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Environmental education and children's pro-environmental behavior on plastic waste. Evidence from the green school certification program in Chile☆

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ABSTRACT

Environmental education provides people with the information they need to understand the causes and consequences of environmental issues, helping to promote positive attitudes toward nature. This paper uses a multivalued treatment effects model to evaluate the effects of a green school certification program on children's pro-environmental behavior in Chile. Pro-environmental behavior is measured by knowledge, attitudes, and practices related to the consumption and disposal of plastics. Results evidence a positive effect of schools' higher certification level on children's plastic waste behavior. This effect seems stronger in practices where children have more decision-making power (e.g., packing a lunch box). The observed reverse effect when switching from basic to intermediate level of certification is in line with the potential non-linear effects of environmental education on pro-environmental behavior regarding the consumption and disposal of plastic. To improve the design of the program, it is important to redefine incentives in the certification system to differentiate better the benefits of reaching each level of environmental certification

1. Introduction

There are several ways to encourage individuals to adopt more sustainable consumption behaviors. Standard pecuniary incentives and command and control policies, such as taxes and bans, are some common approaches. In settings with limited access to economic instruments, one alternative is to use non-pecuniary incentives. One such incentive is informational campaigns, which are designed to influence individual attitudes, norms, and, eventually, individual behaviors (Alpizar et al., 2020). It is well established that the process of shaping attitudes and norms begins at an early age (Fehr et al., 2013; Sutter et al., 2019), and that children exhibit pro-environmental preferences and behaviors of their own (Dewey, 2021; Grønhøj and Thøgersen, 2009). Thus, what we experience and what we are taught at the beginning of our lives is likely to affect our environmental values throughout adulthood.

There is ample evidence that interventions geared toward changing people's attitudes and norms at a young age are key to promoting pro-environmental behavior (Bettinger and Slonim, 2006; Kosse et al., 2020). From a public policy perspective, one way of promoting pro-environmental preferences is to incorporate environmental education into school curricula. Literature indicates that educational campaigns and other information-related interventions are suitable instruments for promoting changes in individual behavior (Grodzinska-Jurczak et al., 2003; Bettinger and Slonim, 2006; Duvall and Zint, 2007; Hartley et al., 2015; Boudet et al., 2016; Hoang and

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Kato, 2016; Owens, 2018; Hartley et al., 2018; Jaime et al., 2023). Environmental education provides people with specific information to better understand the causes and consequences of environmental issues, helping to promote positive perceptions and attitudes toward nature. These kinds of information-based interventions incentivize pro-environmental practices that minimize the impact of human activity on the environment (Abd-El-Khalick et al., 2003; Tuncer et al., 2005; Alagoz and Akman, 2016). Environmental education does not only provide knowledge about the importance of changing behaviors, but it also encourages the emergence of personal norms, which has shown to generate long-lasting changes in pro-environmental behavior (Viscusi et al., 2011; Huber et al., 2018), even in domains beyond those being targeted (Carlsson et al., 2020). Another strand of the literature is devoted to analyzing the direct effects of students' participation in environmental education programs on outcomes such as intention towards solid waste separation on campus (Liao and Li, 2019) and water-savings behavior (Iwasaki, 2022) to list just a few. More recently, literature has focused on the indirect effects of these programs, particularly on intergenerational transmission of behavior. Hiramatsu et al. (2014) assess the effects of energy environmental education programs with visualization in elementary and junior high schools on the awareness and behavior of children and their families. These programs had a positive and significant effect on children's awareness of effectiveness, which, along with behavior, influenced parent's intentional and behavioral change. This positive result is reinforced by the study of Parth et al., (2020), evidencing intergenerational learning from children to parents among participants in the climate change education program "k.i.d.Z.21". Similar effects have been evidenced in other domains, such as knowledge, attitudes, and behaviors regarding disaster risk reductions (Harada et al., 2023). Even though educational programs have been recognized as a power instrument to mitigate the impact of human activity on the environment, there are some concerns emerging about their real effectiveness. First, it is argued that education programs can take years to influence changes in behavior. Thus, conducting an evaluation to discern whether or not behavior change occurs due to the educational program will require costly and long-term study (Thomson et al., 2003). Second, another criticism is that education programs focus on children, expecting to provide the future generation with the ability to contribute to an ecologically sustainable future. Although worthy and essential, this strategy will not address today's serious environmental problems, as urgent behavior changes are needed today from parents and grandparents (Duvall and Zint, 2007). Third, frequent changes in government agendas regarding priorities on the role of education in fostering sustainability, along with other educational policies, can affect the effectiveness of educational programs (Smith and Stevenson, 2017). Finally, critics of environmental education argue that even though this instrument has been effective in enhancing awareness of complex environmental issues, there are still challenges to designing programs that effectively increase knowledge about the roots of the problems and promote real changes in personal lifestyle (Gigliotti, 1990; Blumstein and Saylan, 2007).

From a policy perspective, plastic waste is a relevant environmental and development issue at the face of plastic marine pollution, and its adverse consequences on the environment and the health of living organisms, particularly in marine life. Plastic pollution is a global concern that has its roots in excessive plastic production, growing plastic consumption but also because of inadequate waste disposal systems. This paper contributes to get some insights on the role of environmental education in promoting pro-environmental behavior regarding consumption and disposal of plastic. Children targeted in this program take part in a national environmental certification scheme promoted by the Ministry of the Environment of the Chilean Gobernmeny as part of their strategy to increase sustainable practices in students and educational communities in Chile. Schools earning environmental certification are categorized into three groups: (i) basic, (ii) intermediate, and (iii) excellent. Each of these categories entails different levels of environmental commitment. This paper aims to evaluate the effects of an environmental education program on children's pro-environmental behavior, with a special focus on how the environmental certification status of schools may affect potential outcomes and children's responsiveness to treatment. Pro-environmental behavior is measured by knowledge, attitudes, and practices (KAP) regarding the consumption and disposal of plastics. We hypothesize that the program has the potential to incentivize significant changes in the behavior of children in schools with various certification levels, as each certification level indicates a different level of treatment. To evaluate the impact of the program, we estimate treatment effects by applying a doubly robust method within a multivalued treatment effect framework. This empirical strategy combines the regression adjustment and inverse-probability weights, following three stages (Wooldridge, 2007). First, the probability of selection into treatments is estimated by applying a multinomial probit model. Second, we estimate linear regression models for the outcome of interest for each level of treatment. Results are adjusted by inverse probability weights estimated from stage 1. Finally, measures of treatment effects are calculated.

This paper contributes to the literature in a number of aspects. Firstly, most previous literature focuses on the effect of participation in voluntary environmental schemes on private firms' outcomes (see, e.g., Galati et al., 2017; Jiang et al., 2019; Aragon-Correa, et al., 2019), but the objectives of schools could differ substantially from private firms. Secondly, most initiatives that integrate environmental issues into the day-to-day procedures of educational establishments are voluntary and, therefore, represent a decision process that is ultimately influenced by school characteristics. The program that we aim to evaluate offers more than just one possible treatment—certification levels include basic, intermediate, and excellent. Most studies dealing with the effects of education assume a single treatment framework or equality of yearly returns across educational levels, which turns out to be a very restrictive assumption. One exception is Goldman et al. (2018), who studied the impact of a green school certification program on environmental literacy and the adoption of sustainable practices among students in Israel. They found that students' environmental literacy and school environmental performance are higher in schools that had earned higher-level certifications. Results are based on comparisons of a set of indicators across groups of schools at different stages of green school certification. This procedure, however, is not different from other studies evaluating the impact of participation of schools in environmental programs on children's pro-environmental behavior; these studies are often evaluations of primary comparisons of behavior and attitudes before and after, or between groups in the absence of a suitable counterfactual framework (see Krnel and Naglič, 2009; Boeve-de Pauw and Van Petegem, 2011; Cincera et al., 2012; Ozsoy et al., 2012; Spinola, 2015). A related study by Li and Lang (2015) investigate the effects of schools and parents -two of the most important sources of influence- on views of the human-nature relationship among 6th-grade primary school children in China following a structural equation modeling approach. Using a modified new environmental paradigm scale to measure the human-nature relationship, results show that attendance at a green-certified school has a positive effect on children's scores. There is also evidence that children's and parent's scores are positively correlated, even though children score higher than their parents. Unlike these results, findings in Olsson et al., (2019) evidence that students enrolled in schools participating in the Green Schools Partnership Project in Taiwan do not exhibit a larger sustainability consciousness (i.e., knowingness, attitudes, and behaviors in relation to sustainability), compared with those enrolled in non-participant schools by using the same methodological, approach. Our proposed empirical strategy allows us to estimate the casual effects of the program and, therefore, constitutes an important methodological contribution to understanding of the effects of environmental education on pro-social preferences. Specifically, we use a novel methodology that takes into account the voluntary nature of participation within a multivalued treatment effect framework

(Uysal, 2015). Given the different certification levels that schools can achieve in the Chilean certification program, using a multivalued treatment framework is more suited to assess the effects of earning a particular certification level on the outcomes of interest. By doing so, we account for the fact that the levels of school certification differ in the qualitative input they provide. Thirdly, our proposed identification strategy is important from a policy perspective because it allows us to indicate the different returns of the program on existing certification levels, which could be an important input when assessing the cost-effectiveness of a program. By understanding certification levels as different doses—or treatment—of the program, it is also possible to predict what the effects on children's behavior would be if a certain treatment level was assigned to a school demonstrating a different environmental commitment. Such an assessment could inform us on whether the current certification levels are encouraging Pareto-efficient outcomes among targeted children, which implies an adequate functioning of the program (Baliga and Maskin, 2003). It implies that the features of the program (i.e., the conditions needed for an establishment to be awarded a specific level of certification) are promoting the desired behavior and, therefore, that the program is a suitable mechanism for obtaining the desired social outcomes (Manski and Sjöström, 2002). Understanding the performance of the program is an important input for the assessment and redesign of future cohorts of the program. Finally, although the KAP model has been widely used to explore changes in pro-environmental behavior, the literature is more limited in the area of sustainability in general, and among school children populations in particular as it comes to consumption and disposal of plastic (Salas-Zapata et al., 2018). This is important because plastic pollution can be understood as a collective problem, where responsible behavior towards others and cooperation are key to providing solutions.

The remainder of the paper is organized as follows: Section 2 describes the school environmental certification system in Chile. Section 3 presents the empirical strategy and data used to evaluate the program. Section 4 discusses the main results. Section 5 provides a robustness check. Section 6 provides a discussion. Finally, Section 7 summarizes the main conclusions.

2. The school environmental certification system in Chile

The National System for Environmental Certification of Educational Establishments (SNCAE) is a voluntary, inter-sectorial program. It provides a public certification to educational establishments that successfully implement environmental education in their school communities. The program seeks to integrate environmental education in three areas: curriculum, management, and relationship with the environment (Ministerio del Medio Ambiente, 2020). With curriculum, schools reinforce existing environmental education in their curriculum, lesson plans, and programs; the management area seeks to incorporate more environmentally-friendly practices into the school's resource management (water, energy, waste, etc.); and in relationship with the environment, schools emphasize their interactions with the immediate surroundings in economic, social-environmental, and cultural dimensions. Through these relationships, schools become actors and members of the cooperation networks in their local communities.

In Chile, schools can receive one of three levels of certification: (i) basic, (ii) intermediate (medium), and (iii) excellent (high).[1] Levels are determined by the schools' progress in curriculum, management, and relationship with the environment. Each school begins the certification process by developing an environmental education program and defining a plan to integrate that program into the school community. From these actions, schools can earn the basic and intermediate levels. To reach the highest level of certification, schools must show major progress on implementing environmental education within the whole educational community. Thus, each level indicates a higher level of environmental commitment. For certification purposes, the basic and intermediate levels are understood as a transition to excellence, and either status is awarded for two years. Only the establishments that are more advanced in all dimensions reach the excellent level, which is awarded for four years (Ministerio del Medio Ambiente, 2020).

The level of environmental certification reached by each school is given after fulfilling a series of indicators related to the three areas of action established in the "Environmental Matrix instrument" (Ministerio del Medio Ambiente, 2022a). This matrix had a total of 20 indicators for the year 2019. Each of these indicators is measured by a score of one or two. The sum of points is used to classify the school into one of the three certification levels. The assessment process starts with a self-evaluation conducted by each school independently. This self-report is submitted to the Regional Environmental Certification Committee[2] (CRCA), which reviews the report to verify compliance with the indicators (Ministerio del Medio Ambiente, 2022b). Once the school is certified, the CRCA can carry out environmental audits to compare what is reported with what is observed. Audits are only conducted for a random sample of schools and do not include an inspection of the actions undertaken in the classroom.[3]

Environmentally certified schools get access to a series of benefits, regardless of which certification level is earned. First, schools receive public recognition for integrating environmental values into their educational mission, which can be used to differentiate them from other educational missions. Second, schools' efforts at improving resource management (e.g., water, energy, and waste) can generate some cost savings, money that can be used to cover other expenses or to implement other initiatives of the school's interest. Third, certified schools receive preferential invitations for training, workshops, and seminars, as well as access to resources and educational materials related to environmental sustainability. Finally, schools get involved in a large network of certified educational establishments, where opportunities to exchange experiences are promoted (Ministerio del Medio Ambiente, 2022b).

3. Material and methods

3.1. Empirical strategy

Since our treatment variable is expressed in certification levels, we propose a multivalued treatment effects model to evaluate the effect of environmental certification on children's pro-environmental behavior. Different methods exist to estimate treatment-effects models for observational data in a multivalued framework. We propose a doubly robust method for estimating the treatment effects of interest. The doubly robust method is a combination of regression adjustment and inverse-probability weights (Wooldridge, 2007). An important advantage of this method is that it allows us to estimate a multivalued treatment, which, in our case, relates to the establishment's certification level (basic, intermediate, or excellent). This empirical strategy is particular in considering the treatment as a discrete variable, ensuring consistent and unbiased estimators of ATE and ATT even when one of the models is misspecified. For more details, see Imbens (2000), Lechner (2001), and Uysal (2015).

The estimation strategy follows three steps: first, we estimate the

[1] Certified schools receive a flag and a diploma with different colors: blue (basic), orange (intermediate) and green (excellent).

[2] The Regional Environmental Certification Committee is made up of representatives from the regional offices of the Ministry of the Environment (MMA), the Ministry of Education (MINEDUC), the National Forestry Corporation (CONAF), the United Nations Organization for Education, Science and Culture (UNESCO), the Ministry of Energy (MINENERGIA), the Agency for Energy Sustainability (ASE), the General Directorate of Waters (DGA), the National Board of Kindergartens (JUNJI) and INTEGRA Foundation.

[3] This process was described in an interview with a professional from the Ministry of the Environment.

parameters of the treatment model, from which inverse probability weights are obtained. Second, we use the inverse probability weights to adjust regression estimates for the outcome of interest for each level of treatment. Third, we estimate the treatment effects of the intervention. This procedure allow us to calculate three quantities of interest: (i) Potential Outcomes (POM), (ii) Average Treatment Effects (ATE), and (iii) Average Treatment on the Treated (ATT).

We begin by estimating the treatment model, whose specification is presented as follows:

$$Prob(T_i = j) = \mathrm{G}(Z\gamma + \varepsilon) \tag{1}$$

where the treatment T denotes different levels of schools' environmental certification j=0,1…J, Z is a vector of explanatory variables, γ is a vector of estimated parameters, and ε are the error terms not related to Z. The function G is the cumulative probability distribution function. Eq. 1 is estimated by means of a Multinomial model. The estimats of interest are the inverse probability weights.

We continue estimating the outcome model for each level of treatment by means of linear regressions adjusted by the previously-obtained inverse probability weights as follows:

$$Y_j = X\beta_j + \nu_j \tag{2}$$

where β_j are the estimated coefficients for treatment level j, X is a vector of explanatory variables, and ν_j are the error terms not related to X. The observable variable Y_j is the outcome of interest for each certification level j. Eq. 2 is then estimated for each level of treatment (i.e., basic, intermediate, and excellent).

We conclude by performing the treatment-effects estimation. At this stage, we estimate the three aforementioned effects of interest: the POM, ATE, and ATT of the environmental education program. The POM corresponds to the average of each potential outcome for each treatment level. This is expressed as follows:

$$POM_j = E(Y_j) = \quad E(Y_j|X, \quad T = j) \tag{3}$$

where Y_j represents the outcome for the certification level j, X represents the covariates matrix, and T denotes the level (doses) of treatment for each individual. Similarly, the average treatment effect (ATE) corresponds to the average treatment effect in the population, i.e., the average effect of providing each student with treatment level j instead of another level. The ATE is defined as the difference between the individuals' potential outcomes as follows:

$$ATE_j = E(Y_j - Y_0) = E(Y_j|X, T = j) - E(Y_0|X, T = 0) \tag{4}$$

Finally, the average treatment effect on the treated (ATT) corresponds to the difference between the individuals who receive treatment level j and are in schools with certification level j in relation to the individuals who receive treatment j given and are in schools with certification level 0.

$$ATT_{j0} = E[(Y_j - Y_0)|T = j] = E(Y_j|X, T = j) - E(Y_0|X, T = j) \tag{5}$$

Three assumptions are needed to estimate the treatment effects of the intervention: (i) the conditional-independence assumption, (ii) the overlap assumption, and (iii) the independent and identically distributed (i.i.d) assumption. The conditional independence assumption restricts the dependence between the treatment model and the potential outcomes. The overlap assumption ensures that each individual can receive any level of treatment. And finally, the assumption of i.i.d. ensures that each individual's potential outcomes and treatment status are unrelated to the potential outcomes and treatment statuses of all other individuals in the population (Wooldridge, 2007).

3.2. Data

Our data come from primary and secondary sources.[4] First, we conducted a survey in 30 schools participating in the environmental certification program in the Bío-Bío Region of Chile to gather information on pro-environmental behavior among children. This information was complemented with secondary data at the school level from the Chilean Ministry of Education and the Chilean Ministry of the Environment.

Our primary data provides us information at the student level. We randomly selected a matched sample of 30 schools out of a possible 205 schools that were participating in the environmental certification program in 2018. The matched sample was based on the following observable characteristics: (i) coastal versus non-coastal towns, (ii) low- versus high-income schools, (iii) public versus private schools, and (iv) basic, intermediate, or excellent environmental certification level. This sample allows us to consider the heterogeneity among schools in Chile.[5] We adapted the knowledge, attitudes, and practices (KAP) model to develop a survey measuring children's pro-environmental behavior related to plastic pollution. This model assumes a relative ordering of knowledge, attitudes, and practices (Valente et al., 1998; Salazar et al., 2022a). The questionnaire was administered to 1521 children in fourth grade elementary from the selected schools and their parents/guardians.[6]

The survey was designed to gather information on the knowledge, attitudes, and practices related to the consumption and disposal of plastics.[7] These are the outcomes of interest. Following Boudet et al. (2016), we compute indexes for each outcome based on a series of survey questions. With the exception of knowledge, which reflects the percentage of correct answers from a series of validated questions related to plastic pollution, the rest of our outcomes are built up on self-reported information. While attitudes were measured based on perception questions about plastic pollution, practices were divided into consumption and recycling. Practices regarding the consumption of plastic are measured in two ways: with an index of avoidance of plastic and with a lunch-box index. In particular, the lunch box index considers the items included in the child's lunch box. An increase in the index indicates children and parents pack children's food for school using reusable containers.

The information on schools' levels of certification was obtained from the National System of School Environmental Certification (SNCAE) from Chile's Ministry of the Environment. This database records all schools active in the program and their level of certification in a given period.

[4] Data is available upon request.

[5] A larger number of schools and students in our sample are at the highest certification level, representing 60 % of the total schools (18 of 30) and 65.9 % of the total students (1003 of 1521). Furthermore, most schools are public, representing 56.67 % of total educational establishments (17 of 30). These figures are in line with the general national pattern, where most schools earn the highest certification level and a larger number of schools in the Chilean educational system are public (Salazar et al., 2022b).

[6] The choice of school grade and the subsequent age range of children in this study was not arbitrary. The survey design and implementation process was supported by a team integrated by a pedagogist and two pedagogy students, who participated as monitors during the survey elicitation process. Because our focus was on children's pro-environmental behavior, we were advised to balance children's attention span and literacy, being fourth grade (i.e., the last grade of the first basic cycle (1st-4th grades) of primary/elementary education) most suitable for balancing both criteria.

[7] The knowledge module of the questionnaire was adapted from NOOA (2015; 2017), which targeted school children at the same educational level.

4. Results

This section presents descriptive statistics of data and estimations from the multivalued treatment effect model. This econometric model estimates Eqs. (1)-(2) above.

4.1. Descriptive statistics

Descriptive statistics of the KAP variables for the entire sample and by certification level are shown in Table 1.

Data reveals, on average, a higher performance in pro-environmental behavior in children enrolled in schools with higher levels of certification. However, with the exception of recycling, this effect does not seem to be monotonic. To illustrate, while schools with the excellent level of certification present better performance than both basic and intermediate certification schools, schools with basic environmental certification show a better performance than schools with intermediate certification.

Our methodology requires computing the inverse probability weights and then performing adjusted regression estimations. To do so, we need to define a set of covariates Z, X for Eqs. 1 and 2, respectively. Children's and households' characteristics were obtained from our primary data. School level characteristics were obtained from different databases available through the Ministry of Education (MINEDUC). This information contains detailed records regarding each school's type (public, private-voucher, or private-paid schools), socioeconomic status, and teachers' general perceptions of their school administration. In addition, official records from MINEDUC statistics provide information on the number of students and teachers in each participating school. In Table 2, we present descriptive statistics of the explanatory variables for both outcome and treatment equations by certification level. A detailed description of each variable is available in Table A1, Appendix A.

Some regularities in the data deserve some attention. First, data shows that students in schools with the highest certification levels live in households with higher incomes and fewer family members. Parents' formal education is also higher in schools with the highest certification levels. With respect to school characteristics, schools with better academic performance (SIMCE) are schools earning the highest certification levels, and those that have relatively more students per teachers. In contrast, teachers' perceptions of school administration is more positive in schools obtaining the lowest certification level. Second, public schools earn lower certification levels than private schools. Third, there appears to be a non-linear behavior across certification levels. For example, parents/guardians in schools with the intermediate certification level show lower schooling levels compared to schools with a basic certification level. The same phenomenon occurs with household income per capita and household size variables.

Table 1
Descriptive statistics. KAP variables by certification level.

KAP variables by certification levels	Mean	Std. Err.	Min.	Max.
Knowledge [N = 1521]	0.538	0.005	0	0.938
Basic	0.510	0.013	0	0.875
Intermediate	0.489	0.015	0	0.875
Excellent	0.557	0.006	0	0.938
Attitudes [N = 1370]	0.800	0.005	0	1
Basic	0.794	0.011	0.223	1
Intermediate	0.784	0.015	0	1
Excellent	0.805	0.007	0	1
Practices - Lunch Box [N = 1372]	0.453	0.009	0	1
Basic	0.422	0.021	0	1
Intermediate	0.411	0.025	0	1
Excellent	0.470	0.011	0	1
Practices - Consumption [N = 1354]	0.560	0.006	0	1
Basic	0.539	0.012	0	1
Intermediate	0.520	0.017	0	1
Excellent	0.575	0.007	0	1
Practices - Recycling [N = 1385]	0.467	0.008	0	1
Basic	0.420	0.017	0	1
Intermediate	0.462	0.020	0	1
Excellent	0.482	0.009	0	1

Source: Own elaboration.

4.2. Estimation of the treatment decision

We estimate the treatment equation as a multinomial logit model. The levels of the multinomial logit are the levels of green school certification (i.e., our treatment variable). In Table 3, we present the results of the multinomial logit model, i.e., the treatment equation. We estimated the output equation for each of the five KAP variables. Thus, we have five multinomial logit models. We do so because the outcome variables have different numbers of observations. Nevertheless, findings are consistent across the five models. The baseline category in the multinomial logit is the basic certification level.

The results show that public schools have a lower probability of being certified at the intermediate level than at the basic level. Being a public school also decreases the probability of receiving the highest level of certification when compared to a basic certification. Regarding the SIMCE variable (i.e., our proxy of schools' academic performance), an increase in this standardized test score decreases the probability of being at the intermediate level of certification when compared to the basic level. However, this variable is not statistically significant in explaining the excellent certification level. Moreover, a larger number of students per teacher decreases the probability that the school will earn the intermediate or excellent certification levels compared to the basic level. Furthermore, a better teachers' perception of their school administration increases the probability that the school is certified at an intermediate or excellent level, as compared to the basic level. Finally, the students' household education and students' household per capita income are not related to the level of certification, which implies that only school—not household—characteristics impact the green school certification level.

In program evaluation methods based on econometric models, it is essential to assess the common support to ensure that the identified impact is attributable to the program and not to preexisting differences between the treatment and control groups.[8] This means that there should be an adequate overlap (i.e., common support) in the distributions of the variables of interest between the treatment and control groups, ensuring that each individual has a positive probability (different from zero) of receiving each treatment level. Consequently, we test whether this overlap assumption is violated. Fig. 1 displays the overlap after estimating the multivalued treatment effects.

The results indicate that there are sufficient common support areas to make meaningful comparisons between the certification levels. In other words, there is no evidence that this assumption has been violated, suggesting that groups are similar in terms of their observable characteristics.[9]

4.3. Estimation of the outcome variables

We estimate the output equation by a linear regression model. As previously mentioned, our outcomes of interest are the KAP dimensions (i.e., children's knowledge, attitudes, and practices). We present our main results in Table 4 and Fig. 2. We calculate the ATE and ATT for each KAP variable by comparing pairs of certification levels. Table 4

[8] Ensuring parallel trends is crucial for identification. This is true under the DiD approach, which is not feasible to implement in this paper due to data limitations. Then, evaluating the assumption for common support serves as an analogous test.

[9] We also report five additional figures showing standardized differences for each covariate used in the treatment model estimations, giving similar evidence of overlapping (See Figures A1-A5, Appendix A).

Table 2
Descriptive statistics of explanatory variables.

Variable	*Certification Level*					
	N	Average-Excellent	N	Average – Inter.	N	Average-Basic
Outcome model						
Dummy parents/guardian	904	0.967	173	0.954	249	0.928
		(0.179)		(0.211)		(0.259)
Age of guardian	848	38.429	153	38.288	231	38.58
		(7.618)		(7.849)		(8.115)
Household size [No.]	907	3.411	173	3.705	245	3.584
		(1.32)		(1.475)		(1.419)
Involvement in children's education [index]	885	0.868	167	0.867	243	0.894
		(0.123)		(0.138)		(0.118)
Household's formal education	830	13.304	147	10.978	223	12.071
		(3.027)		(3.031)		(2.557)
ln (Household's income per capita)	869	12.105	169	11.531	238	11.708
		(0.881)		(0.626)		(0.698)
Gender (male)	985	0.465	221	0.566	297	0.529
		(0.499)		(0.497)		(0.5)
Children's experience 1	934	0.91	192	0.917	262	0.954
		(0.286)		(0.277)		(0.209)
Children's experience 2	934	0.739	194	0.722	262	0.756
		(0.44)		(0.449)		(0.43)
Children's experience 3	929	0.692	192	0.745	262	0.756
		(0.462)		(0.437)		(0.43)
Children's experience 4	936	0.459	191	0.534	261	0.46
		(0.499)		(0.5)		(0.499)
Children's altruism level	937	8.267	190	8.311	261	8.126
		(2.324)		(2.493)		(2.328)
Treatment model						
Dummy public school	1006	0.327	222	0.707	297	0.848
		(0.469)		(0.456)		(0.359)
ln (SIMCE)	1003	6.326	221	6.197	297	6.276
		(0.061)		(0.03)		(0.091)
Household size [No.]	907	3.411	173	3.705	245	3.584
		(1.32)		(1.475)		(1.419)
ln (Household's income per capita)	869	12.105	169	11.531	238	11.708
		(0.881)		(0.626)		(0.698)
Students per teachers	1006	18.532	222	11.944	297	16.204
		(5.098)		(1.753)		(3.862)
School admin. perception	1006	0.861	222	0.821	273	0.868
		(0.26)		(0.385)		(0.339)

Note: Standard errors in parentheses.

shows the ATE and ATT estimated parameters as proportions. To calculate these measures, we divide ATE_t/POM_0 and ATT_t/POM_0, respectively.[10]

ATE: Estimate average treatment effect in population; ATT: Estimate average treatment effect on the treated.

Regarding knowledge, we found statistically significant results for ATT when comparing intermediate and excellent levels. Figures suggest that students in schools with an excellent certification have 7.31 % more knowledge, if all of those students are in a school with an excellent, rather than intermediate, certification, i.e., they received the high *treatment* instead than medium treatment.

Regarding attitudes, we found significant results for ATE when comparing schools with the highest certification level (treatment) and schools with intemediate certification level (control). In other words, if all students in the sample were enrolled in a school with an excellent certification level, they would perform 11.65 % higher in pro-environmental attitudes than if they were in a school with an intermediate certification level.

Regarding practices, we found statistically significant results for both ATE and ATT when considering the contents of the children's lunch boxes. This practice is one where children could have more decision making power in the household, and it can be closely linked with the performance of the program on children's behavior. In ATE, we find a significant effect when comparing excellent certification level (treatment) against basic certification level (control) and excellent certification level (treatment) against intermediate certification level (control). Findings indicate that if all students in the sample were enrolled in a school with an excellent certification, they would perform 34.96 % better in lunch box practices than if they were in a school with basic certification. We found similar results when comparing excellent and intermediate certification levels, with an increase in performance of 35.48 %. Additionally, the ATT for this practice is statistically significant when we estimate and compare the pairs of certification: intermediate vs. basic, excellent vs. basic, and excellent vs. intermediate. Findings suggest a positive effect when students in schools with high levels of certification receive the excellent *treatment* instead of basic, and when they receive the excellent *treatment* instead of intermediate (41.72 % and 40 %, respectively). However, when students in schools with intermediate levels of certification receive the intermediate *treatment* instead of basic, the performance of this KAP indicator decreases by 30.69 %. This finding signals a non-linear effect of different levels of environmental certifications on pro-environmental behavior. Previous literature estimating the returns to education in the labor market has found a similar regularity, with a lower marginal effect of education at lower levels of schooling (Uysal, 2015). This non-linear return effect is also observed in the health/education nexus (Russo and Dias, 2016).

Another variable included in the consumption dimension of KAP relates to avoiding the use of plastic. These practices are less likely to be

[10] The outcome model (linear regressions) for the KAP variables (outcomes) are presented in Tables A2-A5, Appendix A.

Table 3
Multinomial Logit model for certification levels (KAP variables).

	(1) Knowledge	(2) Attitudes	(3) Pract. Lunch-Box	(4) Pract. Consumption	(5) Pract. Recycling
Certification Level: Basic					
		(baseline outcome)			
Certification Level: Intermediate					
Dummy Public School	−3.7637***	−3.5718***	−3.7953***	−3.5077***	−3.4744***
	(0.4321)	(0.4830)	(0.5505)	(0.5085)	(0.4909)
ln(SIMCE)	−14.0197***	−14.7297**	−16.5381***	−14.9629**	−13.6330**
	(5.0508)	(5.8405)	(6.3918)	(6.1306)	(6.0254)
Household's education	−0.0012	−0.0340	−0.0803	−0.0183	−0.0702
	(0.0650)	(0.0739)	(0.0740)	(0.0744)	(0.0724)
ln(Income per capita)	0.0616	0.0279	0.1700	0.0250	0.0660
	(0.2491)	(0.2778)	(0.2876)	(0.2849)	(0.2803)
Students by teachers	−0.5153***	−0.5143***	−0.5215***	−0.5374***	−0.5354***
	(0.0480)	(0.0534)	(0.0575)	(0.0545)	(0.0547)
School Administration	1.8842***	1.8236***	2.0912***	1.7894***	1.6415***
	(0.5153)	(0.5958)	(0.6385)	(0.6341)	(0.6211)
Constant	95.2060***	100.3533***	110.6305***	101.9642***	93.8109**
	(31.0820)	(35.9116)	(39.5029)	(37.7441)	(37.1020)
Certification Level: Excellent					
Dummy Public School	−3.2971***	−3.0295***	−3.2535***	−2.9955***	−2.8724***
	(0.4087)	(0.4453)	(0.5021)	(0.4636)	(0.4495)
ln(SIMCE)	3.4857	2.9958	1.2431	1.3730	3.2674
	(3.0487)	(3.4792)	(3.7502)	(3.6086)	(3.5416)
Household's education	−0.0066	−0.0137	−0.0270	−0.0269	−0.0258
	(0.0395)	(0.0426)	(0.0431)	(0.0432)	(0.0421)
ln(Income per capita)	0.0443	0.0396	0.1250	0.1364	0.0605
	(0.1658)	(0.1790)	(0.1790)	(0.1815)	(0.1756)
Students by teachers	−0.1381***	−0.1304***	−0.1353***	−0.1179***	−0.1245***
	(0.0218)	(0.0231)	(0.0265)	(0.0245)	(0.0230)
School Administration	1.0462***	0.8441*	1.1312**	0.8122*	0.7181
	(0.4049)	(0.4582)	(0.4802)	(0.4867)	(0.4774)
Constant	−17.6262	−14.5119	−4.2888	−5.4884	−16.3804
	(19.0080)	(21.6823)	(23.6177)	(22.6081)	(22.1311)
No. obs	1041	904	887	870	900
Prob > Chi2	0.0000	0.0000	0.0000	0.0000	0.0000
Log pseudo-likelihood	−554.2288	−471.6181	−452.6046	−451.2288	−468.0664
Pseudo R2	0.3479	0.3443	0.3464	0.3444	0.3370
Akaike Inf. Criteria	1136.4576	971.2362	933.2092	930.4576	964.1328
Bayesian Inf. Criteria	1205.7287	1038.5318	1000.2390	997.2166	1031.3663

Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parenthesis.

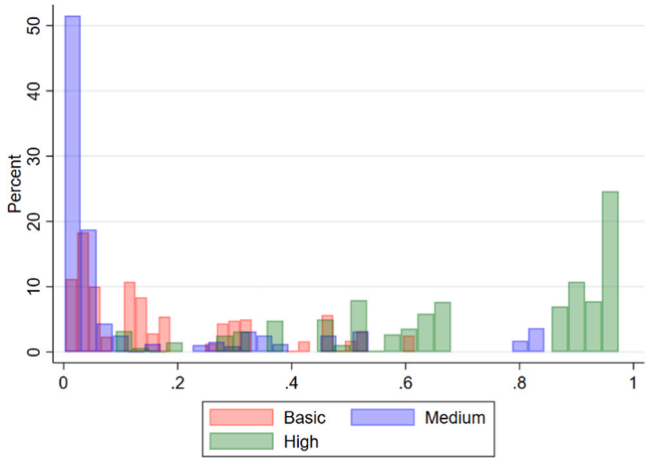

Fig. 1. Multivalued treatment-effects (Overlap). *Source*: Own elaboration based on secondary data.

under the children's control compared with lunch box practices. Results evidence a positive and statistically significant effect when students in schools with high levels of certification receive the excellent *treatment* instead of basic (increase of 7.85 %). Again, the effect turns negative when students in schools with intermediate levels of certification receive the intermediate *treatment* instead of basic (decreased by 17.12 %). The last set of practices in the children's KAP relates to recycling. We only find statistically significant effects in ATT when estimating and comparing students in schools with intermediate certification levels instead of basic. This suggests that students in schools with intermediate levels of certification would perform 30.99 % lower in recycling if all of them were in a school with an intermediate certification level instead of a basic one. These results reinforce the argument of a potential non-linear effect across levels of environmental certifications.

Fig. 2 displays the potential outcomes for the KAP variables.

As previously discussed, results suggest non-linearities in our outcomes of interest by treatment level. Specifically, the mean of the estimated potential outcomes decreases at the intermediate certification level (compared to the basic certification level) and increases at the excellent certification level.

5. Robustnes checks

One potential limitation of this paper is having a small number of observations in the categories of intermediate and basic levels of environmental certification (i.e., the lower doses of our treatment). It is worth clarifying that this composition mirrors the national figures; that is, there are more schools certified at the excellent level compared to the two other levels. To assess whether dealing with a small number of observations may be driving our results, we aggregate both basic and intermediate certification levels into one category. Then, we estimate

Table 4
Multivalued Treatment-effects (Doubly Robust Estimation).

Variable	*Knowledge*		*Attitudes*		*Practices – Lunch Box*		*Practices – Consumption*		*Practices – Recycling*	
	ATE	ATT	ATE	ATT	ATE	ATT	ATE	ATT	ATE	ATT
	Certification level									
Inter. vs Basic	−0.0370	0.0224	−0.0768	−0.0520	−0.0038	−0.3069***	−0.0183	−0.1712**	−0.0383	−0.3099***
	(0.0435)	(0.0713)	(0.0490)	(0.0351)	(0.1281)	(0.0879)	(0.0602)	(0.0673)	(0.1107)	(0.0900)
High vs Basic	0.0173	0.0002	0.0307	0.0479	0.3496***	0.4172***	0.0284	0.0785**	−0.0110	0.1028
	(0.0326)	(0.0387)	(0.0322)	(0.0340)	(0.1226)	(0.1303)	(0.0336)	(0.0378)	(0.0856)	(0.0634)
High vs Inter.	0.0563	0.0731*	0.1165**	0.0899	0.3548**	0.4004**	0.0475	0.0590	0.0284	0.0761
	(0.0384)	(0.0424)	(0.0543)	(0.0583)	(0.1468)	(0.1873)	(0.0599)	(0.0660)	(0.0792)	(0.1033)
No. obs.	1041		904		887		870		900	

Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parenthesis.

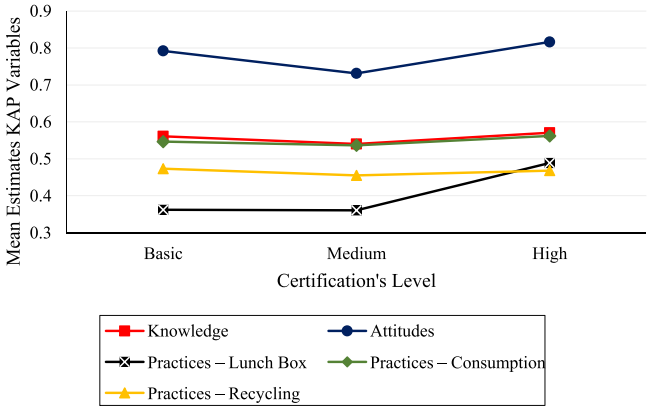

Fig. 2. Estimated mean of KAP variables by certification levels. Source: Own elaboration based on primary data.

the multivalued treatment effect model by comparing the excellent certification level (treatment) versus the basic-intermediate certification level (control), as shown in Table 5.

ATE: Estimate average treatment effect in population; ATT: Estimate average treatment effect on the treated.

Overall, results show a positive and statistically significant effect in most of the pro-environmental behavior measures reported by students in schools with the excellent level of certification (i.e., students with higher doses of the treatment). In other words, we can conclude that the environmental certification program has been effective in boosting pro-environmental behavior in school children when the highest level of certification is achieved.

6. Discussion

Our findings confirm the relevance of incentivizing pro-environmental behavior in the early stages of life. In other words, our results show that an environmental educational program targeting school children can affect those children's value systems, which could, in turn, change their habits towards more sustainable consumption and disposal of plastic waste. As expected, environmental certification system has a stronger effect on children enrolled in schools achieving the highest level of certification. However, this is not the case for the intermediate level of environmental certification.

The reverse effect observed when switching from basic to intermediate level of certification could be in line with a non-linear effect of environmental education on pro-environmental behavior (e.g., diminishing returns to education), which was also documented in the literature. An alternative explanation of this finding could be the program's inability to implement the desired social outcome (i.e., higher doses of the treatment promoting larger changes in behavior).[11] The robustness check results appear to support this notion. Specific characteristics of the program design (e.g., current requirements to achieve a given certification level) may make the intermediate certification irrelevant for boosting pro-environmental behavior. To improve the program's design, it is important to redefine incentives in the certification system so that schools value a higher certification level as a step further toward achieving excellent environmental performance. This can be achieved by better differentiating the benefits of reaching each level of environmental certification.

Finally, socialization within the family provides an interesting context for learning. Results reveal a larger effect of the program on more visible pro-environmental practices with respect to the consumption and disposal of plastic, i.e., lunch box packing. This finding sheds some light on the importance of incentivizing parent-child work at home to strengthen the intergenerational transmission of personal environmental norms and environmental awareness within the household.

7. Conclusion

Environmental education provides people with the information they need to better understand the causes and consequences of environmental issues such as plastic pollution, helping promote positive attitudes toward nature and pro-environmental practices. These knowledge, attitudes, and practices contribute to minimizing the impact of human activity on the environment. This paper aims to evaluate the effects of an environmental education program on children's pro-environmental behavior on plastic waste. This program takes the form of school environmental certifications, which are part of a larger strategy to increase sustainable practices in students and educational communities in Chile. In this paper, pro-environmental behavior is measured by knowledge, attitudes, and practices (KAP) regarding the consumption and disposal of plastics.

The different certification levels that schools can reach can be understood as different doses of a treatment with the potential of affecting children's outcomes. To address the nature of the treatment variable, we propose estimating a multivalued treatment framework to evaluate the effects of the certification program. We use student and school level data from 30 schools participating in the environmental certification system in the Bío-Bío Region of Chile.

Results evidence a positive effect of a school's excellent level of

[11] A detailed revision of the indicator matrix used for the assessment of certification levels by the Ministry of the Environment indicates a lack of differences in the requirements to reach either a basic or an intermediate level of certification. Additionally, both levels of certification last the same number of years, and schools in either level can reach the same benefits upon certification. Thus, it can be hypothetized that with the current requierements, these certification levels are not providing different doses of a treatment.

Table 5
Multivalued Treatment-effects (Doubly Robust Estimation).

Variable	*Knowledge*		*Attitudes*		*Practices – Lunch Box*		*Practices - Consumption*		*Practices – Recycling*	
	ATE	ATT	ATE	ATT	ATE	ATT	ATE	ATT	ATE	ATT
	Certification level									
High vs.	0.0108	−0.0007	0.0546**	0.0485	0.3496***	0.4020***	0.0577*	0.0735**	0.0902*	0.1042*
Basic - Medium	(0.0290)	(0.0342)	(0.0259)	(0.0321)	(0.0950)	(0.1212)	(0.0312)	(0.0352)	(0.0546)	(0.0609)
No. obs.	1041		904		887		870		900	

Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parenthesis.

environmental certification on children's pro-environmental behavior regrading consumption and disposal of plastic. This effect seems stronger in plastic waste practices where children hold more decision-making power (e.g., deciding on the plastic contents of their lunch box) and when comparing the excellent level of certification with both the intermediate and basic categories. This finding confirms our notion that higher doses of the program promote larger responses in children, which translates into larger effects on the studied dimensions of their KAP. Surprisingly, estimated effects for lower doses of the treatment do not seem to follow a monotonic trend, suggesting that children enrolled in establishments with basic certification levels may be more pro-environmental than those in schools with an intermediate level of certification. Despite its importance, this issue has received scarce attention, especially in the framework of environmentally certified schools. Thus, an assessment of the emergence of intergenerational spillovers in environmentally certified schools is an interesting venue for future research.

Finally, one of our study's limitations is the lack of information on schools joining the certification program over time, which impedes the exploitation of data variation across time and groups. If this data were available, the DiD approach would be preferred, as it would provide additional insights and strengthen the robustness of our findings. This could also be investigated in the future.

CRediT authorship contribution statement

Nuria González: Writing – original draft, Investigation, Formal analysis, Conceptualization. **Marcela Jaime:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Mauricio Leiva:** Writing – original draft, Software, Investigation, Data curation. **César Salazar:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Cesar Salazar reports financial support was provided by Environment for Development. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ijedudev.2024.103106.

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