RedNIE
Red Nacional de Investigadores en Economía

How Much are Students Aware of Environmental Issues? Is this Awareness Related to their Socioeconomic Status? A Look from PISA 2006 and 2015

Cecilia Adrogué (CONICET-UDESA-CEDH)

Eugenia Orlicki (CEDH-UDESA)

DOCUMENTO DE TRABAJO N° 202

Diciembre de 2022

Citar como:
Adrogué, Cecilia y Eugenia Orlicki (2022). How Much are Students Aware of Environmental Issues? Is this Awareness Related to their Socioeconomic Status? A Look from PISA 2006 and 2015. *Documento de trabajo RedNIE N°202*.

How much are students aware of environmental issues? Is this awareness related to their socioeconomic status? A look from PISA 2006 and 2015

Cecilia Adrogué
CONICET-UDESA-CEDH
cadrogue@gmail.com
https://orcid.org/0000-0002-3716-7352

Eugenia Orlicki
CEDH-UDESA
eugeniaorlicki@hotmail.com
https://orcid.org/0000-0002-4184-0263

Abstract

Global environmental problems have recently highlighted the importance of acting responsibly towards natural resources and the environment. In this sense, science education which shapes how people interact with the environment, has gained importance. In line with this concern, in 2005, UNESCO launched its Decade of Education for Sustainable Development (DESD) (2005-2014), by which educational institutes around the world would focus on educating individuals for a more sustainable future. The main purpose of this study is to present the results of the changes in environmental literacy of students before and after the implementation of this policy, as well as to analyze which are the main features that affect the probability of being environmentally aware. For this aim, we estimate a probit model with data provided by the Programme for International Student Assessment (PISA) 2006 and 2015. The estimation suggests that in 2015 students are more aware of the increase of greenhouse gases in the atmosphere than in 2006, and that those from more disadvantaged socio-economic classes are less aware of the three types of environmental awareness analyzed; this difference is deeper in the case of upper-middle and lower-middle income countries.

Keywords: Environmental awareness, environmental literacy, Programme for International Student Assessment (PISA), socio-economic variables

JEL Codes: I29, Q59

Introduction

Human consumption, industrial production, agriculture and technology make life more comfortable and safe but may also harm the environment (Polat et al., 2014). Therefore, deficient individual understanding of the fundamental environmental problem is often cited as a cause of environmental deterioration (Schneider, 1997). Currently, we face extremely important environmental problems such as increased air pollution, extinction of plants and animals, clearing forests, water shortages, greenhouse gases and others. These problems affect not only human beings but also all living things. Therefore, we need more environmentally literate individuals (Kaya & Elster, 2018).

Environmental literacy is the development of knowledge, attitudes, and skills necessary to make informed decisions concerning the relationships among natural and urban systems. Environmental awareness is a basic level of environmental literacy and it prepares students to become adults who have more knowledge and understanding of the environment. Hence, environmental awareness is of international concern, as well as being of economic relevance. Attitudes in this area have been the subject of extensive research since the 1970s (see, for example, Bogner & Wiseman, 1999; Eagles & Demare, 1999; Rickinson, 2001; Weaver, 2002). In December 2002, the United Nations approved resolution 57/254 declaring the ten-year period beginning on January 1st 2005 to be the United Nations Decade of Education for Sustainable Development (Mulà & Tilbury, 2009). The International Implementation Scheme (Sector, 2005) identifies the environment as one of the three spheres of sustainability (along with society, including culture, and economy) that should be included in all education programs for sustainable development. Given the importance of environmental issues to the continuation of life on Earth and the survival of humanity, young people today need to understand the basic principles of ecology and the need to organize their lives accordingly. This means that developing environmental awareness and a responsible disposition towards the environment is an important element of contemporary science education.

In parallel with this sustainability movement, a learning assessment movement has evolved. It uses test-based accountability and learning outcomes as a fundamental element of the education policy and decision making process. These large scale educational assessment surveys provide very valuable data for researchers to study relevant issues by applying a cross-country comparative approach which has a number of unique advantages over national studies. Within this movement, the OECD promotes the Programme for International Student Assessment (PISA). PISA is a comprehensive and rigorous international program to assess the 'quality, equity and efficiency' of the school system of different countries and for 'defining and implementing educational goals about the skills that are relevant to adult life' (OECD, 2010). In particular, rather than examining how well they perform a particular curricula specified by the school system, information from this survey focuses on how well students are prepared to meet the challenges of life (Gui et al. 2014).

In 2006 and 2015, PISA focused on students' knowledge of environmental issues and their attitudes towards the environment to understand further this aspect of students' scientific literacy.

The main purpose of this study is to present the results of the changes in environmental awareness of students before and after the implementation of this DESD by analyzing the data of the Programme for International Student Assessment (PISA) 2006 and 2015, as well as to analyze which are the main features that affect the probability of being environmentally aware. We examine the awareness regarding greenhouse gasses in the atmosphere, nuclear waste and the consequences of clearing forest for other land uses.

The structure of the paper is as follows. Section 2 reviews the background literature on educational assessment, environmental awareness and responsibility. Section 3 describes the methods, data and estimation strategy used for the analysis. Results are presented in Section 4 and the paper concludes with a discussion of the main findings and their policy implications.

Literature Review

The present study intends to give a step further in the knowledge regarding how aware students are about environmental issues, and as such, it intends to analyze a subject that lies between two different movements. On the one hand, the sustainability movement and, on the other hand, the learning assessment movement. These two have different agendas and have evolved in different ways during the last decades. While the learning assessment movement champions the use of test-based accountability and learning outcomes as a fundamental element of the education policy and decision making process, the sustainability movement is evident in the adoption of the United Nations Sustainability Development Goals (SDGs) and in the recent wave of students' climate strikes worldwide.

Large-scale assessment surveys on education have gained importance in the last two decades and have incentivated research (Gustafsson, 2008; Kamens, 2009). These large-scale assessments are surveys that intend to collect data on knowledge, skills, or behaviors in a certain way that provide comparable data about many different educational systems around the world (Cordero et al. 2018). This information can be analyzed by researchers to show the differences in achievement between and within countries and to investigate the effects of different educational and social factors on educational achievement, as well as the impact of skills on economic and social outcomes (Hanushek & Woessman, 2011).

Also, such international comparisons are especially useful to evaluate the impact of educational reforms, in particular with respect to some specific institutional feature for which the variation can only be observed across countries (Strietholt et al., 2014). These large scale

educational assessment surveys provide very valuable data for researchers to study important issues by applying a cross-country comparative approach which has a number of unique advantages over national studies. Moreover, it allows exploiting institutional variation that does not exist within countries; revealing whether the result observed is country-specific or more general; test whether effects are always heterogeneous in different settings and avoid selection issues that are very common in within-country identification models among others (Hanushek & Woessmann, 2011). However, it is important to mention that for decades, international comparative studies had cross-sectional designs and the possibilities to use such data for studies that aimed to identify the causal effects of educational policies on educational outcomes were very limited. It is only within the last ten to fifteen years that longitudinal studies have been implemented. New data from multiple cycles of such studies are now available. It seems to be promising that now studies can be performed using such newly available data, which is much more appropriate to use when testing hypotheses about the causal effects of certain educational policies and reforms on students (Strietholt et al., 2014).

Regarding the sustainability movement, which is related to the environmental awareness, a very relevant event was the launching of the United Nations Decade of Education for Sustainable Development (2005 – 2014) (DESD). It aimed to integrate the principles and practices of sustainable development into education and learning, to encourage changes in knowledge, values and attitudes with the vision of enabling a more sustainable society for all.

The environmental concern varies within and between countries. Different studies have found that 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 uses, water shortages and nuclear waste. Besides, they seemed to be less optimistic about the state of environmental problems over the next 20 years. In general, 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 are expected to display high levels of awareness of, and responsibility for environmental problems (Van Liere & Dunlap 1980, Erbas et al. 2012). People from lower classes, tend to live and work in places with poorer physical conditions and environmental threats. When they grow up, they get used to their environments, and hence, when grown-ups, they are less aware of the fact that they live in a polluted and overcrowded condition. In contrast, people from middle and upper classes tend to live and work in nice environments and therefore, tend to be more concerned about its deterioration. Consequently, it would be reasonable to expect that these children may be more aware about environmental problems and become more pessimistic about their future. In other words, it may be “relative” deprivation rather than “absolute” deprivation that leads to environmental concern (Morrison et al. 1972, Van Liere & Dunlap, 1980).

Maslow's hierarchy of needs theory has also explained this relationship between social class and environmental awareness. It was based on the assumption that for those who are deprived of the basic needs –such as adequate food, shelter and economic security- the concern for the quality of the environment is somehow a luxury, which can only be addressed after the others have been fulfilled (Van Liere & Dunlap, 1980).

Palmerg and Kuru (2000) found an interesting way to develop environmental awareness among young students by exposing them to outdoor activities. Even more, they found that these activities also helped to improve social behavior and moral judgment. Barraza and Walford (2002) found that schools with strong orientation in environmental studies seem to communicate environmental information more effectively than schools with no environmental policies. In addition, that the development of effective environmental policies in all schools is needed in order to promote an environmental awareness in the school population.

The overall picture disclosed by this literature presents economic, social and cultural status as the features most responsible for shaping awareness of, and responsibility toward the environment. Regarding environmental responsibility and the achievements and challenges after a decade of progress and action on the education for sustainable development, Bucker & Creech (2014) presents a map at the global, regional, national and local levels, and within areas and levels of education. He found there is an increased recognition at the international policy level that education is essential to the advancement of sustainable development, with many countries committed to continuing to work to advance in this respect at the national and local levels.

Regarding science education, it is worth mentioning that it plays an important role in developing a correct understanding of concepts that underpin environmental issues, leading potentially to pro-environmental behavior. A central challenge of environmental education, therefore, is how to encourage and develop in children a sense of relationship with the environment, which may translate into pro-environmental behavior that follows through into adulthood (Littledyke, 2008). Chu et al. (2007), who investigate Korean children's environmental literacy levels and the variables that affect their environmental literacy, develop an instrument that measures four different dimensions: knowledge, attitude, behavior, and skills, and find that the correlation between attitude and behavior is the strongest while that between knowledge and behavior is the weakest. Therefore, it is not enough to work on knowledge attitude may be pertinent.

Since the term sustainability is a complex one, and can refer either to social aspects, as well as economic aspects, and environmental ones, we would like to clarify that in the present study, we refer to sustainability in the latter sense (Goodland, 1995). We consider it as the challenge of ensuring that next generations are decently fed and housed without damaging the environment on which we all depend. Undoubtedly, it is important to bear in mind that economic and social issues are related to environmental aspects, therefore, the three terms of sustainability are in a certain

way associated. Sustainability requires the reorientation of education, from a narrow preparation for economic life towards an education for wellbeing, which implies a more sustainable world economy, that respects the environment and has a greater ecology conscience.

In this paper we intend to disentangle with our own estimation based on PISA data, whether environmental awareness has increased among students during the last decade and which are the main factors that influence it. We expect our study to contribute to the state of the art of environmental education, in particular, to that related to environmental awareness and sense of responsibility for environmental issues and sustainable development.

Data & Methodology

Data

In this analysis, we use the dataset of the third and sixth edition of the Programme for International Student Assessment (PISA), a survey of 15-year-olds conducted in 65 countries around the world in 2006 and 2015. The sample used for the present research is composed of 370,048 students in 2006 and 366,132 in 2015, and corresponds to those students who reside in the group of countries that participated in both years and responded to the questionnaires regarding environmental issues.

PISA is a comprehensive international programme promoted by OECD to assess the 'quality, equity and efficiency' of the school system of different countries and for 'defining and implementing educational goals about the skills that are relevant to adult life' (OECD, 2010). In particular, rather than examining how well they perform a particular curricula specified by the school system, information from this survey focuses on how well students are prepared to meet the challenges of life (Gui et al. 2014).

Although OECD sponsors PISA, both OECD members and non-OECD countries participate (Bybee & McCrae, 2011). PISA offers opportunities to improve and compare the performance of these nations' educational systems (OECD, 2003). The first PISA survey was launched in 2000. Since that year, PISA surveys are carried out every three years. Every edition has a different major subject area of inquiry selected from the three that are tested every time: reading, mathematics and science. Thus, PISA provides data on the specific knowledge and skills of students, schools, and nations about these forms of literacy (Dobrota et al., 2015). Scientific literacy was the main topic of PISA 2006 and 2015.

PISA 2006 is the first international survey to consider science competency, student interests and attitudes towards science and school contexts jointly in an international context. Thus provides an important opportunity to assess how students' science performance varies between countries

and between school contexts within countries. In the same line, PISA 2015 provides significant information about scientific education policies, programs, and practices in different nations (Bybee & McCrae, 2011). Therefore, while PISA was not designed specifically to assess environmental science and geoscience, the questionnaires included science assessment in general and environmental science in particular.

It is significant to mention that throughout the years, the concept of scientific literacy has evolved (Kaya & Elster, 2018). It was first defined by PISA 2000 as "The ability to employ scientific data, to determine questions, and to obtain evidence-based conclusions for comprehending and helping make decisions regarding the natural world and the alterations made to the natural world by human activities" (OECD, 2000. p. 76; OECD, 2002. p. 102). Therefore, distinguishing features of science literate individuals are to understand scientific concepts, to have the ability to assume a scientific perspective, and to think scientifically about evidence (OECD, 2004). In PISA 2006, science was assessed more comprehensively, including the application of this scientific knowledge as a willingness to play a role in scientific subjects as a reflective citizen with scientific ideas. The main difference was the distinction between knowledge of science and knowledge about science (OECD, 2009). By the year 2015, scientific literacy was defined by PISA directly as the ability to play a role as a reflective citizen with scientific ideas, not simply as the willingness to play a role (OECD, 2016). Ultimately, scientific literacy is constantly evolving, but it is always related to the knowledge regarding how to take care of the planet. The importance and characteristics of science were already in PISA 2000 and have become more specified in PISA 2006 and 2015.

The PISA assessment not only focuses on student performance, it also collects data on student´s family and institutional factors that can help explain variations in awareness and performance, including aspects of environmental science. It uses a two-stage sampling process. First there is a random selection of schools in each country and then a second selection of students in each school. Along with assessing literacy in certain subject areas, PISA 2006 and 2015 collected contextual data through three questionnaires: a student questionnaire, a parent questionnaire and a school questionnaire. The first one, administered to participating students, is a 30-minute questionnaire covering the following aspects: 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 (Erbas et al, 2012). This study, which focuses on the changes in environmental literacy of students before and after the implementation of this DESD by analyzing the data of the PISA 2006 and 2015, therefore, uses students' responses on their environmental awareness in their student questionnaire regarding greenhouse gasses in the atmosphere, nuclear waste and the consequences of clearing forest for other land uses.

Descriptive Statistics

In PISA 2006 and 2015 information was collected on students' awareness of a selection of environmental issues. As OECD (2007) has shown, the average level of awareness varies significantly from issue to issue. Table 1 shows the level of environmental awareness for 2006 and 2015 by country. It presents the percentages for each year, for the three environmental issues analyzed, and also the difference between 2006 and 2015 and its statistical significance.

On average, 54% of students in 2006 and 62% in 2015 reported being aware of the increase of greenhouse gases in the atmosphere, though there are some countries where students reported being less aware of these issues –especially among upper income countries-. Notably in upper-middle income countries the average awareness increased from 39% in 2006 to 52% in 2015; and in lower-middle income countries, where the awareness was very low in 2006 (13%), it almost tripled on average by 2015 (32%).

Nuclear waste is an environmental issue for which very few students reported awareness among countries, with an average of 48% in 2006 and 52% in 2015 of students having reported that they were familiar with it or knew something about it. Again, there are differences across groups of countries by income: 52% in 2006 and 55% in 2015 of students reported being aware of nuclear waste in high-income countries, 41% in 2006 and 48% in 2015 in upper-middle income countries and only between 16% in 2006 and 23% in 2015 of students reported being aware of these consequences in lower-middle income countries.

The majority of students (74% in 2006 and 73% in 2015 on average) reported being aware of the consequences of clearing forest for other land uses. This was the case for near 75% in both years of students from high income countries, 71% in 2006 and 69% in 2015 of students in upper-middle income countries and 55% and 62%, respectively, in lower-middle income countries.

Table 1

Level of environmental awareness for 2006 and 2015 by country and groups of countries.

	Awareness of the increase of greenhouse gases in the atmosphere			Awareness of nuclear waste			Awareness of the consequences of clearing forests\other land use		
	2006	2015	Diff	2006	2015	Diff	2006	2015	Diff
Total	**54%**	**62%**	**8% *****	**48%**	**52%**	**5% ****	**74%**	**73%**	**-1% *****
High Income Group	**61%**	**66%**	**5% *****	**52%**	**55%**	**3% *****	**75%**	**75%**	**-1% *****
Australia	70%	66%	-4% ***	52%	50%	-2% ***	78%	77%	-1% ***
Austria	61%	57%	-3% ***	65%	59%	-5% ***	81%	76%	-4% ***
Belgium	60%	62%	2% ***	48%	54%	6%	74%	74%	0% ***
Canada	70%	75%	4% ***	48%	54%	6% ***	79%	80%	1% ***
Switzerland	52%	60%	8% **	53%	55%	2% ***	74%	69%	-5% ***
Chile	39%	54%	15% ***	35%	53%	18% ***	65%	74%	9% ***
Czech Republic	65%	53%	-12% ***	71%	65%	-7% ***	81%	77%	-4% ***
Germany	60%	66%	6% ***	61%	65%	4% ***	80%	79%	0% ***
Denmark	54%	72%	18% ***	49%	58%	9% ***	71%	78%	6% ***
Spain	70%	73%	3%	48%	56%	8% ***	76%	71%	-6% ***
Estonia	63%	62%	-2% ***	59%	60%	2%	84%	84%	0% ***
Finland	65%	74%	9% ***	63%	66%	3%	74%	72%	-2% ***
France	58%	66%	9% ***	38%	51%	13% ***	66%	68%	3% ***
United Kingdom	71%	77%	7% ***	60%	62%	2% ***	75%	76%	1% ***
Greece	59%	69%	10% ***	58%	53%	-5% ***	51%	59%	8% ***
Hong Kong	81%	75%	-6% ***	48%	53%	5% ***	92%	84%	-7% ***
Croatia	44%	53%	9% ***	65%	58%	-7% ***	77%	74%	-4% ***
Hungary	65%	64%	0% ***	52%	43%	-9% ***	78%	72%	-7% ***
Ireland	76%	79%	3% ***	64%	60%	-4% ***	82%	84%	1%
Iceland	36%	57%	21% ***	45%	50%	5%	73%	70%	-3% ***
Israel	31%	47%	17% ***	38%	35%	-3% ***	61%	64%	3% ***
Italy	68%	72%	3%	50%	51%	1% ***	75%	74%	-2% ***
Japan	54%	59%	5% ***	33%	36%	3% ***	68%	59%	-9% ***
Korea	52%	72%	20% ***	42%	43%	1%	42%	52%	9% ***
Kosovo	46%	62%	16%	49%	57%	8%	79%	80%	1%
Luxembourg	48%	55%	7% **	51%	56%	5%	70%	70%	0% ***
Latvia	44%	47%	4% ***	60%	64%	4% ***	86%	86%	-1% ***
Macao	66%	74%	7% ***	33%	45%	12% ***	87%	84%	-3% ***
Netherlands	71%	69%	-2% ***	54%	60%	5% ***	81%	78%	-4% ***
Norway	58%	72%	14% ***	57%	53%	-5% ***	77%	81%	4%
New Zealand	54%	60%	6%	40%	39%	-1% ***	71%	69%	-2% ***
Poland	56%	57%	1%	61%	60%	-1% **	87%	86%	-1% *
Portugal	68%	84%	16% ***	48%	66%	18% ***	77%	83%	6% ***
Qatar	21%	61%	40% ***	37%	49%	12% ***	55%	69%	14% ***
Russian Federation	55%	57%	2% ***	64%	71%	6%	87%	88%	1% ***
Slovak Republic	63%	54%	-9% ***	62%	57%	-6% ***	71%	66%	-5% ***
Slovenia	54%	63%	9% ***	64%	54%	-10% ***	77%	77%	0% **
Sweden	66%	81%	15% ***	55%	61%	6%	47%	51%	4%
Chinese Taipei	82%	77%	-5% ***	60%	69%	10% ***	92%	89%	-3% ***
United States	53%	54%	1%	51%	53%	2%	74%	73%	0% ***
Uruguay	42%	42%	0% ***	37%	42%	5% ***	69%	62%	-7% ***
Upper-middle-income group	**39%**	**52%**	**14% *****	**41%**	**48%**	**8% *****	**71%**	**69%**	**-3% *****
Argentina	29%	43%	14% ***	30%	35%	4% ***	68%	76%	8% ***
Bulgaria	55%	63%	8%	53%	58%	4% ***	76%	80%	4% ***
Brazil	49%	54%	5% ***	37%	49%	12% ***	66%	68%	2% ***
Colombia	41%	44%	4% *	33%	36%	3% ***	62%	60%	-1% ***
Jordan	41%	56%	14% ***	51%	52%	1% *	70%	68%	-2% ***
Mexico	29%	52%	23% ***	35%	50%	15% ***	75%	76%	1% ***
Montenegro	51%	56%	5% **	51%	53%	2% ***	73%	70%	-3% ***
Romania	35%	32%	-3% ***	44%	48%	4% ***	58%	67%	9% ***
Thailand	59%	73%	14% ***	29%	34%	5% ***	69%	65%	-4% ***
Turkey	33%	53%	20% ***	75%	69%	-6% ***	85%	74%	-11% ***
Lower-middle-income group	**13%**	**32%**	**19% *****	**16%**	**23%**	**7% *****	**55%**	**62%**	**7% *****
Tunisia	19%	37%	18% ***	31%	35%	4% ***	63%	65%	1% ***
Indonesia	10%	29%	19% ***	9%	15%	5% ***	52%	60%	8% ***

Source: Own estimation based on information provided by PISA.

As table 2, 3 and 4 show, in all countries students from more advantaged socio-economic backgrounds reported higher levels of awareness of environmental issues. In accordance with OECD (2007), both PISA results strongly suggest that students from more disadvantaged socio-economic backgrounds are less aware of environmental issues such as acid rain and nuclear waste.

Table 2

Level of environmental awareness of the increase of greenhouse gases in the atmosphere for 2006 and 2015 by socioeconomic level: Low, Middle and High, by groups of countries.

	Awareness of the increase of greenhouse gases in the atmosphere					
	2006			2015		
	Low	Middle	High	Low	Middle	High
Total	**49%**	**54%**	**58%**	**56%**	**62%**	**67%**
High Income Group	**56%**	**61%**	**64%**	**60%**	**66%**	**69%**
Upper-middle-income group	**33%**	**37%**	**48%**	**45%**	**53%**	**63%**
Lower-middle-income group	**10%**	**12%**	**18%**	**24%**	**30%**	**46%**

Source: Own estimation based on information provided by PISA.

Table 3

Level of environmental awareness of nuclear waste for 2006 and 2015 by socioeconomic level: Low, Middle and High, by groups of countries.

	Awareness of nuclear waste					
	2006			2015		
	Low	Middle	High	Low	Middle	High
Total	**43%**	**48%**	**52%**	**48%**	**52%**	**57%**
High Income Group	**47%**	**52%**	**55%**	**51%**	**55%**	**59%**
Upper-middle-income group	**36%**	**39%**	**47%**	**42%**	**47%**	**54%**
Lower-middle-income group	**12%**	**15%**	**22%**	**19%**	**22%**	**28%**

Source: Own estimation based on information provided by PISA.

Table 4

Level of environmental awareness of the consequences of clearing forests for other land use; for 2006 and 2015 by socioeconomic level: Low, Middle and High, by groups of countries.

	Awareness of the consequences of clearing forests\other land use					
	2006			2015		
	Low	Middle	High	Low	Middle	High
Total	**69%**	**73%**	**76%**	**68%**	**74%**	**77%**
High Income Group	**71%**	**75%**	**77%**	**70%**	**75%**	**77%**
Upper-middle-income group	**66%**	**70%**	**78%**	**61%**	**69%**	**76%**
Lower-middle-income group	**48%**	**54%**	**64%**	**50%**	**62%**	**73%**

Source: Own estimation based on information provided by PISA.

Methodology

In order to study the relevance of the policy implemented and that of other factors associated with the probability of being environmentally aware, we used a probit regression model. To this end, we estimated the parameters of the following model:

$$Prob\ (EA = 1)\ = F(X\beta) \qquad (1)$$

Where the dependent variable is the probability that student *i* is aware of environmental issue j in year *t*. This is a dichotomous variable, which has a value equal to one if students *i* is aware of an environmental issue j in year t, and zero otherwise.

X represents those observable variables corresponding to the characteristics of the student that affect the probability of having environmental awareness as well as a dummy variable for the year 2015 to reflect the period after the policy and β the vector of coefficients.

The characteristics of the students and schools analyzed are:

- Social class: Following Groisman's (2016) classification, we refer to those who belong to the first quintile of per capita income as the lower class; to those in the second, third and fourth quintile of per capita income as the middle class; and to those who belong to the fifth quintile of per capita income as the upper class.

- Gender: Dummy that takes the value 1 if the student is a boy and 0 otherwise

- Parental education: Highest parental education in years of schooling

· Number of books in the household: in recent years, the number of books in the household was added to socio, economic and cultural indexes (OECD, 2004; Taylor & Yu, 2009; Zhao et al., 2012).

· Dummy to identify the student´s country of residence.

. Dummy to identify if the school has a science club.

. Dummy to identify if the school has a science competition.

Results

Table 5 presents the results obtained for the estimated model that examines the importance of the different factors related to the probability of the students being environmentally aware.

After controlling for all other factors, the dummy for the year 2015 has different results. Firstly, the probability of being aware of the increase of greenhouse gases in the atmosphere is near 4 per cent higher in 2015 than in 2006. Secondly, there is only 0.6% difference in the awareness of nuclear waste between 2006 and 2015. Finally, the probability of being aware of the consequences of clearing forests for other land use is near 5 per cent lower in 2015 respect to 2006.

The marginal effect of the social class is positive and significant for both, the middle class and the upper class with respect to the lower class, except for the middle class in the case of the awareness of nuclear waste. Which means that on average, students from middle and upper classes have a higher probability of being aware of environmental issues than students who belong to the lower class. The marginal effects for the gender dummy variable indicate that male respondents are more likely to be aware of the increase of greenhouse gases in the atmosphere and nuclear waste.

All other things equal, there is a higher probability of being aware of the three environmental issues when the parents' schooling years increase. In the same line, as the number of books at home increases, the probability of being aware of the three environmental issues analyzed increases. The probability of being environmentally aware of the increase of greenhouse gases in the atmosphere for a student who has more than 200 books is near 26% higher compared to that of the students who have less than 10 books. In the case of the awareness of nuclear waste it is near 18% higher and in the case of the awareness of the consequences of clearing forests for other land use, near 20% higher.

In addition, the results in Table 3 show that students that assist schools with science club or science competitions have a substantially higher probability of being environmentally aware. The

probability of a student that assists a school with a science club is nearly 1.2% and 1.3% higher of being environmentally aware of the increase of greenhouse gases in the atmosphere and of the consequences of clearing forests for other land use respectively, compared to students with no science club at school. In the case that the school has science competitions, the probabilities are 2.1% higher of being environmental aware of the increase of greenhouse gases in the atmosphere and of the consequences of clearing forests for other land use and 1% higher of being environmental aware of nuclear waste

In the annex, we present three graphics for the country dummies which capture the higher or lower probability of being environmentally aware in that country with respect to the United States. The awareness of the increase of greenhouse gases in the atmosphere presents higher dispersion than the other two issues analyzed.

Table 5

Probit Estimates of the Probability of Students of Being Environmental Aware

	Awareness of the increase of greenhouse gases in the atmosphere		**Awareness of nuclear waste**		**Awareness of the consequences of clearing forests\other land use**	
	Probit Coefficients	**Marginal Effects**	**Probit Coefficients**	**Marginal Effects**	**Probit Coefficients**	**Marginal Effects**
Year 2015	0.102	0.043	0.012	0.006	-0.142	-0.048
	(0.004) ***	(0.001) ***	(0.004) ***	(0.001) ***	(0.004) ***	(0.001) ***
Middle Class	0.040	0.016	0.004	0.002	0.046	0.015
	(0.005) ***	(0.002) ***	(0.005)	(0.002)	(0.005) ***	(0.002) ***
High Class	0.034	0.014	0.019	0.009	0.042	0.014
	(0.005) ***	(0.002) ***	(0.005) ***	(0.002) ***	(0.005) ***	(0.002) ***
Men	0.154	0.061	0.240	0.096	0.002	0.001
	(0.003) ***	(0.001) ***	(0.003) ***	(0.001) ***	(0.003)	(0.001)
Parental education	0.036	0.014	0.022	0.009	0.029	0.010
	(0.001) ***	(0.000) ***	(0.001) ***	(0.000) ***	(0.001) ***	(0.000) ***
Books in home: 11-25 books in home	0.207	0.079	0.149	0.059	0.214	0.069
	(0.005) ***	(0.002) ***	(0.005) ***	(0.002) ***	(0.005) ***	(0.002) ***
26-100 books	0.417	0.159	0.262	0.105	0.413	0.132
	(0.005) ***	(0.002) ***	(0.005) ***	(0.002) ***	(0.005) ***	(0.002) ***
Books in home: 101-200 books	0.584	0.216	0.357	0.143	0.544	0.161
	(0.006) ***	(0.002) ***	(0.006) ***	(0.002) ***	(0.006) ***	(0.002) ***
Books in home: 201-500 books	0.768	0.271	0.457	0.179	0.687	0.192
	(0.007) ***	(0.002) ***	(0.007) ***	(0.002) ***	(0.007) ***	(0.002) ***
Books in home:More than 500 books	0.753	0.261	0.515	0.201	0.639	0.176
	(0.008) ***	(0.002) ***	(0.008) ***	(0.003) ***	(0.008) ***	(0.002) ***
Science Club	0.044	0.012	0.014	0.004	0.039	0.013
	(0.004) ***	(0.001) ***	(0.003) ***	(0.001) ***	(0.004) ***	(0.001) ***
Science Competitition	0.053	0.021	0.035	0.010	0.060	0.021
	(0.004) ***	(0.001) ***	(0.004) ***	(0.001) ***	(0.004) ***	(0.001) ***
Number of observations	649365		649365		649365	
Control by country	yes		yes		yes	

Source: Own estimation based on information provided by PISA 2006 and 2015. Standard Errors in parenthesis, * p<0.05; ** p<0.01; *** p<0.001.

Conclusions and Discussion

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. In line with this concern, in 2005, UNESCO launched its Decade of Education for Sustainable Development (DESD) (2005-2014), by which educational institutes around the world would focus on educating individuals for a more sustainable future.

This study is one of the pioneers in using data of the PISA 2006 and 2015 to analyze the changes in environmental literacy of students before and after the implementation of this DESD. The average change of awareness varies significantly from issue to issue. On average, the awareness of the increase of greenhouse gases in the atmosphere increased from 54% in 2006 to 62% in 2015 and the awareness of nuclear waste increased from 48% in 2006 to 52% in 2015. On the other hand, the awareness of the consequences of clearing forest for other land uses almost maintained the same level (74% in 2006 and 73% in 2015 on average). In addition, our results show that the environmental awareness increased more in upper-middle and lower-middle income countries than in high-income countries

To study deeply the relationship between environmental awareness and factors associated with them, we specified a probit regression model and used it to estimate the marginal effects of the different factors related to the probability of the student being environmentally aware. Firstly, after controlling for various factors and country fixed effects, it is observed that time passed between 2006 and 2015 and the implementation of the DESD increased 4% the probability of the students being aware of the increase of greenhouse gases in the atmosphere. By contrast, the probability of the students being aware of the consequences of clearing forests for other land use decreased in 2015 respect to 2006 and no significant changes were observed in the awareness of nuclear waste. Hence, between 2006 and 2015 the evolution of the students` environmental awareness depended on the type of environmental awareness analyzed.

Secondly, students from middle and high classes have a higher probability of being aware of the three environmental issues than students who belong to the lower class. Our results are in line with the literature that suggests that students from more disadvantaged socio-economic classes are less aware of environmental issues. In addition, we also found that there is a higher probability of being aware of the three environmental issues for men, when the parents` schooling years and the number of books at home increase. As regards schools` proposals, students that assist to schools with either science club or science competitions have a substantially higher probability of being environmentally aware. Finally, the environmental awareness is clearly related to the country of

residence, our results show that countries with similar economic development and level of education may present very different environmental awareness.

.

Environmental awareness is a basic level of environmental literacy and prepares students to become adults who have more knowledge and understanding of the environment. Our results encourage further research on several topics, among which we can mention the importance of comparing the different educational systems and their transformation in the last years regarding the sustainability aspects and the role of the household in environmental literacy.

References

Barraza, L., & Walford, R. A. (2002). Environmental education: A comparison between English and Mexican school children. *Environmental Education Research*, *8*(2), 171-186.

Bogner, F. X., & Wiseman, M. (1999). Toward measuring adolescent environmental perception. *European Psychologist*, 4(3), 139.

Buckler, C., & Creech, H. (2014). *Shaping the future we want: UN Decade of Education for Sustainable Development; final report*. Unesco.

Bybee, R., & McCrae, B. (2011). Scientific literacy and student attitudes: Perspectives from PISA 2006 science. *International Journal of Science Education*, *33*(1), 7-26.

Chu, H. E., Lee, E. A., Ko, H. R., Shin, D. H., Lee, M. N., Min, B. M., et al. (2007). Korean year 3 children's environmental literacy: A prerequisite for a Korean environmental education curriculum. *International Journal of Science Education,* 29, 731–746.

Cordero, J. M., Cristobal, V., & Santín, D. (2018). Causal inference on education policies: a survey of empirical studies using PISA, TIMSS and PIRLS. *Journal of Economic Surveys*, *32*(3), 878-915.

Dobrota, M., Jeremić, V., Bulajić, M., & Radojičić, Z. (2015). Uncertainty and sensitivity analyses of PISA efficiency: Distance based analysis approach. *Acta Polytechnica Hungarica,* 12(3), 41-58.

Eagles, P. F., & Demare, R. (1999). Factors influencing children's environmental attitudes. *The Journal of Environmental Education*, 30(4), 33-37.

Erbas, A. K., Tuncer Teksoz, G., & Tekkaya, C. (2012). An evaluation of environmental responsibility and its associated factors: Reflections from PISA 2006. *Egitim Arastirmaları-Eurasian Journal of Educational Research*, 46, 41-62

Goodland, R. (1995). The concept of environmental sustainability. *Annual review of ecology and systematics*, *26*(1), 1-24.

Groisman, F. (2016). Estructura Social e Informalidad Laboral en Argentina. EUDEBA.

Gui, M., Micheli, M., & Fiore, B. (2014). Is the Internet creating a 'learning gap' among students? Evidence from the Italian PISA data. *Italian Journal of Sociology of Education*, *6*(1), 1-24. Retrieved from http://www.ijse.eu/wp-content/uploads/2014/02/2014_1_1.pdf

Gustafsson, J. E. (2008). Effects of international comparative studies on educational quality on the quality of educational research. European Educational Research Journal, 7(1), 1-17.

Hanushek, E. A., & Woessman, L. (2011). The economics of international differences in educational achievement. In Hanushek, E.A., Machin, S., Woessmann, L. (Eds.), Handbook of the economics of education (vol. 3), North Holland, Amsterdam, pp. 89– 200.

Kamens, D.H. (2009). Globalization and the growth of international educational testing and national assessment, Comparative Education Review, 54(1), 5-25.

Kaya, V. H., & Elster, D. (2018). German Students' Environmental Literacy in Science Education Based on PISA Data. *Science Education International*, *29*(2), 75-87.

Littledyke, M. (2008). Science education for environmental awareness: approaches to integrating cognitive and affective domains. *Environmental Education Research*, *14*(1), 1-17.

Morrison, D. E., Hornback, K. E., & Warner, W. K. (1972). The environmental movement: Some preliminary observations and predictions. *Social behavior, natural resources and the environment*, 259-279.

Mulà, I., & Tilbury, D. (2009). A United Nations Decade of Education for Sustainable Development (2005–14) What Difference Will It Make? *Journal of Education for Sustainable Development*, 3(1), 87-97.

OECD (2000). *Measuring Student Knowledge and Skills, The PISA 2000 Assessment of Reading, Mathematical and Scientific Literacy.* Paris: OECD Publications.

OECD (2002). *Sample Task form the PISA 2000 Assessment of Reading, Mathematical and Scientific Literacy.* Paris: OECD Publications.

OECD (2003). *Literacy Skills for the World of Tomorrow Further Results from PISA 2000.* Paris: OECD Publications.

OECD (2004). *Learning for Tomorrow's World First Results from PISA 2003.* Paris: OECD Publications.

OECD (2007). *PISA 2006: Science Competencies for Tomorrow's World, Volume 1: Analysis*. Organisation for economic co-operation and development.

OECD (2009). *Take the Test Sample Questions from OECD's PISA Assessments.* Paris: OECD Publications.

OECD (2010). *Education at a Glance 2010: OECD Indicators*. OECD Publishing: Paris.

OECD (2016). *PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic and Financial Literacy.* Paris: OECD Publishing.

Palmerg, I. E., & Kuru, J. (2000). Outdoor activities as a basis for environmental responsibility. *Journal of Environmental Education*, *31*, 32–36.

Polat, D., Kaya, V.H., & Karamuftuoglu, O. (2014). Perceptions of Undergraduate and Master Students Towards Conservation of Nature. Adana, Turkey: Paper presented at the 11th National Science and Mathematics Education Congress.

Rickinson, M. (2001). Estudiantes y aprendizaje en educación ambiental: una revisión crítica de la evidencia. *Investigación en educación ambiental*, 7 (3), 207-320.

Schneider, S.H. (1997). Defining and teaching environmental literacy. *Trends in Ecology and Evolution* (TREE), 12(11), 457.

Sector, U. E. (2005). United Nations Decade of Education for Sustainable Development (2005-2014): International Implementation Scheme. *UN Educ Sci Cult Organ UNESCO Paris Fr*.

Strietholt, R., Gustafsson, J. E., Rosén, M., & Bos, W. (2014). Outcomes and causal inference in international comparative assessments. *Educational policy evaluation through international comparative assessments*, 10-18.

Taylor, S., & Yu, D. (2009). The Importance of Socio-economic Status in Determining Educational Achievement in South Africa. Available from: https://www.ideas.repec.org/p/sza/wpaper/wpapers73.html.

Van Liere, K. D., & Dunlap, R. E. (1980). The social bases of environmental concern: A review of hypotheses, explanations, and empirical evidence. *Public Opinion Quarterly, 44*, 181–197.

Weaver, AA (2002). Determinantes de las actitudes ambientales: una comparación de cinco países. *Revista internacional de sociología*, 32 (1), 77-108.

Zhao, N., Valcke, M., Desoete, A., & Verhaeghe, J. (2012). The quadratic relationship between socioeconomic status and learning performance in China by multilevel analysis: Implications for policies to foster education equity. *International Journal of Educational Development*, 32, 412-422.

Annex A

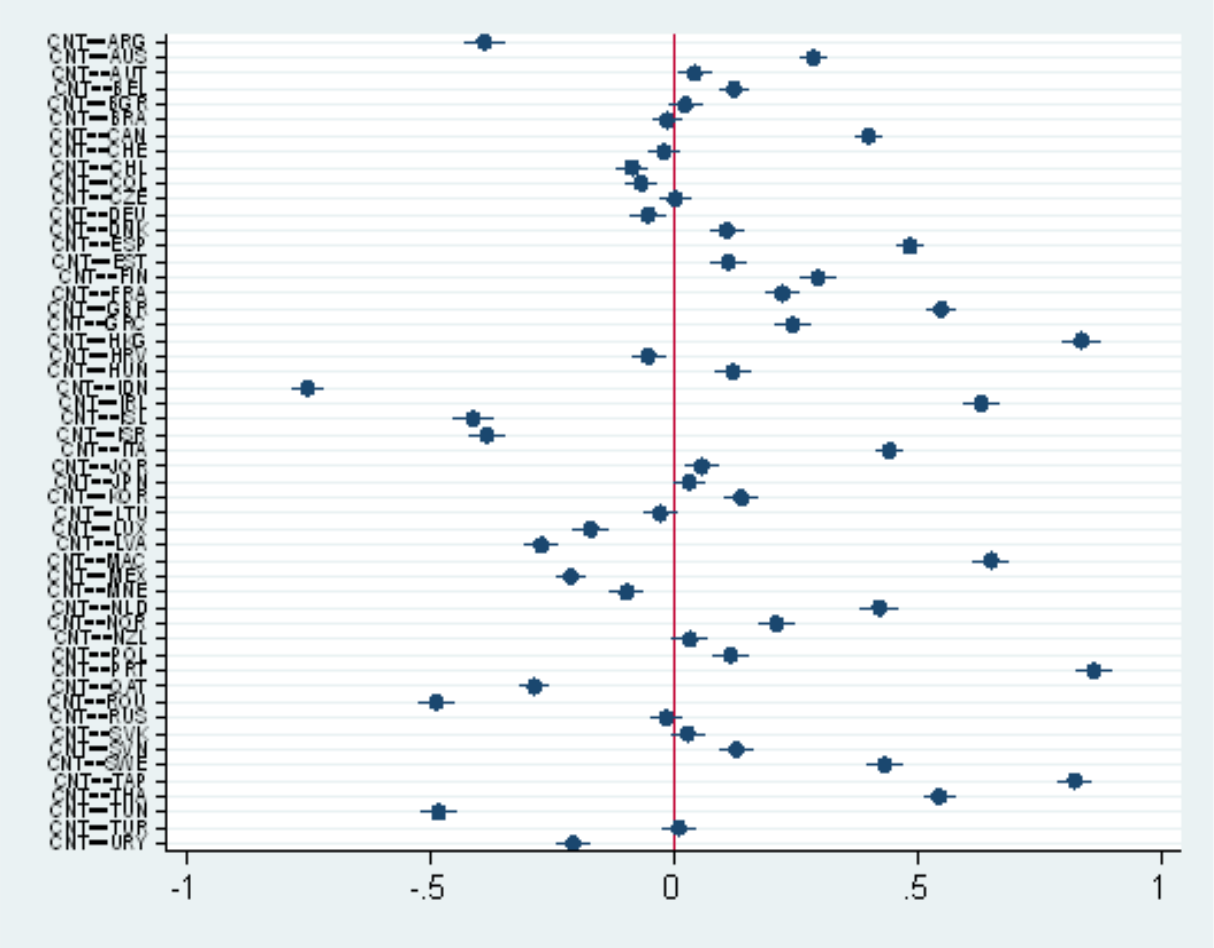
Table A1. Level of environmental awareness for 2006 and 2015 by socioeconomic level: Low, Middle and High, by country and groups of countries.

	Awareness of the increase of greenhouse					
	2006			2015		
	Low	Middle	High	Low	Middle	High
Total	**49%**	**54%**	**58%**	**56%**	**62%**	**67%**
High Income Group	**56%**	**61%**	**64%**	**60%**	**66%**	**69%**
Australia	66%	70%	70%	59%	67%	71%
Austria	55%	61%	66%	52%	58%	61%
Belgium	49%	60%	64%	56%	63%	68%
Canada	66%	70%	72%	69%	75%	78%
Switzerland	48%	52%	54%	54%	61%	63%
Chile	28%	38%	53%	44%	54%	63%
Czech Republic	57%	65%	70%	46%	53%	59%
Germany	52%	59%	62%	57%	67%	73%
Denmark	48%	53%	56%	65%	73%	75%
Spain	67%	71%	71%	65%	74%	78%
Estonia	61%	62%	67%	59%	62%	65%
Finland	62%	66%	66%	70%	76%	74%
France	49%	59%	63%	61%	67%	68%
United Kingdom	63%	71%	75%	74%	77%	82%
Greece	57%	59%	58%	65%	71%	70%
Hong Kong	77%	82%	85%	71%	75%	77%
Croatia	38%	45%	49%	46%	53%	59%
Hungary	58%	66%	71%	59%	65%	68%
Ireland	69%	76%	79%	75%	80%	79%
Iceland	36%	36%	33%	59%	57%	55%
Israel	25%	30%	32%	43%	49%	54%
Italy	64%	69%	72%	67%	72%	76%
Japan	50%	55%	54%	55%	59%	62%
Korea	44%	53%	64%	65%	73%	77%
Luxembourg	39%	49%	55%	47%	55%	63%
Latvia	40%	44%	51%	43%	48%	51%
Macao	62%	67%	70%	69%	74%	77%
Netherlands	65%	70%	76%	65%	70%	71%
Norway	56%	58%	56%	69%	74%	72%
New Zealand	48%	55%	59%	50%	61%	66%
Poland	51%	55%	67%	48%	58%	65%
Portugal	54%	69%	79%	75%	85%	89%
Qatar	17%	21%	24%	64%	63%	53%
Russian Federation	50%	55%	62%	49%	58%	66%
Slovak Republic	56%	64%	68%	43%	57%	59%
Slovenia	47%	53%	52%	59%	64%	64%
Sweden	64%	66%	67%	78%	83%	81%
Chinese Taipei	80%	83%	83%	70%	78%	83%
United States	43%	54%	62%	33%	41%	53%
Uruguay	36%	41%	51%	44%	54%	63%
Upper-middle-income group	**33%**	**37%**	**48%**	**45%**	**53%**	**63%**
Argentina	22%	28%	37%	26%	43%	59%
Bulgaria	45%	56%	59%	52%	65%	66%
Brazil	36%	45%	69%	41%	53%	69%
Colombia	36%	39%	51%	39%	43%	55%
Jordan	35%	41%	45%	44%	57%	64%
Mexico	26%	28%	38%	48%	51%	60%
Montenegro	48%	52%	48%	53%	56%	61%
Romania	28%	35%	45%	25%	31%	40%
Thailand	52%	56%	75%	64%	72%	83%
Turkey	29%	33%	38%	49%	53%	60%
Lower-middle-income group	**10%**	**12%**	**18%**	**24%**	**30%**	**46%**
Tunisia	16%	19%	23%	19%	26%	46%
Indonesia	7%	9%	15%	32%	36%	46%

	Awareness of nuclear waste					
	2006			2015		
	Low	Middle	High	Low	Middle	High
Total	**43%**	**48%**	**52%**	**48%**	**52%**	**57%**
High Income Group	**47%**	**52%**	**55%**	**51%**	**55%**	**59%**
Australia	49%	52%	55%	46%	50%	54%
Austria	58%	65%	69%	53%	61%	61%
Belgium	40%	47%	54%	48%	53%	60%
Canada	44%	47%	52%	51%	53%	59%
Switzerland	49%	54%	56%	51%	55%	59%
Chile	28%	35%	41%	47%	54%	56%
Czech Republic	64%	71%	74%	60%	65%	69%
Germany	52%	60%	67%	60%	65%	71%
Denmark	42%	49%	54%	52%	58%	61%
Spain	44%	48%	51%	51%	57%	58%
Estonia	57%	58%	60%	57%	60%	65%
Finland	61%	63%	66%	63%	66%	68%
France	34%	39%	40%	47%	51%	54%
United Kingdom	56%	59%	64%	59%	61%	65%
Greece	53%	58%	62%	48%	53%	60%
Hong Kong	46%	48%	52%	50%	52%	57%
Croatia	60%	66%	68%	50%	59%	64%
Hungary	47%	53%	53%	38%	42%	49%
Ireland	60%	63%	69%	59%	59%	61%
Iceland	42%	45%	48%	48%	49%	54%
Israel	32%	37%	40%	31%	34%	43%
Italy	45%	50%	57%	48%	50%	57%
Japan	30%	34%	33%	34%	35%	42%
Korea	38%	42%	51%	37%	42%	51%
Luxembourg	41%	52%	58%	52%	56%	61%
Latvia	55%	61%	61%	59%	64%	67%
Macao	28%	33%	42%	37%	44%	53%
Netherlands	49%	53%	57%	57%	60%	62%
Norway	53%	57%	58%	51%	52%	57%
New Zealand	36%	41%	43%	37%	38%	44%
Poland	56%	60%	70%	53%	61%	65%
Portugal	39%	47%	58%	62%	65%	71%
Qatar	35%	35%	38%	51%	49%	45%
Russian Federation	59%	65%	68%	63%	72%	74%
Slovak Republic	54%	62%	68%	47%	58%	62%
Slovenia	57%	62%	65%	49%	54%	59%
Sweden	52%	54%	58%	57%	61%	62%
Chinese Taipei	57%	61%	60%	64%	69%	75%
United States	46%	51%	56%	35%	42%	46%
Uruguay	31%	36%	42%	49%	53%	55%
Upper-middle-income group	**36%**	**39%**	**47%**	**42%**	**47%**	**54%**
Argentina	22%	30%	37%	24%	35%	42%
Bulgaria	46%	53%	57%	51%	58%	63%
Brazil	28%	34%	47%	39%	48%	60%
Colombia	28%	32%	37%	33%	35%	43%
Jordan	44%	50%	56%	44%	52%	59%
Mexico	30%	34%	44%	45%	48%	57%
Montenegro	47%	50%	50%	51%	52%	58%
Romania	39%	43%	51%	42%	49%	54%
Thailand	28%	29%	30%	33%	34%	36%
Turkey	70%	75%	79%	61%	69%	73%
Lower-middle-income group	**12%**	**15%**	**22%**	**19%**	**22%**	**28%**
Tunisia	22%	30%	40%	13%	14%	19%
Indonesia	8%	9%	13%	28%	34%	42%

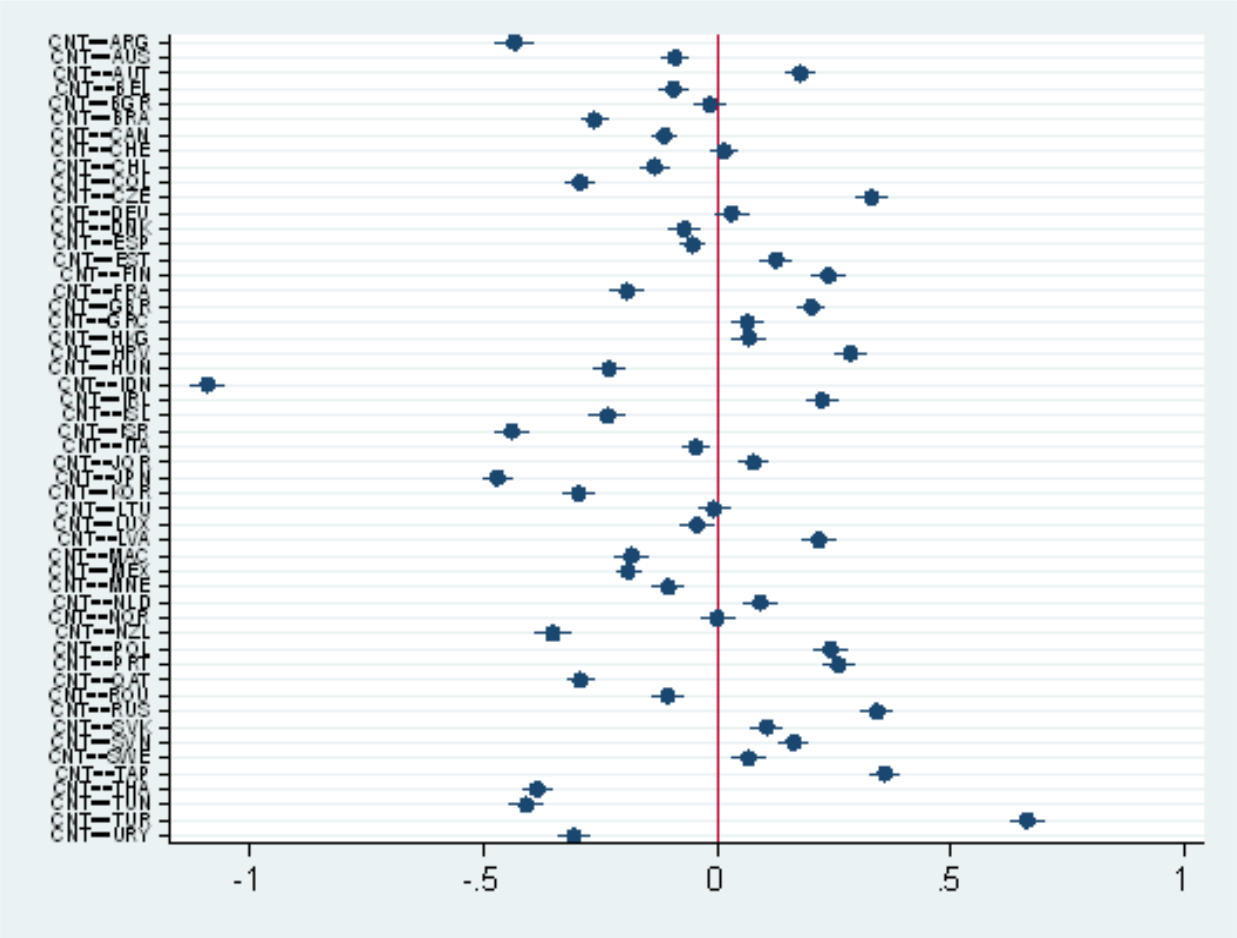
	Awareness of the consequences of clearing					
	2006			2015		
	Low	Middle	High	Low	Middle	High
Total	**69%**	**73%**	**76%**	**68%**	**74%**	**77%**
High Income Group	**71%**	**75%**	**77%**	**70%**	**75%**	**77%**
Australia	73%	79%	78%	71%	78%	80%
Austria	75%	81%	83%	71%	78%	77%
Belgium	64%	74%	77%	68%	75%	79%
Canada	75%	79%	80%	74%	81%	82%
Switzerland	71%	74%	74%	64%	70%	71%
Chile	56%	65%	75%	66%	74%	81%
Czech Republic	74%	81%	82%	73%	77%	81%
Germany	71%	78%	81%	73%	80%	84%
Denmark	65%	71%	75%	72%	78%	81%
Spain	73%	76%	78%	66%	72%	72%
Estonia	82%	84%	86%	81%	84%	87%
Finland	74%	74%	73%	71%	73%	72%
France	59%	66%	70%	63%	69%	73%
United Kingdom	70%	75%	78%	75%	76%	78%
Greece	48%	52%	50%	56%	59%	64%
Hong Kong	90%	92%	92%	82%	84%	86%
Croatia	72%	79%	78%	68%	75%	77%
Hungary	75%	79%	81%	66%	72%	77%
Ireland	78%	82%	83%	81%	85%	84%
Iceland	70%	74%	72%	70%	70%	70%
Israel	50%	59%	65%	60%	66%	69%
Italy	71%	76%	79%	71%	74%	77%
Japan	64%	69%	70%	55%	59%	65%
Korea	37%	43%	51%	44%	52%	59%
Luxembourg	59%	72%	72%	64%	71%	76%
Latvia	86%	87%	85%	84%	87%	84%
Macao	87%	87%	85%	83%	85%	84%
Netherlands	76%	79%	82%	74%	78%	78%
Norway	75%	77%	75%	79%	83%	80%
New Zealand	65%	72%	74%	65%	69%	71%
Poland	84%	86%	90%	82%	87%	87%
Portugal	67%	79%	85%	77%	84%	89%
Qatar	54%	55%	50%	72%	71%	59%
Russian Federation	85%	87%	88%	86%	90%	86%
Slovak Republic	65%	71%	75%	56%	68%	68%
Slovenia	70%	75%	73%	72%	78%	78%
Sweden	46%	46%	53%	49%	50%	55%
Chinese Taipei	90%	92%	91%	84%	89%	91%
United States	63%	75%	80%	54%	62%	69%
Uruguay	60%	69%	72%	65%	74%	80%
Upper-middle-income group	**66%**	**70%**	**78%**	**61%**	**69%**	**76%**
Argentina	53%	67%	80%	58%	79%	83%
Bulgaria	65%	76%	79%	69%	82%	82%
Brazil	55%	63%	78%	56%	67%	78%
Colombia	53%	60%	72%	53%	59%	73%
Jordan	62%	70%	75%	57%	69%	77%
Mexico	71%	74%	81%	70%	76%	82%
Montenegro	73%	73%	67%	69%	71%	70%
Romania	51%	59%	63%	57%	68%	74%
Thailand	66%	68%	75%	61%	64%	71%
Turkey	81%	85%	89%	67%	75%	79%
Lower-middle-income group	**48%**	**54%**	**64%**	**50%**	**62%**	**73%**
Tunisia	54%	64%	67%	45%	60%	75%
Indonesia	46%	50%	62%	59%	64%	70%

Graph A.1: Marginal effects of country dummies the probability of students of being environmental aware regarding the increase of greenhouse gases in the atmosphere



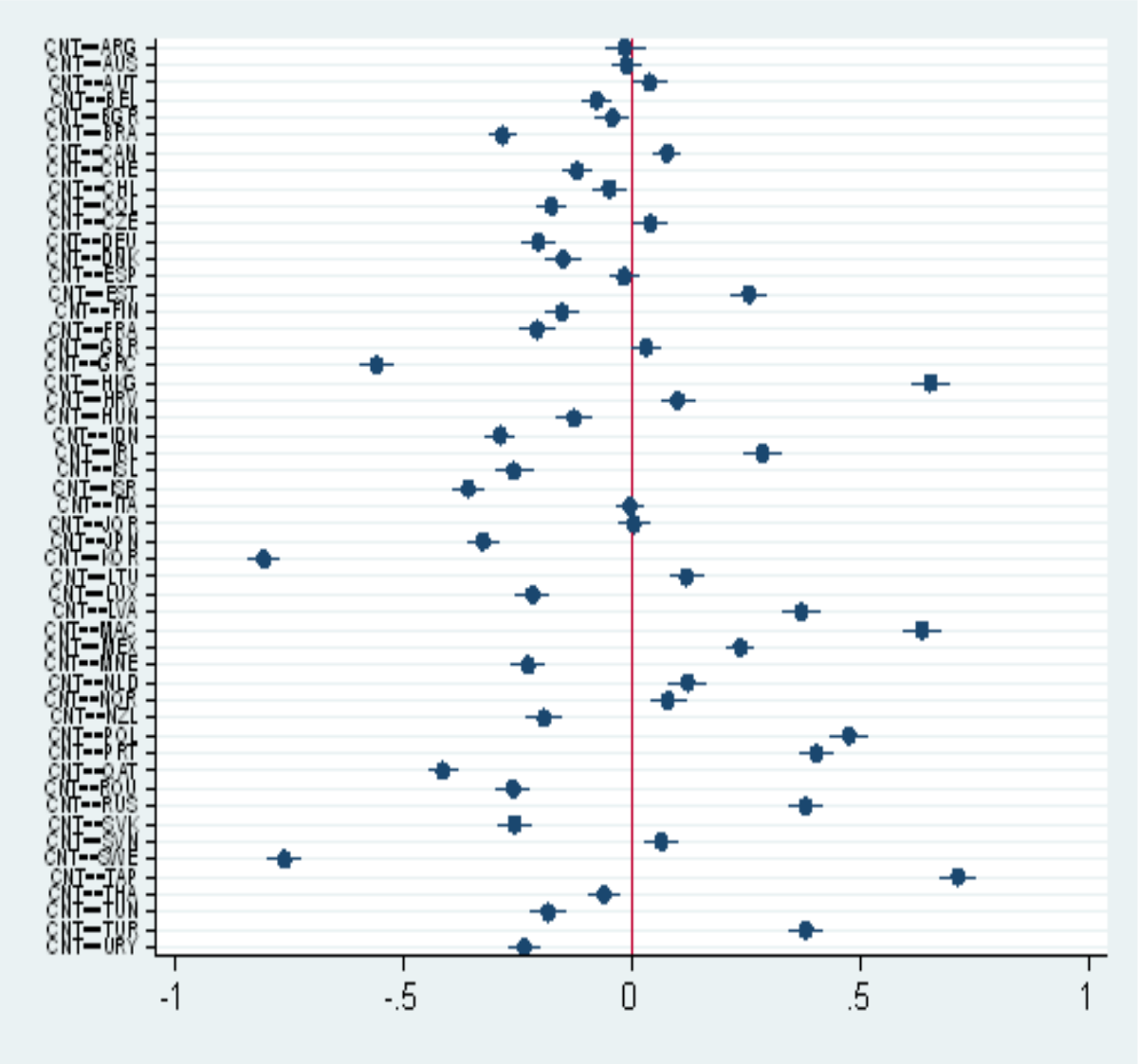
Source: Own estimation based on information provided by PISA.

Graph A.2: Marginal effects of country dummies of the probability of students of being environmental aware regarding nuclear waste



Source: Own estimation based on information provided by PISA.

Graph A.3: Marginal effects of country dummies of the probability of students of being environmental aware regarding clearing forest for other land use



Source: Own estimation based on information provided by PISA.