Greening through schooling: understanding the link between education and pro-environmental behavior in the Philippines

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Greening through schooling: understanding the link between education and pro-environmental behavior in the Philippines

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Abstract

In recent years, changing lifestyle, consumption and mobility patterns have contributed to a global rise in greenhouse gases responsible for the warming of the planet. Despite its increasing relevance, there is a lack of understanding of factors influencing the environmental behavior of people from emerging economies. In this study, we focus on the role of formal education for pro-environmental behavior in the Philippines and study three potentially underlying mechanisms explaining the education effects: differential knowledge about climate change, risk perceptions, and awareness. Whilst there is some evidence showing that education is associated with pro-environmental behavior, little is known about the actual mechanisms through which it influences decision-making. Using propensity score methods, we find that an additional year of schooling significantly increases the probability of pro-environmental actions, e.g. planting trees, recycling, and proper waste management, by 3.3%. Further decomposing the education effects, it is found that education influences behavior mainly by increasing awareness about the anthropogenic causes of climate change, which may consequently affect the perception of self-efficacy in reducing human impacts on the environment. Knowledge and perceptions about climate risks also explain the education effect on pro-environmental behavior, but to a lesser extent.

1. Introduction

Taking action to combat climate change and its impacts is urgent and vital in achieving the Sustainable Development Goals. Although per capita emissions are still highest in high-income countries, several emerging low and middle-income countries have seen a rise in carbon dioxide and other greenhouse gas emissions in recent years (IPCC 2014). While much of that rise was due to increased (export-oriented) industrial activities, changing lifestyle, consumption, and mobility patterns also played a significant role. How societies succeed in mitigating and adapting to climate change depends largely on the behavior of human beings acting both individually and collectively (Gough 2013, Lutz and Muttarak 2017). Accordingly, promoting sustainable lifestyle and consumption is a key strategy in reducing the human impact on the climate and of topical importance for sustainable development policy. This applies to advanced industrialized countries and emerging economies alike.

Despite a call for a stronger emphasis on demand-side solutions in mitigation strategies (Steg and Vlek 2009, Creutzig *et al* 2018, Dubois *et al* 2019), little is known about the determinants of pro-environmental behaviors of people from the developing world. Recent studies from high-income countries have emphasized the role of universal education as a mean to reduce demand-side emissions (Anderson 2012, Lutz and Striessnig 2015). For example, educated individuals have been found to have higher levels of environmental consciousness and to be more likely to show pro-environmental concerns and

protective actions (Ortega-Egea *et al* 2014, Meyer 2015, Steg 2016, Chankrajang and Muttarak 2017, Long *et al* 2018). However, the exact channels through which education and more broadly learning affect environmental behavior require a deeper understanding, especially in resource-scarce and low-income contexts. How and why education affects environmental behavior is of particular relevance for policy-makers who can use this knowledge to design effective measures and demand-side interventions aimed at promoting environmental consciousness and improving environmental protection.

To this end, this study investigates the relationship between formal education and pro-environmental behavior in the Philippines, a lower-middle income country, and analyzes the role of climate change knowledge, risk perceptions, and awareness of the causes of climate change as possible mechanisms in explaining education effects. To the best of our knowledge, there is no other study, which simultaneously considers the link between education and its mediating channels in promoting pro-environmental actions in a low-income context. The Philippines represents an interesting case for our study. The educational system was reformed several times in the past decades resulting in improved access, high enrolment rates, and a low illiteracy rate of less than 4% (UNESCO 2018). Moreover, environmental education has a long-standing tradition in formal education curricula and overall awareness of environmental issues is high in the country. More than 73% of the population can identify with a person who gives importance to looking after the environment compared to 55% and 63% in the neighboring countries Thailand and Malaysia, respectively (Inglehart *et al* 2014). Nevertheless, the country is faced with severe environmental issues, such as pollution, deforestation, and environmental degradation. The government has responded to these challenges by emphasizing the need for action and awareness raising following bottom-up community-centered and inclusive approaches as well as continued environmental education and learning in the formal schooling system (Republic of the Philippines 2017).

This study uses original survey data collected among female household heads from low-income neighborhoods in Metro Manila and the neighboring province of Rizal who were members of a social development organization. The surveys, which were conducted as part of a project on microfinance and health care, contained a detailed module on environmental behavior and climate change knowledge and perceptions. Although specific in its nature, the sample of households represents an interesting case allowing us to study the relationship between pro-environmental actions and education in a low-income setting. Pro-environmental behavior is estimated controlling for a rich set of personal and contextual background characteristics determining educational attainment in form of generalized propensity scores (Hirano and Imbens 2004). We employ a mediation analysis to estimate whether and to what extent the three considered mechanisms, knowledge, risk perception and awareness of climate change, explain the education effects on pro-environmental behavior (Breen *et al* 2013). Mediation analysis is a relevant methodological tool, which allows to identify and explore the mechanisms underlying relationships. While the need for a better understanding of the mechanisms is emphasized in the literature (e.g. Meyer 2015), these are rarely empirically explored. Based on a theoretical framework, our analysis generates insights, which help understanding not only *whether*, but also *why* education may be important for mitigation efforts and how it could best be used.

We find that education is positively related to pro-environmental behavior such as recycling, proper garbage disposal, and planting trees. Controlling for generalized propensity scores, an additional year of schooling is estimated to increase the probability of carrying out climate-friendly actions by 3.3%. Likewise, each of the three tested mediating factors, i.e. having greater knowledge about climate change, higher perception of climate risks, and being aware of its causes, has a significant positive impact on green behavior. The mediation analysis reveals that education effects are mainly driven by differences in the awareness of climate change being caused by human actions. Being aware of the link between anthropogenic activities and climatic change can influence the perceived self-efficacy to interfere with and mitigate climate change, and ultimately the willingness to take actions against it. Altogether, the three mediating factors explain between 30.5% and 32.2% of the total education effects.

The remainder of the paper is structured as follows. Section 2 presents the previous literature and our theoretical framework. Section 3 introduces the research setting of our study and the data. Section 4 presents our identification strategy and discusses the measurement of the key variables. The results are presented in section 5. Section 6 concludes with a discussion of the main findings and implications for future research. The main text accompanied by supplementary material available online at stacks.iop.org/ERL/15/014009/mmedia presenting detailed background information on the study sample (S1), the estimation strategy (S2), the measurement (S3), and further results (S4).

2. Previous literature and conceptual framework

Previous micro-level studies, mostly from high-income countries, have found a positive relationship between education and a wide range of pro-environmental behaviors, including consumption patterns, conservation, and lifestyle choices. For example, there

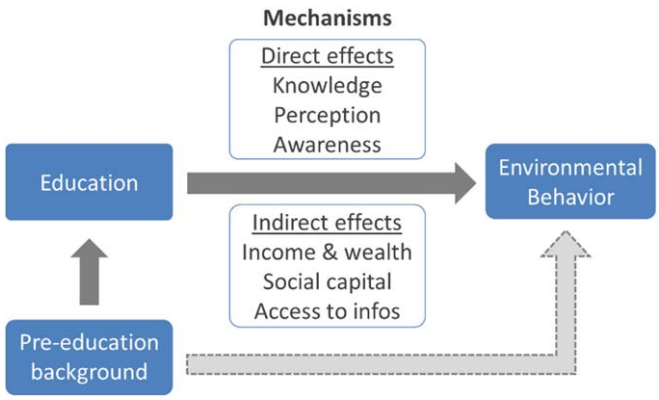

Figure 1. Conceptual framework explaining the direct and indirect channels through which education influences environmental behavior. Note: the empirical design controls for the respondents' pre-education background and indirect channels of influence allowing us to capture the direct effects of education on pro-environmental behaviors.

is ample empirical evidence showing a correlation between education and environmentally friendly food choices. This includes the purchasing of organic food products (Blend and van Ravenswaay 1999, Lockie *et al* 2004, Ngobo 2011), the willingness to pay higher prices for eco-labeled seafood (Brécard *et al* 2009, Xu *et al* 2012), the consumption of seasonal fruits and vegetables (Tobler *et al* 2011), and a reduced consumption of meat (de Boer *et al* 2014, De Backer and Hudders 2015, Graça *et al* 2015, Weibel *et al* 2019).

At the same time, better educated individuals have been shown to be more likely to adopt energy conservation behaviors that yield a lower carbon footprint, such as purchasing eco-labeled, higher efficiency electrical and heating appliances (Flamm 2009, Mills and Schleich 2010, Michelsen and Madlener 2012, Ma *et al* 2013, Wijaya and Tezuka 2013), adopting renewable energy sources (Sardianou and Genoudi 2013), and deliberatively saving energy (Poortinga *et al* 2004, Sardianou 2007, Ouyang and Hokao 2009, Mills and Schleich 2012, Lacroix and Gifford 2018, Niamir 2019). A positive relationship has also been reported for recycling and waste disposal activities (Hage *et al* 2009, Sidique *et al* 2010) and the adoption of fuel-efficient or alternative fuel vehicles (Mannberg *et al* 2014, Potoglou and Kanaroglou 2007).

In low and middle-income countries, on the other hand, increasing education levels often go hand in hand with enhanced economic development and the emergence of a wealthier middle class who can afford higher consumption levels. In fact, studies that shift the focus beyond high-income countries do not necessarily find the positive relationship between education and green environmental behavior (Ameli and Brandt 2015, Inglesi-Lotz and Morales 2017). The educational expansion in many countries has resulted in increased energy and resource consumption, which on the macro level led to a nonlinear relationship between development and sustainable lifestyle, commonly referred to as Environmental Kuznets Curve (EKC). For example, Inglesi-Lotz and Morales (2017) find that higher education levels are associated with higher energy consumption in developing countries whilst in developed countries, energy consumption declines as educational levels increase. On the other hand, controlling for per capita income, increasing education levels have been shown to compensate for the negative effects of economic growth on CO_2 emission in Australia (Balaguer and Cantavella 2018).

While most of the evidence from low and middle-income countries is based on macro level data, there are only few studies using micro level survey data to test for the relationship between education and environmental behavior. Moreover, most of the existing empirical evidence is based on correlations. Few recent studies attempt to identify the causal effect of education on green behaviors using changes in compulsory schooling laws over time (Meyer 2015, Chankrajang and Muttarak 2017). While these studies provide evidence for a causal relationship between education and pro-environmental behavior, little is known about the actual mechanisms explaining the observed effects. Theoretically, education can affect environmental decision-making either directly or indirectly (see figure 1). In this study, we primarily focus on direct channels of influence while controlling for potential indirect channels and the pre-education background.

Formal schooling can directly influence pro-environmental behavior by improving skills, knowledge and awareness that are relevant for climate change mitigation actions. Evidence from FMRI (functional magnetic resonance imaging) studies have shown a positive association between schooling and the development of neural networks underlying cognitive control and problem solving (Rosenberg-Lee *et al* 2011, Brod *et al* 2017). Being in school allows children to engage in cognitive activities including learning to read, write, understand number, count and solve numerical problems. Schooling activities in higher grades involve tasks that require acquisition and

deployment of meta-cognitive skills including critical thinking, comprehension, logical deduction and abstract reasoning. These cognitive exercises equip educated individuals with the ability to solve novel problems thanks to their skills to identify patterns and make extrapolations. Higher-order cognition indeed has been shown to be relevant for risk assessment and decision-making, which are important elements in judgement and making choices about climate actions (Oechssler *et al* 2009, Del Missier *et al* 2012, Rosi *et al* 2019). Cognitive skills acquired through schooling can thus enable individuals to acquire a better understanding of highly complex environmental issues such as climate change and its scientific underpinnings.

Likewise, it is possible that schooling improves the learners' knowledge about environmental issues through environmental education and consequently increase their consciousness for the consequences of their actions (Stevenson 2007, Anderson 2012, Wals and Benavot 2017). Indeed, there is evidence that more educated individuals have better knowledge about climate change as compared to their less educated peers (McCright 2010, Kabir *et al* 2016). Accordingly, with better knowledge and awareness, it has been found that people with higher education express higher levels of concern about climate change (Poortinga *et al* 2019) and are consequently more likely to engage in pro-environmental behavior (Ortega-Egea *et al* 2014, Muttarak and Chankrajang 2016).

Apart from directly improving knowledge, perceptions, and awareness, education can also influence pro-environmental behavior through many other indirect channels. First, individuals with higher education levels typically have a higher socio-economic status and income levels. This gives them access to more financial resources, consequently allowing them to undertake more costly environmental actions, such as making their houses energy efficient, using eco-friendly building materials, or installing renewable energy sources at home. Second, there is abundant evidence showing that education is positively associated with better access to information, such as weather forecasts and warnings. Taking pro-environmental actions requires information on the effectiveness of different measures and better access to such information enables educated individuals to change their behavior accordingly (Cotten and Gupta 2004, Wen *et al* 2011, Neuenschwander *et al* 2012). On top of that, some studies have argued that more educated individuals have on average higher social capital allowing them to benefit from shared information and risk perceptions in their social networks (Lake and Huckfeldt 1998, Huang *et al* 2009, Witvorapong *et al* 2015). Better economic and social resources as well as better access to information may thus indirectly facilitate the undertaking of pro-environmental behavior of individuals with a higher level of education.

3. Research setting and data

This study uses primary survey data from the Philippines collected by the authors in April 2015. The sample of respondents was randomly drawn among female members of a social development microfinance institution (MFI) as part of a project on MFI delivered health care services. The interviewed women were the household heads of predominantly low-income households in Metro Manila (National Capital Region, NCR) and the surrounding rural province of Rizal. While not being representative for the entire population, the sample reflects an interesting case and a well-suited testing ground to analyze our hypotheses. In total, 1064 women from three neighborhoods were interviewed using a standardized questionnaire consisting of 100 questions on a wide-range of topics, such as the respondent's educational background, her financial situation, and other socio-demographic and household characteristics (see supplement S5).

Figure 2 shows a map of the study areas with locations of the respondents' homes (blue dots). As can be inferred from the map, the areas encompass urban as well as semi-urban and rural neighborhoods at the outskirts of the city. The main research instrument contains a section on the participants' knowledge about and perception of climate change and the environment as well as actions she takes to protect it. For the propensity score estimation, we additionally use aggregate census data on the provincial level for the years 1948, 1960, 1970, 1975, 1980, and 1990, which was provided to us by the Philippine Statistical Authority.

The formal education system of the Philippines is among the most developed in the region with primary school net enrolment rates fluctuating around a high average of 90% since the 1980s, when early school reforms led to improved access to basic education for large parts of the population. Environmental education was integrated in the school curriculum at all levels already in the 1970s, when many regions of the Philippines were confronted with the consequences of environmental degradation and pollution (Antonio *et al* 2012). At the same time, governmental and non-governmental organizations started public information campaigns to stimulate environmental consciousness and promote pro-environmental behavior. In the early 1990s, the National Strategy on Environmental Education and the National Environmental Education Action Plan were formulated, which gave rise to several country-wide initiatives promoting environmental protection in school. In its most recent National Environmental Education Action plan, the government reaffirms its intention to strengthen education for sustainable development in a people-centered and comprehensive way (Republic of the Philippines 2017).

While we focus on the influence of formal education in this study, it is worth noting that other forms of

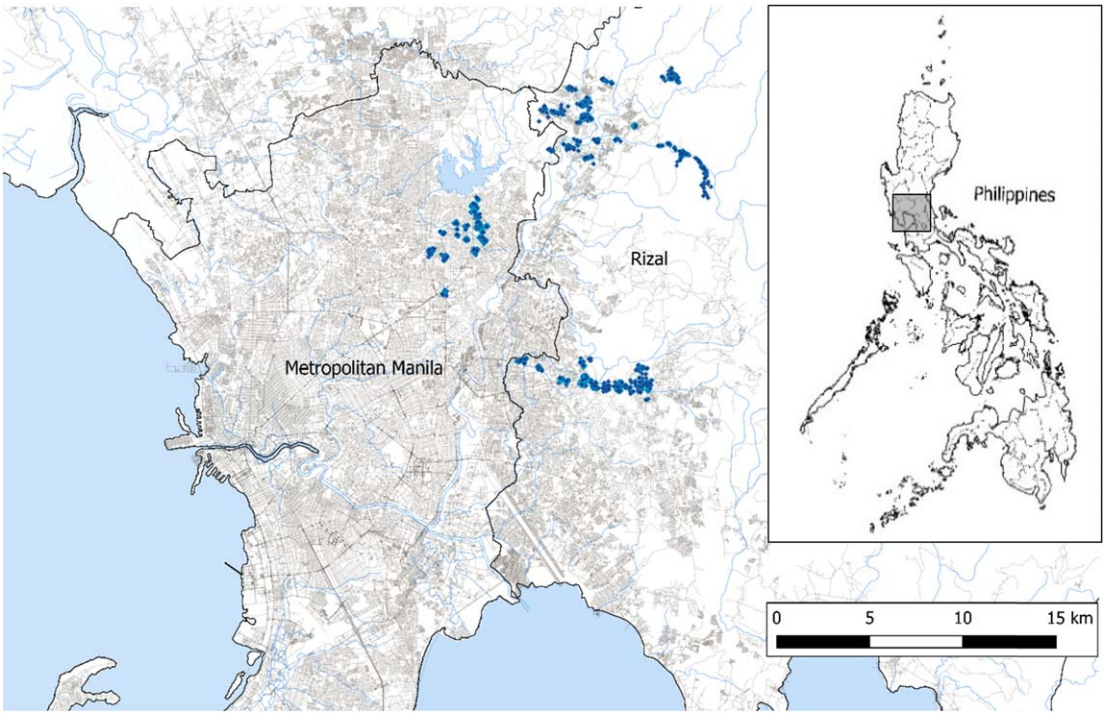

Figure 2. Map of study areas with locations of respondents' homes. The study areas encompassed both more urban and rural areas located in Rizal province towards the East of the National Capital Region.

education, which take place outside the traditional educational institutions, also play an important role in influencing pro-environmental orientations and behaviors (Eshach 2007). Non-formal education and learning programs, such as community-based initiatives, can successfully raise awareness and disseminate knowledge about the importance of environmental protection. Likewise, informal education, which includes learning from daily experience and the educative influences and resources in the immediate environment, including social interactions, can also play a key role (Richardson and Wolfe 2001, Digby 2013). In this regard, the media and public communication channels are an important source of influence (Chan 1998, Holbert *et al* 2003). Although both non-formal and informal learning are highly relevant and underexplored topics, it was beyond the scope of this study to empirically explore their influences in the considered setting.

4. Empirical strategy and measurement

4.1. Pre-education background and propensity score estimation

To answer our main research questions on the relationship between education and environmental behavior as well as to explore the mechanisms underlying the effect of education (if any), we follow a multiple steps estimation strategy. In a first step, we estimate the respondents' propensity to obtain a specific level of education based on different personal and contextual pre-education characteristics. The generalized propensity score (GPS) derived from this exercise is used in the subsequent analysis as an aggregate control variable allowing us to efficiently control for potentially confounding influences of respondent's pre-education characteristics (Hirano and Imbens 2004, Egger and von Ehrlich 2013). As a robustness check we repeated our main analysis including the entire set of pre-treatment controls instead of the GPS (see supplement table S4). None of our results is sensitive to the changes in the estimation procedures. In the estimation of the GPS, we closely followed the procedures outlined in Hirano and Imbens (2004) and Kluve *et al* (2012). Further information on the estimation of the GPS as well as the tests of the central assumptions can be found in the supplementary material (S2) and in Hoffmann and Lutz (2019).

In our propensity score estimation, we rely on a broad set of personal pre-education characteristics: parental education, parental literacy, cognitive abilities, age, and early work experience as a proxy for wealth in childhood. In addition to these personal background variables, we include a set of relevant birth province characteristics, which may have influenced respondents' likelihood to obtain higher education levels. In particular, we are interested in contextual variables, which capture the economic development level and educational infrastructure in the province, such as the distance of the birth province to the capital, the literacy rate, population density, elementary school completion rate, and the

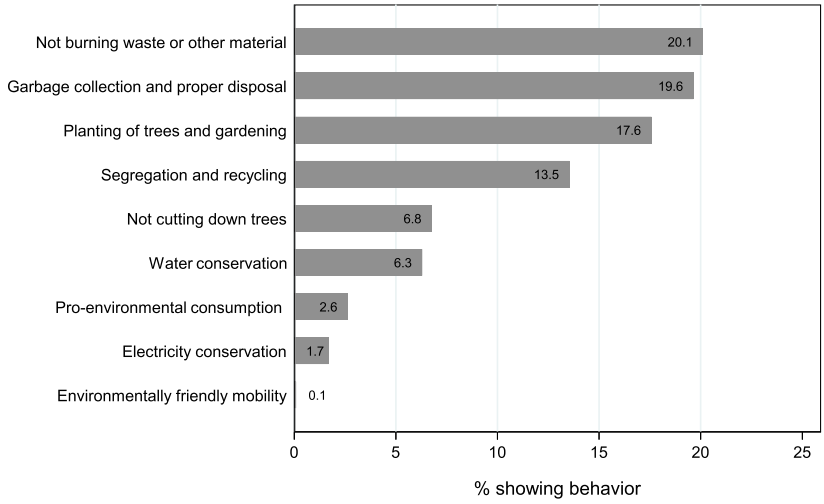

Figure 3. Percentages distribution of pro-environmental behaviors. Categorization based on open answers by respondents listing all activities they currently undertake to protect the environment and to reduce human impacts on climate change.

electrification rate in the province. The information on the respondent's birth province and birth year was merged with these environmental background characteristics of the respective province at the time of the respondent's birth. All contextual data were derived from the Philippine Census of Population and Housing since 1948.

4.2. Measurement of pro-environmental behavior

To measure pro-environmental behavior respondents were openly asked to list all activities they currently undertake to protect the environment and to reduce impacts on climate change. Interviewers were required to probe the respondents several times to obtain complete answers. The answers were later categorized into nine categories, which are displayed in figure 3 below. The categorization of the open-ended questions was done by two coders in order to ensure reliability. To test for the robustness of our findings, we base our analyzes on multiple outcomes: first, we study whether the respondent undertakes any pro-environmental actions as a dummy variable; and second, we analyze the total sum of all actions undertaken (min 0 to max 4), which can serve as an indicator for the intensity of pro-environmental behavior.

The majority of the respondents (59%) undertake at least one form of green behavior. On the other hand, we observe only few respondents who undertake more than two actions (4.2%). Most of the answers given were related to the proper treatment of garbage (e.g. not burning, right disposal, segregation, etc). Only few respondents said they changed their consumption behavior or tried to save energy or water. Interestingly, very few respondents said that they tried to use environmentally friendly ways of transportation. Since the use of public transportation is common for the interviewed sample, changing to or selecting pro-environmental mobility seems to not be considered as a pro-environmental action by the respondents.

The survey-based subjective measurement of respondent's environmental behavior may be prone to measurement errors and social desirability biases (Gatersleben *et al* 2002). To account for these issues, we also collected observational data on respondent's littering and garbage disposal behavior, which affects the immediate environment. When visiting respondents' homes, interviewers were asked to rate the space in and around the houses of the respondents in terms of littering and garbage disposal on a four-point scale ('lots of uncollected garbage/very dirty', 'some uncollected garbage/dirty', 'very little garbage/clean', 'no garbage visible/very clean'). Based on this information, we generated a dummy variable taking the value zero if there was a lot of or some garbage in the immediate area around or inside the house. Although this measure serves only as a proxy for environmental actions, it allows us to test the robustness of our findings.

4.3. Measurement of mediating factors and mechanisms

In the mediation analysis, we consider three factors, namely, knowledge about climate change, the perception of climate change risks, and awareness of the causes of climate change, which are expected to explain the relationship between education and pro-environmental behavior. These factors were measured only for those respondents who have at least heard of the term 'climate change' before ($N = 860$), which served as filter variable in our survey. Having heard of climate change naturally is a pre-condition for assessing its causes and associated risks. Therefore, in the mediation analysis in table 2, we control for whether the respondents have such a basic awareness of climate change, which, in itself, is strongly associated with a

person's education level (see supplement S4.3). The effects of the main mediators are estimated conditional on whether respondents were aware of the term climate change. In the supplementary materials, we replicate our mediation analysis only for those respondents who have heard of climate change before. The results are consistent with the findings for the entire sample (see supplement tables S8 and S9).

The first mediating factor—general *knowledge* about climate change—was assessed with a question on whether the respondents were able to explain the term to the interviewer (minimum acceptable answer was steady or sudden changes in weather due to changing climatic conditions). General knowledge was coded as a dummy variable, which takes the value one if the respondents were able to explain it. In total, 70.72% of the reduced sample of 860 respondents were able to give a correct answer. The second mediating factor is the respondents' *risk perception*, which was assessed with a question on how serious they perceived climate change to be on a 10-point scale. The 10 point-scale was dichotomized at the value 7 resulting in a total of 62.2% of the respondents who perceived a high risk of a changing climate. Finally, the third mediating factor measures the *awareness of the causes of climate change*. The respondents were asked for their beliefs about the causes of climate change. The responses were categorized in a dichotomous variable, which takes the value one if the respondents said that climate change was (at least in part) caused by human activity as opposed to being an outcome of natural or supernatural processes. Overall, 69% believed climate change to be caused by human activities, which can also be interpreted as a measure of the perceived self-efficacy to fight climate change by changing own behavior.

4.4. Estimating and explaining education effects

In our result section, we focus on the estimation of the effects of education measured by years of schooling on pro-environmental behaviors using the GPS to condition our sample on the pre-education characteristics of the respondents. Logit models are employed to estimate the effect of education on the probability of taking any environmental actions and Poisson models to estimate the effect of education on the total number of actions. The latter model takes the specific count distribution of the outcome variable into account. Education effects are estimated first in a *baseline specification* without and then under control for the main mediating mechanisms.[5] Including the additional variables in the regression allows us to infer information about the strength of the mediation by considering changes in the education effects.

In the analysis we additionally control for a wide set of other potential mediating channels and factors that may be directly or indirectly influenced by education and potentially confound our mediation analysis. We include measures for economic resources, risk preferences, social capital, marital status, number of children in the household, religiosity, household size, and subjective health status. Furthermore, we control for the average years of schooling among other respondents from the same neighbourhood and those in the direct peer group as assessed with a social network questionnaire to take potential contextual peer effects into account (Durlauf and Ioannides 2010, Jackson 2011).

Mediation analysis is a valuable tool to identify and explore underlying mechanisms explaining the relationship between educational attainment and pro-environmental behavior. To derive an estimate of the explanatory power of each of the different mediating factor, we compare the education coefficients from the baseline model with those in the models controlling for the single mediators. If the mediators explain at least part of the education effect, we expect the education coefficients to be reduced in the extended models. The comparison of effects across nonlinear models is not straightforward, as the scale of the underlying models may change if an additional factor is included. To be able to make cross-model comparisons, we apply the *KHB method* (Kohler *et al* 2011, Breen *et al* 2013, Hoffmann and Muttarak 2017), which harmonizes the scale of the baseline and extended Logit models. The KHB procedure also provides a test if the difference in the coefficients is significantly different from zero, which would support the mediation argument.

5. Results

5.1. Baseline specification: the role of education for environmental behavior

Table 1 shows the results of our baseline specification in which we regress the behavioral outcomes on years of education. While the model specifications (a) and (c) control only for neighborhood dummies and the GPS, which captures the relevant variation in pre-education characteristics, models (b) and (d) include a richer set of control variables. To facilitate the interpretation of the effects and to make them comparable across models, all coefficients are reported as marginal effects.

Across all models, we find evidence for substantial education effects on the probability to undertake environmental actions. According to the baseline Logit specification, an additional year of schooling significantly raises the probability to show some form of environmental behavior by 3.3% ($p < 0.01$). Having

[5] The effects of education on the considered mediating factors is analyzed in a separate analysis (see supplement table S6). Through this, we can infer information about the extent to which the considered mediators are actually related to and possibly influenced by education levels.

Table 1. Logit and poisson models: effect of education on environmental behavior.

	Outcome: environmental behavior			
	Logit: any actions		Poisson: number of actions	
	(a)	(b)	(c)	(d)
Years of education	0.033***	0.030***	0.073***	0.065***
	[0.005]	[0.006]	[0.010]	[0.012]
GPS	−0.105	−0.17	−0.029	−0.196
	[0.414]	[0.396]	[0.623]	[0.617]
Area 2: medium density	0.009	−0.005	0.026	0.01
	[0.049]	[0.053]	[0.089]	[0.094]
Area 3: high density	−0.074*	−0.077**	−0.167**	−0.168**
	[0.039]	[0.038]	[0.078]	[0.076]
Wealth		0.031*		0.078**
		[0.019]		[0.038]
Subjective health		0.008		0.006
		[0.008]		[0.017]
Social support		0.026		0.058
		[0.046]		[0.076]
Married		0.044		0.033
		[0.033]		[0.051]
Children		0.043***		0.064**
		[0.014]		[0.028]
Household size		−0.033***		−0.054**
		[0.011]		[0.023]
Religiousness		0.015		0.026
		[0.025]		[0.040]
Risk preferences		−0.005		−0.011
		[0.006]		[0.011]
Average education microfinance group		−0.006		0.004
		[0.023]		[0.039]
Average education direct peers		−0.001		−0.015
		[0.013]		[0.024]
Observations	1034	1034	1034	1034
Pseudo R^2	0.032	0.044	0.023	0.028
AIC	1366.7	1370.1	2478.4	2486.4

Notes: Coefficients are displayed as marginal effects calculated at the mean of all covariates, standard errors in brackets. Standard errors are clustered at the microfinance group level ($m = 70$). $^{*}p \leqslant 0.1$, $^{**}p \leqslant 0.05$, $^{***}p \leqslant 0.01$.

10 years of education (equivalent to the completion of secondary education compared to a person with no education in the Philippines) hence substantially increases the respondents' likelihood of undertaking pro-environmental actions by 33%. Comparable results are found for the count outcome, indicating an important role of education net of potentially confounding pre-education factors. While we do not find that the GPS as an aggregate factor itself is significant in the estimated models, some of the variables used for the GPS estimation exert a statistically significant effect on the considered outcomes (see supplement table S4, which reports the results of a model using the full-set of pre-treatment characteristics as controls instead of the GPS).

Apart of the education effects, we find that several of the additional controls reflecting other potential mediators have a significant effect on the likelihood and intensity of environmental actions. Higher wealth levels are positively associated with environmental behavior; a result which mirrors findings in the previous literature (Torras and Boyce 1998, Diekmann and Franzen 1999, Golley and Meng 2012). Furthermore, having a greater number of children is positively related with the outcomes of interest. This may reflect stronger preference of parents to protect the environment for future generations explaining their more forward-looking behavior. At the same time, controlling for the number of children, we observe a decrease in the tendency to carry out environmental actions with increasing household size.

5.2. Extended models including mediating factors

In the second step of our analysis, we add the mediating variables to our baseline models in a stepwise fashion to estimate their effect on environmental behavior. Table 2 shows the results of our Logit and Poisson models, which control for area fixed effects and the additional control variables, including

Table 2. Logit and poisson models: effect of mediators on environmental behavior.

	Outcome: environmental behavior				
	Logit: any actions				
	(a)	(b)	(c)	(d)	(e)
Years of education	0.021***	0.020***	0.019***	0.016***	0.014**
	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]
GPS	−0.259	−0.214	−0.212	−0.176	−0.125
	[0.381]	[0.376]	[0.391]	[0.373]	[0.376]
Wealth	0.024	0.021	0.023	0.014	0.011
	[0.018]	[0.018]	[0.018]	[0.016]	[0.017]
Heard of climate change	0.224***	0.169***	0.169***	0.036	−0.022
	[0.042]	[0.047]	[0.050]	[0.045]	[0.054]
Climate change knowledge		0.082**			0.064
		[0.039]			[0.040]
Risk perception			0.096***		0.039
			[0.035]		[0.033]
Awareness of causes				0.272***	0.260***
				[0.030]	[0.031]
% change edu. coefficient		−6.3%	−10.6%	−22.0%	−30.5%
Observations	1034	1034	1034	1034	1034
Pseudo R^2	0.066	0.069	0.072	0.116	0.119
AIC	1341.3	1337.9	1334.9	1273	1272
	Poisson: count of actions				
	(a)	(b)	(c)	(d)	(e)
Years of education	0.049***	0.045***	0.044***	0.038***	0.033***
	[0.011]	[0.011]	[0.011]	[0.011]	[0.011]
GPS	−0.481	−0.345	−0.394	−0.447	−0.293
	[0.607]	[0.593]	[0.621]	[0.577]	[0.574]
Wealth	0.065*	0.056	0.062*	0.045	0.037
	[0.038]	[0.037]	[0.037]	[0.034]	[0.034]
Heard of climate change	0.604***	0.424***	0.495***	0.123	−0.053
	[0.111]	[0.121]	[0.119]	[0.129]	[0.140]
Climate change knowledge		0.255***			0.218***
		[0.067]			[0.063]
Risk perception			0.187***		0.075
			[0.060]		[0.051]
Awareness of causes				0.656***	0.628***
				[0.072]	[0.073]
% change edu. coefficient		−8.5%	−8.9%	−22.3%	−32.2%
Observations	1034	1034	1034	1034	1034
Pseudo R^2	0.042	0.046	0.045	0.07	0.074
AIC	2453	2442.6	2447.1	2382.5	2376.1

Notes: Coefficients are displayed as marginal effects calculated at the mean of all covariates, standard errors in brackets. Standard errors are clustered at the microfinance group level ($m = 70$). Additional controls included in the model, but not displayed: neighborhood dummies, household size, number of children, marital status, subjective health, social support, subjective religiosity, risk preferences, education levels in microfinance and direct peer group. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

wealth. Note that the models additionally control for whether the respondents have heard of the term 'climate change', which was the filter requirement for the successive questions on knowledge, awareness and risk perception of climate change, our key mediating variables.

To be able to compare the education effects across the models, we re-calculated the baseline education coefficient (tables 1(b) and (d)) additionally controlling for whether the respondents have heard of the term 'climate change'. Especially in the Logit models, we observe a smaller education effect on the likelihood of undertaking environmental actions if our analysis controls for this additional factor. This suggests that basic awareness of the existence of climate change is also an important mechanism on its own as it explains part of the education effects reported in table 1. In further analyzes in the supplementary material (S4.4), we further explore this factor and as a sensitivity test re-run our models excluding the respondents who said

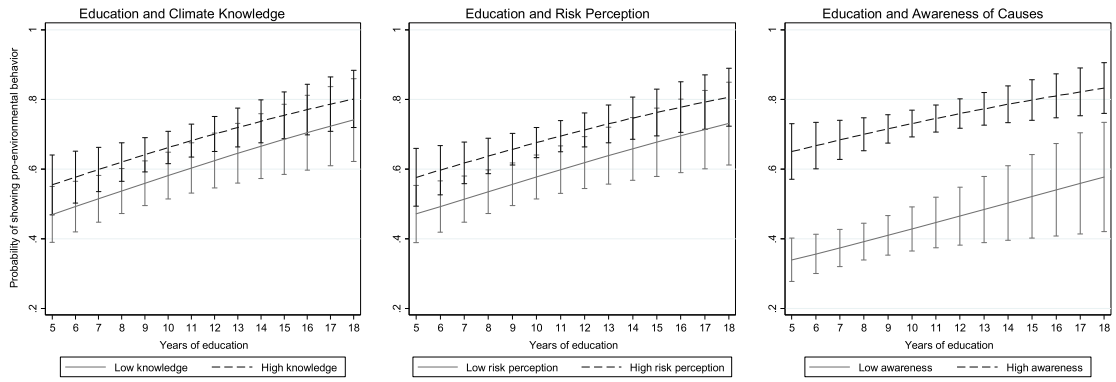

Figure 4. Estimated probabilities to undertake environmental actions for different levels of schooling. Notes: the graphs are based on the Logit models presented in table 2. On average, the respondents with higher climate knowledge, a higher risk perception and an awareness of the causes of climate change are more likely to report undertaking pro-environmental actions.

they have never heard about climate change ($n = 174$) from our analytical sample. All results reported here remain fully robust to the sample variation.

Also after adding further controls, education effects are significant and meaningful. According to the Logit estimates (a), the probability to undertake environmental actions increases by a substantial 2.1% with each additional year of schooling. Once the mediating variables are introduced to the models (b)–(d), the education coefficients are reduced as compared to the baseline specification in model (a) suggesting that all mediators can at least in part explain the observed education effects.

We find that all three mediating factors exert a significant positive effect on environmental behavior. Having knowledge about climate change, perceiving climate change as a threat for the livelihood, and being aware of the anthropogenic causes of climate change raise the probability to partake pro-environmental actions by 8.2%, 9.6% and a substantial 27.2%, respectively. In the full Logit and Poisson models including all mediators (e), the risk perception effects are no longer significant in both the Logit and Poisson specification, suggesting that this mediating factor may be of less relevance in influencing environmental action. Likewise, the knowledge effect is slightly reduced and loses its significance in the final Logit specification.

Figure 4 shows the estimated probabilities to undertake pro-environmental actions by years of schooling stratified by the levels of the dichotomous mediating variables (high versus low). We observe higher levels of pro-environmental behavior if the respondents have greater knowledge, perceive a higher threat of changing climatic conditions, and are aware of the anthropogenic causes of climate change. The difference is particularly pronounced for the latter, as indicated by its very large coefficients in table 2. Those who are aware that human activities contribute to global warming may feel greater self-efficacy that they can actually make a difference by engaging in climate-friendly actions. In the models controlling for all mediators the effect of education on pro-environmental behavior (though reduced in magnitude) remains significant suggesting that there are other unobserved channels that may play a role.

In additional analyzes, we study the influence of education on the three mediating factors, climate change knowledge, risk perception, and awareness (see supplement table S6). We find a strong positive association between education and the mediators, which is a necessary condition for the mediation argument to hold. An increase in education by one year raises the probability to know about climate change by 2.0%. Likewise, the probability to perceive climate change as a risk and of being aware of the human causes of changing environmental conditions increase by 2.4% with every additional year of schooling. An even stronger education effect is found for the variable based on which we filter out respondents who have not heard of the term 'climate change'. The probability of having heard of this term increases by a substantial 3.9% with every school year revealing a potentially large role of education in making people aware of the very basic existence of global environmental changes.

5.3. Explaining education effects

Complementing the previous findings, we derive an estimate for the strength of mediation and test to what extent the considered mediators explain the reported education effects. For this analysis, we compare the size of the education coefficients between the baseline (a) and extended models (b)–(e), which additionally control for the mediators. The KHB method employed here makes the coefficients comparable by adjusting the underlying scales in the nonlinear estimation. The row '% change edu. coefficient' in table 2 shows the estimated percentage change in the education effects due to the inclusion of the mediating factor. Note that the size of this measure, which can be interpreted as an indicator for the strength of mediation, is influenced by both the effect of education on the mediator, and its influence on the outcome, i.e. pro-environmental behavior.

Table 3. Logit models: effects of education and mediators on alternative outcome measure.

	Outcome: garbage disposal and no littering				
	(a)	(b)	(c)	(d)	(e)
Years of education	0.009**	0.010**	0.010**	0.008*	0.009**
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
GPS	−0.15	−0.155	−0.156	−0.132	−0.148
	[0.257]	[0.256]	[0.259]	[0.254]	[0.254]
Wealth	0.058***	0.058***	0.058***	0.056***	0.057***
	[0.016]	[0.017]	[0.016]	[0.016]	[0.017]
Heard of climate change	0.059*	0.068*	0.067*	0.025	0.046
	[0.032]	[0.040]	[0.035]	[0.036]	[0.043]
Climate change knowledge		−0.012			−0.014
		[0.026]			[0.026]
Risk perception			−0.014		−0.026
			[0.025]		[0.025]
Awareness of causes				0.056*	0.063**
				[0.030]	[0.031]
% change edu. coefficient		2.0	3.4	−10.9	−3.1
Observations	981	981	981	981	981
Pseudo R^2	0.056	0.057	0.057	0.062	0.063
AIC	833.4	835.2	835.2	831.1	834

Notes: Coefficients are displayed as marginal effects calculated at the mean of all covariates, standard errors in brackets. Standard errors are clustered at the microfinance group level ($m = 70$). All models control for the full set of control variables: neighborhood dummies, household size, number of children, marital status, subjective health, social support, subjective religiosity, risk preferences, education levels in microfinance and direct peer group. $^{*}p \leqslant 0.1$, $^{**}p \leqslant 0.05$, $^{***}p \leqslant 0.01$.

While education effects remain significant even if the additional mediators are included, the magnitude of the estimates decreases considerably. The difference between the coefficients of the baseline and extended model is the largest when climate change awareness is introduced as a mediator. The former explains about 22% of the education effects, revealing its important role as potential mechanism explaining the relationship between education and pro-environmental behavior. While we do find that knowledge and perceptions of the risks associated with climate change also play a role, the proportion of the education effects explained is merely 6.3% and 10.6%, respectively. Hence, they seem to be less relevant factors in explaining the link between education and environmental actions. Overall, the three main mediators together explain 30.5% and 32.2% in the Logit and Poisson specifications, respectively, controlling for the full set of additional variables and neighborhood fixed effects.

As mentioned above, education effects are also substantially reduced once the filter variable, measuring whether respondents have heard of 'climate change', is included in the baseline model. As the measurement of the main three mediators considered in this study depends on the respondents having at least heard of climate change before, we cannot directly compare the importance of this filter variable vis-a-vis the other mediators. However, our results suggest that already the very basic awareness of the existence of climate change is an important mechanism on its own explaining part of the effect of education on pro-environmental behavior (see supplement table S7).

5.4. Robustness check using observational data

The previous models used behavioral information based on the subjective survey responses. In a final step, we test for the robustness of our results using observational data about the environmental behavior of the respondents. For this, we analyze the interviewer's assessments of garbage disposal and littering in the space in and around the houses of our respondents. Table 3 shows the results of Logit models, which regress the binary-coded observational variable on years of education and the considered mediators. All models control for the full set of alternative mediators that may confound the relationships.

While the effect using the alternative outcome are smaller than for the subjective measure, the overall pattern is similar. The probability for showing a pro-environmental behavior increases by 0.9% with each additional year of education. Adding the mediators to the models, we do not see substantial changes when knowledge about climate change and respondent's risk perception are included. However, in line with the previous models, education effects are significantly reduced by 10.9% when differences in the awareness of the anthropogenic causes of climatic changes are controlled for suggesting an important role of this mechanism in explaining education effects on the considered outcome. Apart from the role of education, we also find a substantial effect of household wealth in

influencing the garbage disposal and littering outcome.

6. Discussion and conclusion

How does education affect environmental behavior and what are the underlying mechanisms? In this paper, we employ a generalized propensity score approach and a mediation analysis to answer these questions. The analysis is performed using original survey data that was collected among women in low-income households in the greater area of Metro Manila and the neighboring province of Rizal. While the previous literature has a strong focus on advanced industrialized countries, our study represents one of the few that explore the determinants of environmental behavior in a developing country context.

We find education positively influences environmental behaviors. An additional year of schooling raises the propensity to undertake environmentally friendly actions by a significant 3.3% (table 1, Logit model a) and the number of actions undertaken by 0.073 (table 1, Poisson model c). The education effects estimated in our baseline models closely resemble the effects reported in other studies both from high as well as low and middle-income countries. Using the Eurobarometer data, Meyer (2015) finds a statistically significant effect of 0.071 of education on the number of environmental actions undertaken, which is almost identical to our estimate (see Meyer 2015, p. 113, table 4, col 1). Other studies from high-income countries report similar results, such as Mills and Schleich (2012) Di Maria *et al* (2010), or Sardianou and Genoudi (2013). As one of a few studies from a developing country, Chankrajang and Muttarak (2017) report significant point estimates between 0.035 and 0.059 for education effects on different pro-environmental actions in Thailand (see Chankrajang and Muttarak 2017, page 441, table 5, col 1 to 4). The comparison of the findings suggests considerable similarities in the education effects across settings, which seem to be independent of the respective country wealth level.

A mediation analysis based on the KHB method (Breen *et al* 2013) is employed to identify the underlying mechanisms of the effect of education on pro-environmental behavior. Our results show that being aware of climate change and its causes explains as much as one-fourth of the education effects suggesting that education plays an important role in raising awareness levels, which positively affects environmental decision-making. This reveals an important role of understanding the causes and consequences of climate change in triggering pro-environmental actions.

This result is in line with the theory of planned behavior which holds that behavioral intentions are a function of one's attitude towards performing a particular act and subjective norms or the strength of normative beliefs (Ajzen 1991). The decision to take an action includes both the evaluation of a certain outcome and the estimation of the likelihood to reach this outcome through one's actions, i.e. the perceived behavioral control (Ajzen 2002). Being aware that one's behavior can attain certain outcomes and the resulting perceived self-efficacy are hence important prerequisites for individuals to take up a desired behavior. This does also apply to pro-environmental behavior. Knowing about the anthropogenic causes of climate change concurrently mean that individuals also know that they can do something about it. Indeed, the previous environmental psychology literature finds that poor understanding of the connection between human actions and climate change influences the perception of human ability to control and take action against it (Lorenzoni and Pidgeon 2006). Accordingly, a lack of awareness about the consequences of human activities on the global climate system discourages individuals to take any climate-friendly actions. Education thus plays a vital role in promoting knowledge about climate change and in raising awareness about the impacts of human activities.

Our study faces some limitations. First, due to the cross-sectional and non-experimental nature of our data, we are unable to make causal claims in our analysis. Although we control for pre-education characteristics using propensity scores and a variety of additional demographic controls, the results could be driven by simultaneity issues or omitted variables, such as time preferences. To check the validity of our results, we performed various consistency checks, which did not indicate any problems with the used identification strategy.

A second limitation is that our findings are mainly based on survey data that are prone to measurement and reporting errors. In particular, we rely on data about self-reported environmental behavior, which is potentially subject to social desirability biases. Some respondents may have over-reported their engagement in pro-environmental actions in order to receive social approval. For example, when comparing household energy use with self-reported pro-environmental behavior among Dutch households, Gatersleben *et al* (2002) revealed that people who reported to act in a more environmentally-friendly way do not necessarily use less energy. Other studies, for example by Milfont (2009), on the other hand, do not find strong evidence of social desirability effects for self-reported pro-environmental behavior. It has also been argued that social desirability is likely to represent a minor problem when the self-reported measures refer to *past/present* behavior like the ones used in this study rather than *intended/future* behavior (Ortega-Egea *et al* 2014). To account for potential measurement errors in our design, we used different operationalization of our key outcomes and replicated our main findings using an alternative, observational outcome measure,

garbage disposal and littering, which confirmed our main conclusions.

Third, our sample is restricted to female household heads, who were members of a social development organization at the time of the survey. The data hence is not representative for the entire country. We nevertheless believe that the sample and the collected data is highly informative as it allows us to test theoretical predictions in a setting, which has rarely been considered in previous research. The aim of our study is to reach a high internal validity and to carefully explore some of the mechanisms underlying the identified effects. In this regard, we see case studies like ours as a useful tool to understand patterns and mechanisms on the micro level, which can be compared to other studies with a similar empirical design.

Whilst this study focuses mainly on formal schooling, knowledge, awareness and risk perception in the context of climate change can be acquired via other non-formal and informal channels such as through the media and social diffusion. These channels are more difficult to assess empirically and require a specific survey design to be measured. While our study was focused on direct mechanisms, the effects of education on pro-environmental behavior can also operate through other channels, which we do not capture with our design. Factors like low time discount rates (i.e. focusing on benefits in a longer time horizon) have been found to be associated with environmental behavior and energy consumption (Carson and Roth Tran 2009, Long *et al* 2018) and are also reported to be more prominent amongst highly educated people (Chao *et al* 2009, WhitMarsh 2011). Additional factors such as biospheric values may also mediate the effect of education if these values influence pro-environmental actions and are correlated with education (Steg 2016). It is thus highly likely that education affects environmental behavior through other mediators beyond the ones captured in our study. Our study thus opens up new enquiries to be pursued in future research.

Formal schooling functions not only as an instrument to signal the level of education attained but has an intrinsic value in enhancing the capability to achieve the outcomes aspired for (Bengtsson *et al* 2018). Likewise, investments in education may not only have individual-level benefits, but may generate important spill-overs at the community level such as in the case of reductions in infant mortality (Pamuk *et al* 2011) or disaster preparedness (Witvorapong *et al* 2015, Hoffmann and Muttarak 2017). Interactions with well-educated individuals may contribute to the spread of information and awareness in communities and exceed the direct education effects reported in this study. Education may hence generate further environmental externalities that benefit not only the individual and the people in their direct surrounding, but also the general public (Lutz *et al* 2014).

In the context of the 2030 Agenda for Sustainable Development, Bengtsson *et al* (2018) have reviewed and presented evidence on the role of education in enabling the progress of the Agenda ranging from improving health, poverty reduction, promoting gender equality to reducing vulnerability and enhancing adaptive capacity in the context of climate change (Nilsson *et al* 2016, Weitz *et al* 2019, Sachs *et al* 2019). Our findings provide further evidence that education is an important enabler for reaching sustainable development on a global scale. Investments in education can make an important contribution in raising awareness and ultimately in promoting green behavior contributing to reducing the human impacts on the global climate system. In this regard, while it is important to provide learners with the necessary tools and capabilities to undertake pro-environmental actions, it is also key to raise their perceived self-efficacy. Environmental education curricula should thus not only focus on the transfer of knowledge and information, but also highlight the importance of the individual contribution in mitigating the harmful consequences of global environmental change.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available for legal and/or ethical reasons.

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