv) clearing of forests for other land use v) water shortages vi) nuclear waste 	0.85
Student environmental optimism – ENVOPT	<ul style="list-style-type: none"> i) air pollution ii) energy shortages iii) extinction of plants and animals iv) clearing of forests for other land use v) water shortages vi) nuclear waste 	0.87
Responsibility for sustainable development – RESPDEV	<ul style="list-style-type: none"> i) i) it is important to carry out regular checks of car emissions as a condition of car use ii) it disturbs me when energy is wasted through the unnecessary use of electrical appliances iii) I am in favor of having laws that regulate factory emissions, even if this would increase the price of certain products iv) to reduce waste, the use of plastic packaging should be kept to a minimum v) industries should be required to prove that they safely dispose of dangerous waste materials vi) I am in favor of having laws that protect the habitats of endangered species vii) electricity should be produced from renewable sources as much as possible, even if this increases cost 	0.84
Background set		
Economic, social and cultural status (ESCS)	ESCS was derived from three PISA indices: the <i>highest international socioeconomic index of occupational status</i> (HISCEI) of the father or mother; the <i>index of highest educational level of parents</i> (HISCED) converted into years of schooling (for the conversion of levels of education into years of schooling); and the <i>index of home possessions</i> (HOMEPOS)	0.72
School activities that promote environmental learning – ENVLEARN	<ul style="list-style-type: none"> i) outdoor education/trips ii) trips to museums iii) trips to science and/or technology centers iv) extracurricular environmental projects (including research) v) lectures and/or seminars (e.g., guest speakers) 	0.62

Table 1 *Contnd.*

Index	Measuring items in the surveys	Cronbach's alpha
Parental sense of responsibility for environmental issues – PQENPERC (PaQ)	i) air pollution	0.77
	ii) energy shortages	
	iii) extinction of plants and animals	
	iv) clearing of forests for other land use	
	v) water shortages	
	vi) nuclear waste	
Parental environmental optimism – PQENVOPT (PaQ)	i) air pollution	0.83
	ii) energy shortages	
	iii) extinction of plants and animals	
	iv) clearing of forests for other land use	
	v) water shortages	
	vi) nuclear waste	

Data analysis

In this study, canonical correlation analysis (CCA) was performed to examine patterns in the relationships between two sets of variables. Presented in Table 1 under the title *Responsibility towards the environment set*, the first set of variables is considered the dependent variables. The second set of variables is considered the independent variables and consists of the variables presented in Table 1 under the titles *Background set* and gender.

Since our interest was not in examining a single dependent variable and the factors affecting it, but in determining the nature of the independent relationships between two sets of multiple dependent and multiple independent variables, CCA analysis was preferred over simple regression analysis, as suggested by Tabachnick and Fidell (2007). Before using SPSS CONCORR to perform CCA, assumptions were checked. Examined for normality, we observed variables distributed with positive and negative skewness and positive kurtosis. However, because those variables were part of the PISA 2006 data set and were normalized for participating countries, no variables were deleted or transformed to improve linearity and normality. Furthermore, weighting data for analysis guaranteed that distributions were representative of the population projected (i.e., 15-year-olds). No within-set multivariate outliers were identified at $p < 0.001$, although 210 cases were found to be missing and were deleted listwise, leaving $n = 4732$. Pearson's product-moment correlations were calculated to test for the existence of multicollinearity. No correlations exceeded 0.4 (Tabachnick & Fidell, 2007) for the responsibility towards the environment variables or the background variables. Last, all inferential analyses were conducted by weighing the data using the PISA 2006 final student weight (W_FSTUWT), in accordance with the recommendation that analyses with PISA data should always be weighted, to ensure that population estimates are unbiased (OECD, 2009a, 2009b).

Results

Table 2 shows the distribution of students and mean values for the background data set. The percentages in this table were calculated by using the PISA 2006 final student weight to weight the data. They are, thus, reliable estimates for the 15-year-old student population in Turkey. Although the scope of our research does not take into account differences in geographical regions while evaluating student responsibility towards the environment, and by presenting this data, we intended to display the sample structure to be used for the sake of making a sound discussion of the results of the current research. The differences between geographical regions is a major issue for future studies (Teksoz, Tekkaya, & Erbas, 2009). Thus, as seen from the table, about half of the Turkish sample consisted of students from the Marmara and Central Anatolian regions. The percentages of students in these regions reflected actual regional differences in population density in Turkey. That is to say, Marmara is the region with the highest population density, whereas East Anatolia is the region with the least. According to Table 2, although the economic, social and cultural statuses (ESCS) of students all over Turkey was below the OECD mean, students in the Aegean region had the highest ESCS, and students in the South Eastern-Anatolian region had the lowest. Furthermore, school activities to promote environmental learning (ENVLEARN) were most numerous in Central Anatolia and scarcest in Eastern Anatolia. Moreover, while parental sense of responsibility for environmental issues (PQENPERC) was highest in the Mediterranean region, it was lowest in the Eastern-Anatolian region. Consistently, parental optimism regarding environmental issues (PQENVOPT) was lowest in the Mediterranean region and highest in the Eastern Anatolian region, compared to other regions. Thus, summary statistics for the sample in this study revealed that students living in the eastern part of Turkey had the lowest percentages for all parameters, with the exception of parental environmental optimism.

Table 2

*Summary Statistics for the Sample and Estimated Population Characteristics**

Measures	Geographical Provinces						
	Marmara	Central Anatolia	Aegean	Mediterranean	Black Sea	Eastern Anatolia	South-eastern Anatolia
Distribution of students: %							
Girls	48.5	45.4	47.2	51.3	35.7	46.5	32.5
Boys	51.5	54.6	52.8	48.7	64.3	53.5	67.5
Total	29.3	17.7	12.3	13.8	11.9	7.6	7.5
ESCS**	-1.20	-1.20	-1.03	-1.10	-1.39	-1.77	-1.83
ENVLEARN**	0.27	0.44	0.23	0.26	0.05	-0.65	-0.57
PQENPERC**	0.31	0.28	0.29	0.34	0.20	0.11	0.12
PQENVOPT**	0.16	0.18	0.14	0.00	0.11	0.33	0.28

* The means and percentages in this table were calculated by using the PISA 2006 final student weight (W_FSTUWT) to weight the data and, thus, are reliable estimates for the population (i.e., 15-year-olds) to which this study is relevant in Turkey.

** Values for these measures are means for each region.

Correlations, standardized canonical coefficients, canonical correlations, percents of variance and redundancies between the responsibility towards the environment variables and the background variables are presented in Table 3, according to their corresponding canonical variates.

Table 3
Results of Canonical Analysis

		First Canonical Variate		Second Canonical Variate		Third Canonical Variate	
<i>Responsibility Towards Resources and Environment Set</i>		<i>Correlation</i>	<i>Coefficient</i>	<i>Correlation</i>	<i>Coefficient</i>	<i>Correlation</i>	<i>Coefficient</i>
Awareness and understanding of environmental issues (ENVAWARE)		.31	.1	.03	-.02	.95	1.01
Sense of responsibility for environmental issues (ENVPERC)		.38	.18	.92	.96	-.47	-.11
Optimism regarding environmental issues (ENVOPT)		-.97	-.91	.22	.40	.11	.29
Responsibility for sustainable development (RESPDEV)		.26	.09	.36	.11	.15	.03
Percent of variance		.31		.25		.23	Total = .79
Redundancy		.1		.04		.01	Total =.15
<i>Background Set</i>		<i>Correlation</i>	<i>Coefficient</i>	<i>Correlation</i>	<i>Coefficient</i>	<i>Correlation</i>	<i>Coefficient</i>
Economic, social and cultural status (ESCS)		.33	.17	.02	-.12	.90	.9
School activities to promote environmental learning (ENVLEARN)		.21	.09	.21	.18	.41	.19
Parents' sense of responsibility for environmental issues (PQENPERC)		.38	.18	.87	.91	-.11	-.21
Parents' optimism regarding environmental issues (PQENVOPT)		-.94	-.88	.25	.42	.22	.31
Gender		-.23	-.16	-.31	-.22	-.18	-.16
Percent of variance		.25		.19		.21	Total =.65
Redundancy		.08		.03		.01	Total =.12
Canonical Correlation		.56		.37		.20	

The first canonical correlation was .56 (with 32% variance), the second was .37 (with 14% variance) and the third was .20 (with 4% variance). The remaining canonical correlation was effectively zero (.03 with 0.1% variance). χ^2 test results revealed the following values: With all four canonical correlations included, $\chi^2_{(20)} = 2583.21$, $p < 0.001$; with the first canonical correlation removed, $\chi^2_{(12)} = 804.37$, $p < 0.001$ and with the first two canonical correlations removed, $\chi^2_{(6)} = 172.667$, $p < 0.001$. Subsequent χ^2 tests were not statistically significant. The first three pairs of canonical variates, thus, accounted for the significant relationship between the two sets of variables. Canonical correlation, total percent of variance and total redundancy indicated that the first two pairs of canonical variates were moderately related, but the third pair was only minimally related. Thus, interpretation of the third canonical variate is questionable, even though it is statistically significant, and results related to the third pair should be interpreted with caution. The three canonical variates together explained 79% of variance in the responsibility towards the environment set and 65% of variance in the background set.

With a cut-off correlation of .30 (Tabachnick & Fidell, 2007), the variables in the responsibility towards the environment set that were correlated with the first canonical variate were student awareness of environmental issues, student sense of responsibility for environmental issues and student optimism regarding environmental issues. Among the background variables, economic, social and cultural status, parental sense of responsibility for environmental issues and parental optimism regarding environmental issues correlated with the first canonical variate (see Table 3). The percent of variance values revealed that the first canonical variate pair accounted for 31% of variance in the responsibility towards the environment variables and 25% of variance in the background variables. The redundancy value showed that the background variables accounted for 10% of variance in the responsibility towards the environment variables.

Therefore, the first pair of canonical variates indicated that greater student awareness of environmental issues (.31), greater student sense of responsibility for environmental issues (.38) and less student optimism regarding environmental issues (-.97) were associated with higher economic, social and cultural status (.33), higher parental sense of responsibility for environmental issues (.38) and less parental optimism regarding the environment (-.94). That is, students who had higher economic, social and cultural statuses and parents with greater senses of responsibility and lower levels of optimism regarding environmental issues were likely to have higher levels of awareness and senses of responsibility and lower optimism regarding environmental issues.

The second canonical variate in the responsibility towards the environment set was composed of student sense of responsibility for environmental issues and student responsibility for sustainable development, and the corresponding canonical variate from the background set was composed of parental sense of responsibility for environmental issues and gender. Taken as a pair, these variates suggest that a combination of higher student sense of responsibility for environmental issues (.92) and higher student sense of responsibility for sustainable development (.36) were

associated with a combination of higher parental sense of responsibility for environmental issues (.87) and being female (-.31). That is, females and students having parents with a strong sense of responsibility towards environmental issues were likely to exhibit a greater sense of responsibility for environmental issues and sustainable development than were others.

On the other hand, the percent of variance reported in Table 3 revealed that the second canonical variate pair accounted for 25% of variance in the responsibility towards the environment variables and 19% of the variance in the background variables. The redundancy value showed that the background variable accounted for 4% of the variance in the responsibility towards the environment variables. Collectively, these two canonical variates explained 56% of variance in the responsibility towards the environment set and 44% of variance in the background variables set.

The third canonical variate in the responsibility towards the environment set was composed of student awareness of environmental issues and student sense of responsibility for environmental issues, and the corresponding canonical variate from the background variables set was composed of economic, social and cultural status and school activities about environmental topics. Taken as a pair, these variates suggest that a combination of student awareness of environmental issues (.95) and less sense of responsibility for environmental issues (-.47) were associated with a combination of higher economic, social and cultural status and higher levels of participation in school activities about environmental topics. The percent of variance values revealed that the third canonical variate pair accounted for 23% of variance in the responsibility towards the environment variables and 21% of variance in the background variables. On the other hand, the redundancy values in Table 3 showed that the student background variables accounted for only 1% of variance in the responsibility towards the environment variables. Thus, while the effect of school activities about environmental topics was significant, it explained little of the variance in student responsibility toward the environment.

Discussions and Conclusion

The findings of the present study suggested that 15-year-old Turkish students' responsibility towards the environment varied with respect to such socio-demographic variables as gender; economic, social and cultural status; school activities about environmental topics and parental sense of responsibility for and optimism about environmental issues. Among these, although the association was negative, parental level of optimism regarding environmental issues explained the greatest variation in student responsibility towards the environment, followed by parental sense of responsibility for environmental issues. In other words, parents' sense of responsibility for and optimism about environmental issues had a relatively strong impact on children's sense of responsibility for, level of awareness of and optimism regarding environmental issues. Likewise, students with less optimistic parents appeared to be less optimistic about the future and, at the same time, to have larger senses of responsibility for and awareness of environmental problems. This

outcome may be explained by the fact that environmentally-concerned parents have a tendency to pass their concerns on to their children, as well as to model appropriate behaviors (Holdsworth & Boldero, 1996; Musser & Diamond, 1999). The results of the current study also provide some evidence that, although it is weaker than the effect of parental factors (i.e., parental sense of responsibility for and optimism regarding environmental issues), economic, social and cultural status also plays an influential role in clarifying variation in student responsibility towards the environment. Students from more advantaged economic, social and cultural statuses tended to express both higher levels of awareness and responsibility regarding environmental issues like air pollution, energy shortages, the extinction of plants and animals, the clearing of forests for other land use, water shortages and nuclear waste. Besides, they seemed to be less optimistic about the state of environmental problems over the next 20 years. These findings may be explained by the idea, also reported by Carlisle (2007), that such students are provided with a wide range of social and civic advantages and opportunities; they live in better neighborhoods, attend better schools and are exposed to newspapers, books and discussions. Therefore, they display high levels of awareness of and responsibility for environmental problems. According to Morrison, Homback, and Warner (as cited in Carlisle, 2007), people from the lower classes tend to live and work in places with poorer physical conditions and environmental hazards. As they grow up, they get used to their environments, and they are less aware of the fact that they live in polluted and overcrowded conditions. The middle and upper classes, however, tend to live and work in pleasant environments and, thus, are concerned about environmental deterioration. Hence, it is reasonable to assume that children living in such circumstances are more likely to be aware of and responsible for environmental problems and to become pessimistic about their future. In line with Bourdieu's (1976) notion of variations in educational habits, proposed many decades ago, Lee and Bowen (2006) reported that "parents with diverse racial/ethnic, educational, and economic backgrounds are involved in their children's education regardless of whether they are formally involved in their children's school life," even though there might be group differences in levels of parent involvement (p. 210). The relationship between social class and environmental concern has also been explained by Maslow's (1970) hierarchy of needs theory, which was based on the assumption that "concern for environmental quality is something of a luxury which can be indulged only after more basic material needs (adequate food, shelter, and economic security) are met" (Van Liere & Dunlap, 1980, p. 183). Such a result, along with the supporting theories mentioned above, tell us that while trying to help children develop positive attitudes toward the environment, it is necessary to increase parental involvement in environmental conservation activities, so as to increase parents' and children's sense of responsibility. But, as mentioned in discussions of Maslow's hierarchy of needs and as is also suggested by Agenda 21 (UNCED, 1992), meeting basic material needs and increasing living standards are the first steps toward establishing environmental responsibility, especially in the developing world. What is more, serious differences in environmental perceptions and related socioeconomic factors exist between regions within developing countries, as was the case in this study (see Table 2),

making the situation more complicated. Making environmental consciousness a reality, on the other hand, is an issue of first implementing sustainable development concepts via national development plans, then reshaping curricula so that they are in line with environmental education targets at national and local levels.

Like economic, social and cultural status and parental sense of responsibility and optimism regarding environmental issues, gender was found to play an important role in shaping students' responsibility towards the environment, even though the association was not as strong as that between the other three variables. That girls were more likely to have a greater sense of responsibility for environmental issues and sustainable development than their counterparts can be attributed to the different socialization of boys and girls. In general, girls are socialized to be more altruistic, cooperative, nurturing, and interdependent, while males are socialized to be more independent and competitive (Zelezny et al., 2000). Tikka, Kuitunen, and Tynys (2000) reported that whereas boys were more likely to emphasize mastering nature and benefiting from resources, girls obtained more emotional attitudes toward nature. Bord and O'Connor (1997), however, argued that gender differences in environmental surveys resulted from differences in perceived vulnerability to risk from the environment, not necessarily differences in ecological sensibility. These authors stated that in most of the research on "risk-related environmental issues", females expressed higher levels of concern about such topics as nuclear power, irradiated food, chemical and radioactive waste and food preservatives. Bord and O'Connor (1997) concluded that for females, once risk to health and personal wellbeing become associated with environmental issues, their levels of concern tend to surpass those of males. A similar finding was also reported by Riechard and Peterson (1998) and Eisler et al. (2003). For example, Eisler et al. (2003), reported that girls had more "goal-oriented contemporary worldviews and were more inclined to think about new ways of solving the environmental problems and had more responsible attitudes than males towards the protection of nature and the environment" (p. 98). Research conducted in Turkey, on the other hand, consistently shows that girls exhibit more favorable attitudes towards the environment than boys (e.g., Alp et al., 2006; 2008; Berberoglu & Tosunoglu, 1995; Ozden, 2008; Taskin, 2009; Tuncer et al., 2005; 2009; Yilmaz et al., 2004). Our findings also support this trend. Thus, there is an urgent need to support and strengthen boys' sense of responsibility for environmental issues both at school and at home. To this end, at school, for example, science teachers should consider boys' attitudes in more detail and find ways to stimulate their interest, responsibility, motivation and participation in environmental issues. In fact, among others, our results clearly indicated the existence of a gender gap in the Turkish sample. To eliminate or at least reduce the gap, science teachers should be informed first of its presence. As mentioned by Gambro and Switzky (1999), we can also state that the majority of Turkish science teachers may be unaware of the existence of this gap and may unconsciously promote gender inequity by treating girls and boys differently. Another possible way of overcoming the gender gap might be to encourage equal participation. During units on the natural environment, science teachers should create learning environments where girls and boys have equal opportunity to practice with

materials, engage in discussions and interact with their peers. Cooperative learning, for example, can be used to allow each gender to participate equally both in and out of class activities. Another way of narrowing the gender gap might be to re-examine the presentation of environmental topics in science textbooks in terms of possible gender biases. To be brief, the orientation of environmental education in Turkey should seriously consider the gender-related difference in environmental issues.

Although it explains little variance, the current study pointed out the positive impact of school activities on the development of responsibility towards environmental issues. More specifically, students who experienced high levels of school activities related to environmental topics (e.g., trips to museums and science and technology centers, extracurricular environmental projects) tended to express higher degrees of awareness and less sense of responsibility for environmental issues than did others. This finding is not surprising, as far as student awareness is concerned. It is probable that these kinds of school activities, which involve direct contact with different learning environments and make students familiar with current environmental problems, appear to increase student awareness of environmental issues. Traditional environmental education in schools, however, is generally based on indirect experience, with a major emphasis on theory and fact, and does not influence student environmental attitudes (Kollmuss & Agyeman, 2002). As stated by Musser and Diamond (1999), in accordance with social learning theory, children learn from direct experience and from observations of others (Bussey & Bandura, 1999), which is in line with the way in which parents teach their children. However, finding a negative correlation between school activities for learning environmental topics and level of responsibility for environmental issues was unexpected. As mentioned previously, there is currently no formal environmental education in Turkey, and we are at the stage of "just beginning". Environmental education, therefore, has been infused into already existing science curricula, to raise environmentally-informed individuals who are actively involved in solving environmental problems.

Our findings agree well with the results of earlier studies (e.g., Barraza & Walford, 2002; Chu et al., 2007; Palmerg & Kuru, 2000; Worsley & Skrzypiec, 1998). For example, Barraza and Walford (2002) highlighted the importance of school ethos and reported that schools with environmental policies might enhance student appreciation of the environmental crisis and improve student attitudes toward the environment. In a similar vein, Palmerg and Kuru (2000) claimed that outdoor activities not only offered opportunities for the development of strong empathic associations with nature, but also improved social behavior and moral judgment.

The overall picture disclosed by this research presents economic, social and cultural status (ESCS) as the feature most responsible for shaping awareness of and responsibility toward the environment. It is important to remember that this result was obtained with a sample of 15-year-old Turkish students living in Turkey, where there is no strategy for environmental education. That is to say, if we were to gather background data on environmental awareness and responsibility (although these would be below the OECD average), and if we were to identify how this awareness

and responsibility has shaped and been shaped by the country's regional features, then we might make future plans to develop an environmental ethos accordingly. Such change would be important for the developing world. Being pessimistic about low ESCS coincides with low environmental awareness and responsibility, but alternative means to ameliorating this situation can be found by addressing national and even regional factors. Hence, education about the environment and sustainable development would do better to focus on regional, even local, features, making use, for instance, of real cases, local stories and global issues. Awareness of global warming, for example, may follow from explanations of the reasons for global warming within a global context and the consequences of warming, especially within a regional context. Water shortages in Central Anatolia, changes in agricultural products in the Black Sea, water level increases in the Mediterranean and migration in East Anatolia regions are all examples of discussion prompts that could enhance awareness.

In conclusion, we offer three suggestions for future research that aims to explain the socioeconomic bases of environmental responsibility, especially in developing nations, and to produce more research relevant to environmental policymaking. First, given the widespread distribution of concern about a variety of environmental issues, we believe it more feasible to concentrate on specific environmental issues, such as air and water pollution, sustainability, population increase and public policy, because somehow, it is becoming unclear whether people are equally or more concerned about one of these issues than others. Second, the results of some studies (e.g., Bodur & Sarigollu, 2005; Van Liere & Dunlap, 1980) suggest that consumer variables such as taxes, economic growth, private property and demographics should be considered possibly correlated with environmental concern.

Overall, the current study is unique, for presenting a comprehensive picture of the state of 15-year-old Turkish students' responsibility towards the environment and for detecting the factors associated with attitudinal changes throughout the country. In this study, we chose economic, social and cultural status; school activities about environmental topics; parental sense of responsibility for environmental issues; parental optimism regarding environmental issues and gender as independent variables. Future research should examine the relationship between student responsibility towards the environment and other variables such as enjoyment of science, science-related activities, general interest in science and general perceptions of the value of science, as measured in PISA 2006. Later studies should also examine regional differences, as knowledge of these could lead to the exposure of more interesting interconnections.

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Çevre Sorumluluğu ve İlintili Faktörlerin Bir Değerlendirmesi: PISA 2006 Bulguları Özet

Küresel çevre problemlerinin günümüzde ulaştığı nokta, bireylerin doğal kaynaklar ve çevre sorunları ile ilgili sorumluluk taşımasının önemine dikkat çekmektedir. Bu bağlamda, fen eğitiminin insanın çevre ile etkileşimini biçimleyen yönü daha da öne çıkmış; fen eğitimcilerinin, insanların çevre ile ilgili sorumluluklarının geliştirilmesi yönünde çalışarak katkılar sağlamaları çok daha önemli olmuştur. Bu çalışmada, PISA 2006 içeriğinde yer alan “fen okuryazarlığı ve çevre” başlığı araştırma alanı çerçevesinde Türkiye örnekleminde elde edilen veri setinin kullanılarak Türkiye’deki 15 yaş grubundaki öğrencilerin çevre ile ilgili sorumluluklarının çerçevesinin belirlenmesi amaçlanmıştır. Daha açık bir ifade ile bu çalışma, PISA 2006 veri setini kullanarak Türkiye’deki öğrencilerin çevre ile ilgili sorumluluk profillerini ve bu profile etki edebilecek ekonomik, sosyal, kültürel parametreleri araştırmayı amaçlamaktadır. Çalışmanın veri seti iki bölümden oluşmaktadır. Birinci bölüm, *çevre sorumluluk bölümü*, fen okuryazarlığı ile ilgili ölçümler ve çocukların çevre sorunları ile ilgili farkındalık, sorumluluk, iyimserlik durumlarını, sorumluluk duyguları ile bağlantılı ölçümleri içermektedir. İkinci bölüm, *altyapı bölümü*, birinci bölümdeki değişkenleri etkileyebilecek sosyal, ekonomik ve kültürel faktörleri içermektedir. Söz konusu birinci ve ikinci gruptaki parametreler şunlardır:

1. *Çevre sorumluluk bölümü*: Çevre konuları ile ilgili farkındalık, sorumluluk, iyimserlik, sürdürülebilir kalkınma ile ilgili sorumluluk.
2. *Altyapı bölümü*: Ekonomik, sosyal ve kültürel durum, anne-babanın çevre ile ilgili sorumluluk durumu, anne-babanın çevre ile ilgili iyimserlik durumu, çevre ile ilgili okul etkinlikleri.

Bağımlı ve bağımsız değişkenlerin oluşturduğu ilişkilerin açıklanması amacı ile çalışmada “Kanonik Korelasyon Analizi” (CCA) kullanılmıştır. Türkiye’nin 7 coğrafi bölgesinde yaşayan öğrencilerin tanımlanan parametreler bağlamında çevresel sorumluluklarının belirlenmesi, bu çalışmanın alanının dışında olsa bile, çalışmanın sonuçlarının daha geniş bir çerçevede değerlendirilebilmesi için, ilk olarak veri setinde yer alan sosyo-ekonomik parametreler bölgeler bazında değerlendirilmiştir. Buna göre, PISA 2006 veri setindeki Türkiye örneğinin yaklaşık yarısı Marmara ve Orta Anadolu Bölgelerindedir. Her bölgeden katılan öğrenci sayısı, aslında, o bölgenin nüfus yoğunluğunu da yansıtmaktadır. Örneğin, Marmara en yüksek ve Doğu Anadolu Bölgesi ise en düşük nüfus yoğunluğuna sahip bölgelerdir. Çalışmada hesaplanan ekonomik, sosyal ve kültürel indeks değerleri karşılaştırıldığında, tümü OECD ortalamasının altında olmasına rağmen, Ege Bölgesi’ndeki öğrencilerin en yüksek, Güney-Doğu Anadolu Bölgesi’ndeki öğrencilerin ise en düşük ortalamaya sahip oldukları görülmektedir. Buna karşın,

çevre ile ilgili okul aktiviteleri konusunda en yüksek ortalamaya sahip öğrenciler Orta Anadolu'da; en düşük ortalamaya sahip olanlar ise Doğu Anadolu Bölgesi'nde yaşayanlardır. Anne-babaların çevre ile ilgili sorumluluk durumları ise, Akdeniz Bölgesi'nde en yüksek, Doğu Anadolu Bölgesinde en düşük orandadır. Buna bağlı olarak, anne-babanın çevre sorunları ile ilgili iyimserlik durumları, Akdeniz Bölgesinde en düşük; Doğu Anadolu Bölgesinde ise en yüksek orandadır. Kısaca, örneklem ile ilgili istatistikler, Türkiye'nin Doğu Bölgesinde yaşayan öğrencilerin diğer bölgelere oranla, anne-babanın çevre ile ilgili iyimserlikleri dışında, en düşük ekonomik, sosyal ve kültürel parametre ortalamalarına sahip olduklarını göstermektedir. Kanonik analiz sonuçları 3 aşamada gerçekleştirilmiştir. Birinci kanonik korelasyon 0,56 (varyans; %32), ikincisi 0,37 (varyans; %14) ve üçüncüsü 0,20 (varyans; %4) olarak belirlenmiştir. Diğer kanonik korelasyonlar tamamen ihmal edilebilir düzeydedir (0,03 ve %0,1 varyans). Ki-kare (χ^2) testi sonucunda ise aşağıdaki değerler bulunmuştur:

Bütün kanonik korelasyonlar dahil edildiğinde, $\chi^2_{(20)} = 2583,21$ ($p < 0,001$);

İlk kanonik korelasyon çıkarıldığında, $\chi^2_{(12)} = 804,37$ ($p < 0,001$);

İlk 2 kanonik korelasyon çıkarıldığında, $\chi^2_{(6)} = 172,667$ ($p < 0,001$).

İstatistiksel değerlendirmeler sonucunda, ilk 3 çift kanonik bileşenin veri setleri arasındaki ilişkiyi açıkladığına karar verilmiştir: kanonik bileşenler birinci bölüm veri setinin (çevre ile ilgili sorumluluklar) %79'unu, ikinci bölümün ise %65'ini açıklamaktadır. Buna göre, birinci set/çift kanonik bileşene göre, öğrencilerin çevre ile ilgili yüksek farkındalığı, yüksek orandaki sorumluluk duygusu ve düşük orandaki iyimserliği, yüksek ekonomik, sosyal ve kültürel özellikleri, anne-babalarının yüksek sorumluluk duyguları ve düşük iyimserlikleri ile ilintilidir. Bir başka deyişle, yüksek ekonomik, sosyal ve kültürel özelliklere sahip ve anne-babasının çevre ile ilgili sorumluluk düzeyi yüksek ama iyimserlik düzeyi düşük olan öğrencilerin çevre ile ilgili farkındalık ve sorumluluklarının güçlü, iyimserliklerinin düşük olma olasılığı yüksektir. İkinci kanonik analiz sonuçlarına göre ise, öğrencilerin çevre ve sürdürülebilir kalkınma ile ilgili güçlü sorumluluk duyguları, anne-babalarının çevre ile ilgili güçlü sorumluluk duyguları ve cinsiyetlerinin kız olmaları ile ilintilidir. Son kanonik analiz sonuçlarına göre ise, öğrencilerin çevre ile ilgili zayıf sorumluluk duyguları, yüksek ekonomik, sosyal ve kültürel düzey ve okuldaki çevre aktivitelerine yüksek katılım ile ilintilidir. Ancak, okul aktiviteleri öğrencilerin çevre ile ilgili sorumluluk duyguları varyansının çok küçük bir bölümünü açıklamaktadır. Sonuç olarak, çalışmanın sonuçları 15 yaşındaki Türk öğrencilerin çevre ile ilgili sorumluluklarının sosyo-demografik değişkenlere bağlı olarak değiştiğini göstermiştir. Bu değişkenler arasında, anne ve babanın çevre ile ilgili konularla ilgili iyimser yaklaşımının, öğrencilerinin sorumlulukları açısından en önemli parametrelerden biri olduğu görülmüştür.