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**The Effect of School Green Policies on Student Outcomes: a
Counterfactual Impact Evaluation Using ICCS 2022 Data**

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1. Introduction

1.1. Background and motivation

1.1.1. The environmental and policy context

The contemporary global landscape is increasingly shaped by environmental crises of unprecedented scale and intensity. Climate change and environmental degradation have moved from long-term background concerns to immediate political, social and educational priorities. The European Commission describes climate and environmental challenges as “this generation’s defining task”, while the European Climate Pact states that the climate crisis is “not a future problem” but an immediate condition already reshaping ecosystems and human well-being (European Commission, 2019; European Commission, 2020). Similarly, UNESCO argues that sustainable development now requires a transformation involving both changes in individual behaviour and the reorganization of wider social structures. Environmental transition, therefore, cannot be reduced to technological innovation or regulatory reform alone; it must also involve changes in values, learning and everyday practices (UNESCO, 2020).

In response to this global urgency, the European Union has taken a leading role in international climate action through a series of ambitious policy documents. The European Green Deal, introduced by the European Commission in 2019, represents a new growth strategy aimed at converting the EU into an environmentally conscious society and achieving climate neutrality by 2050. Recognizing that top-down governmental action is not enough on its own, it further stresses that public participation and trust in the transition are necessary for its success (European Commission, 2019). In the same policy context, the European Climate Pact (European Commission, 2020) was launched to encourage citizens, communities and organizations to take part in climate action and promote better sustainable behaviours across society (European Commission, 2020). The Pact acknowledges that tackling climate change and lowering carbon emissions will demand a radical rethinking of everyday behaviours and lifestyle choices, highlighting the often overlooked power of individual and collective action in creating a greener Europe (European Commission, 2020). UNESCO’s roadmap for Education for Sustainable Development likewise frames sustainability challenges as pressing worldwide concerns that call for changes at both the individual and collective level, and places

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education at the centre of this response (UNESCO, 2020). Similarly, the 2022 Council Recommendation defines learning for sustainability as a multidimensional approach that provides students with the knowledge, skills and attitudes needed to understand interconnected global crises and to take action towards a more sustainable society (Council of the European Union, 2022).

The urgency of behavioural change is further reinforced by public opinion evidence across Europe. The European Climate Pact reports that nine out of ten Europeans consider climate change a serious problem and regard environmental protection as personally important (European Commission, 2020). Recent data support this concern: according to Special Eurobarometer 550, over three-quarters of Europeans (78%) believe environmental issues directly impact their daily life and health (European Commission, 2024). Furthermore, there is strong public support for social reforms aiming at protecting the environment, with 58% of respondents identifying the promotion of the circular economy as one of the most effective way to address environmental challenges (European Commission, 2024). However, despite these high levels of awareness and willingness to adopt eco-friendly behaviours, the actions Europeans report being most likely to take remain mainly low-effort and low-impact, such as sorting waste for recycling (66%) and using reusable packaging (52%). More demanding behavioural changes, such as willing to pay more for sustainable products, still meet resistance (38% of respondents would not), suggesting that a significant gap persists between general environmental concern and the adoption of high-impact actions (European Commission, 2024).

This gap between environmental awareness and effective action has led to significant disappointment among younger generations, resulting in never-seen levels of youth mobilization. The Fridays for Future movement exemplifies how a locally initiated protest, which began in August 2018 when Greta Thunberg started striking outside the Swedish Parliament, can quickly become a global youth-led climate movement calling on policymakers to listen to scientists and act in accordance with the Paris Agreement (Fridays for Future, n.d.). The movement's importance consists not only in highlighting how serious climate issues are for younger generations, but also in linking environmental concern directly to school-age populations. Considering that the movement originated as a school strike, it also underlines a broader point: schools are not external to climate politics and play as primary institutional sites for the development of environmental knowledge.

1.1.2. Education and schools in the sustainability transition

In this context, the role of education becomes essential. Learning for the green transition and sustainable development is no longer an optional addition to school curricula, it has become a central part of the wider social response to environmental crisis. UNESCO defines education for sustainable

development as a process that provides learners with the knowledge, skills and attitudes required to make informed decisions and take responsible action for environmental integrity, economic viability and a fair society (UNESCO, 2020). Importantly, UNESCO stresses that this is not only a matter of curricular content. It also concerns the learning environment and the broader institutional setting, because learners should experience sustainability as an integrated part of their daily institutional life, not only as abstract content delivered in the classroom (UNESCO, 2020). Another key conceptual instrument in this policy framework is GreenComp, the European sustainability competence framework. Developed as one of the policy actions linked to the European Green Deal, GreenComp is intended to support education programmes by providing a common and shared definition of what sustainability as a competence means for learners across the EU (Bianchi et al., 2022). In this sense, it makes clear that sustainability education is expected not only to raise awareness, but also to develop learners' capacity to act as informed and responsible agents of change. This is particularly important in the school context, where such competences must be translated into concrete educational environments, practices and forms of participation. Likewise, the 2024 Education and Training Monitor states that educational systems across Europe bear the responsibility of preparing learners and educators to engage meaningfully with the new demands of ecological and technological change, positioning education as a core driver of social and environmental resilience (European Commission, 2024). Ultimately, these documents present education not as a secondary support to the sustainability transition, but as one of its central components.

Within this educational landscape, schools act as socialization institutions of particular relevance. They are among the few social environments in which children and adolescents repeatedly engage with norms, values and peers that gradually shape their long-term orientations and behaviours. The rising presence of sustainability-oriented schools, such as eco-schools or institutions with sustainability-focused curricula, reflects a wider recognition of this role. For this reason, recent European and international frameworks increasingly treat schools as key sites for the development of sustainability-related knowledge. The 2024 Education and Training Monitor emphasizes that learning for sustainability relies on both a “whole-person approach”, which goes beyond classic teaching to engage both the emotional and practical dimension of learning, and a “whole-school approach”, which requires sustainability to be embedded inside the organizational, practical and learning dimensions of school life, creating an environment that connects theoretical knowledge to everyday institutional practice (European Commission, 2024). UNESCO advances the same logic by insisting that sustainability learning must involve not only what students know, but also what they feel, value and do (UNESCO, 2020). What emerges from these frameworks is a consistent recognition that

schools contribute to long-term environmental orientations through everyday socialization, not merely through occasional information delivery.

1.1.3. Sustainability learning between policy and practice

The progressive institutionalization of sustainability has also led to a stronger emphasis on monitoring. The 2024 Education and Training Monitor is explicitly built around a new conceptual framework for monitoring learning for sustainability, reflecting the acknowledgement that, as long as sustainability learning remains dependent on the initiative of individual teachers or schools rather than being systematically embedded across educational institutions, its potential to develop young people's competences will remain limited (European Commission, 2024). It further shows that schools can play an important role in encouraging action for sustainability, but that only 42% of young people feel having a good opportunity to learn about sustainability in school (European Commission, 2024). At the same time, the evidence suggests that schools with stronger sustainability profiles are becoming more common, although unevenly and incompletely: according to the same report, most EU education systems have started helping schools develop whole-school approaches to learning for sustainability. Yet curricular coverage remains limited, futures literacy is weakly addressed and school principals tend to focus mainly on relatively low-impact activities, while teachers often feel underprepared for more modern and action-oriented pedagogies. UNESCO's roadmap confirms this pattern, showing that many countries now include sustainability in policies, teacher education and curricula, but that implementation often remains too narrow and too focused on scientific content rather than on the real transformation needed to produce behavioural change (UNESCO, 2020). This combination of policy diffusion and mixed implementation highlights why differences between schools matter. When some schools adopt stronger sustainability profiles than others, it becomes necessary to ask whether these differences simply correlate with student outcomes or actually drive them.

This increased emphasis on monitoring is also reflected in major International Large-Scale Assessments (ILSAs), which have progressively integrated environmental- and sustainability-related constructs into their analytical frameworks and survey instruments. In ICCS 2022, sustainability was identified as one of the five contemporary focus areas, and the study expanded the emphasis on education for sustainable development compared with previous cycles (Schulz et al., 2023). Its results show that majorities of students regarded pollution (80%), water shortages (72%), climate change (68%) and loss of biodiversity (61%) as major threats to the world's future (Schulz et al., 2025). PISA 2018 points in a similar direction by conceptualizing students' readiness to face environmental challenges in terms of knowledge and attitudes: around three quarters of students were

environmentally aware, almost four in five reported a sense of responsibility towards the planet, and nearly half were classified as “environmentally enthusiastic”, yet only around one fifth were actively involved in environmental action (OECD, 2022). TIMSS shows a comparable broadening of scope. While environmental awareness was formalized in TIMSS 2019 through dedicated cognitive scales (Yin & Foy, 2020), TIMSS 2023 extended this concept by introducing a specific framework on environmental attitudes and behaviours and by bringing environmental knowledge, attitudes and behaviours together within a broader conception of environmental literacy (Reynolds & Komakhidze, 2022; Bookbinder et al., 2025). Overall, these developments prove that sustainability is no longer a peripheral concern in comparative educational research, but an increasingly visible and structured domain of international educational measurement.

At the same time, the environmental outcomes of education remain difficult to assess, because policy ambitions, environmental concern and actual student behaviour do not always align. Recent OECD data illustrates this inconsistency among 15-year-olds students, revealing patterns deeply stratified by socio-economic status. Although climate change awareness reaches 88% in the most advantaged quartile and 68% in the least advantaged, actual participation in pro-environmental action is remarkably lower, standing at only 40% and 33% for the respective groups. The report *Monitoring Learning for Sustainability* confirms this trend, identifying a persistent gap between the formal recognition of sustainability in curricula and the actual capacity of schools to foster competences that translate into concrete attitudes and behaviours (Mulvik et al., 2024). The 2024 Education and Training Monitor reaches a similar conclusion for young Europeans: 83.6% believe it is important to make changes to their personal lifestyle to become more environmentally friendly, but only 29.8% report engaging in sustainable practices in daily life (European Commission, 2024).

These findings suggest that schools are relevant settings for shaping environmental dispositions, while also indicating that opportunities and outcomes are unlikely to be evenly distributed. In this context, understanding whether and how school environments influence students’ environmental attitudes and sustainable behaviours becomes an important and timely issue.

1.2. Discussion of the related literature

1.2.1. Conceptual and theoretical foundations

The literature provides a broad theoretical basis for treating sustainability-related dispositions and behaviours as legitimate educational outcomes rather than as purely external social preferences.

In the more general field of green education and education for sustainable development, researchers define the area as extending beyond the transmission of environmental knowledge to include the development of values, competences, critical thinking and action-oriented capacities that enable learners to help building a more sustainable society (Akinsemolu & Onyeaka, 2025). From this perspective, education is expected not only to increase awareness of environmental challenges, but also to cultivate forms of responsibility and participation that can support behavioural change. A related line of research in educational effectiveness reinforces this view by showing that schools can shape traditional cognitive outcomes as well as non-cognitive dispositions and forms of intended participation. In their cross-country analysis of citizenship education, Isac et al. (2014) argue that schools should be understood as environments in which opportunities to learn, democratic climate and participatory experiences may influence a wide range of student outcomes. Although their focus is civic rather than environmental, this framework is highly relevant here because it supports the idea that attitudes, values and future dispositions can be studied as outcomes of schooling. Finally, a recent review by Ambasz et al. (2025) places this argument more directly in the environmental domain, identifying three transmission channels between schooling and environmental outcomes: cognitive mechanisms such as information-processing and understanding, affective mechanisms such as concern and willingness to act, and situational mechanisms linked to resources and opportunities. At the same time, they note that the literature remains largely observational and that behavioural outcomes are generally harder to influence and to measure than attitudes.

These contributions share a conceptual foundation for investigating whether school environments can shape students' environmental attitudes and sustainable behaviours, while also indicating that the underlying mechanisms are multidimensional and go beyond knowledge acquisition alone.

1.2.2. Student environmental outcomes

Shifting focus to individual outcomes, a second body of work examines more directly the nature of the environmental behaviours that education may shape among young people.

Rather than treating pro-environmental orientation as a single construct, recent studies increasingly distinguish between several related but non-identical dimensions, including environmental concern,

attitudes towards environment protection, self-reported sustainable behaviours, consumer practices and expected future participation in environmental action. Drawing on ICCS 2022 data for Poland, Wasilewska (2023) demonstrates this multidimensionality precisely by analysing students' perceptions of environmental threats, their views on environmental responsibility, their reported behaviours and future engagement. Her findings suggest that these dimensions do not always align: concern about environmental threats is widespread, but behavioural indicators are more variable and differ by gender, socio-economic background and civic knowledge. A comparable pattern emerges from Javornik's (2024) analysis of Slovenian ICCS 2022 data, which finds that higher civic knowledge predicts environmental concern and expected future involvement but not related to current or past engagement. This distinction underscores that students' environmental dispositions may involve different layers, from awareness to actual mobilization. More broadly, Isac et al. (2025) argue that ILSA research has increasingly conceptualized these outcomes through complementary domains such as environmental knowledge and willingness to act pro-environmentally, while also showing that no single dataset fully captures the whole spectrum of sustainability-related learning outcomes. Braun et al. (2018), in turn, reinforce the same point from by treating attitude, knowledge and behaviour as analytically separate outcomes and showing that educational effects may vary across them and across demographic groups.

A recurring insight of this body of research is that the literature does not converge on a single environmental outcome, but maps instead a set of related dispositions and practices, among which behaviours emerge as the most difficult to interpret and explain.

1.2.3. The role of the school

More directly relevant to the present study is a third line of research, which moves inside the school to ask whether, and through which institutional mechanisms, educational environments shape students' orientations.

Throughout this literature, the school is understood not as a neutral background, but as an active setting in which policies, pedagogical practices and organizational culture may jointly influence how environmental dispositions are formed. Mónus (2022), studying Hungarian secondary schools, shows that students' environmental attitudes and pro-environmental behaviour are associated not only with school sustainability efforts, but also strongly with socioeconomic factors, including parental education, school socioeconomic composition and place of residence. This result suggests both that school-level sustainability policies may matter and that their effects must be interpreted alongside compositional inequalities. A more explicitly whole-school perspective is developed by Cheah and

Huang (2019), who argue that environmental citizenship is fostered not only through isolated classroom content, but through the interaction of learning activities and experiences embedded in a broader civic and sustainability-oriented school culture. Moving to the classroom level, Penrod et al. (2025) show using ICCS 2016 data that more open discussion climates are associated with higher levels of climate-related activism and pro-environmental behaviour, even after controlling for gender, civic knowledge and socioeconomic factors. Coertjens et al. (2010) likewise provide evidence that hands-on science teaching and environmental learning activities are associated with more favourable environmental outcomes, confirming that schools can make a measurable difference in how students' relate to environmental issues. Other studies reinforce the importance of how environmental education is delivered in practice. Cincera et al. (2023) report that participation in residential outdoor programmes, eco-clubs and nature-oriented non-formal activities, as well as exposure to community-based approaches, is positively related to dimensions of environmental literacy among Czech students. Similarly, Boeve-de Pauw and Van Petegem (2018) show that the educational effects of eco-schools become clearer once formal labels are set aside in favour of the concrete learning processes operating within schools, including environmental policy, didactics and the presence and use of natural elements on campus.

The evidence reviewed here points to a consistent conclusion: schools do matter for environmental outcomes, but the nature and extent of their influence depends on how policy, practices, climate, participation and broader sustainability profiles are conceptualised and operationalised.

1.2.4. Intervention studies and causal evidence

Beyond descriptive associations, a further body of research offers more direct empirical evidence on the effectiveness of environmental and sustainability education, although with considerable variation in design and scope.

At a general level, the meta-analysis by van de Wetering et al. (2022) provides a comprehensive assessment of the cumulative evidence on environmental education for children and adolescents, concluding that such programmes produce indeed positive shifts in knowledge, attitudes and behaviour. Results however differ considerably across studies and , since behavioural outcomes are often measured through self-reports, the strength and generalizability of these effects must be interpreted with caution. More robust designs have nevertheless started to emerge. Olsson et al. (2022), for example, use a three-wave longitudinal design to show that students' action competence for sustainability can develop over time in relation to their experience of ESD teaching at school,

although some components, such as confidence in one's own influence, appear again more difficult to strengthen than others. Even stronger causal evidence is provided by Jaime et al. (2023), who evaluate a randomized field experiment in Chile and find sizeable positive effects of an environmental education programme on children's knowledge, attitudes and practices, while also showing that these effects do not automatically spill over to parents. A related contribution by Salazar et al. (2024) moves closer to the level of broader school profiles by examining a green school certification programme through a multivalued treatment-effects framework. Their findings highlight that higher certification levels are associated with more favourable pro-environmental practices, especially where children have greater room for direct participation, while also suggesting that the relationship may be non-linear across certification stages. Additional studies based on more specific interventions point in the same direction. Houmam and Aomar (2023), using propensity score matching, report positive effects of school-based environmental clubs on awareness and eco-citizen behaviours. Other studies exploring shorter and more targeted interventions can improve environmental outcomes under certain conditions, with their impact dependent on the approach design. For instance, Keskin et al. (2020) showed that interactive, project-based e-learning programs significantly outperform traditional textbook learning in promoting water conservation behaviours among middle schoolers. Pacini et al. (2025) showed that a half-day intervention on green facades successfully produced long-term knowledge gains, but only brings short-term attitudinal changes, suggesting that these shifts require continuous engagement. Even within higher education, Ma et al. (2020) further stress that the pedagogical structure matters, demonstrating that student-driven education leads to significantly higher environmental awareness than conventional teacher-driven learning. At the same time, however, the methodological literature reminds us that stronger designs do not eliminate all inferential problems. As Rutkowski and Delandshere (2016) argue, causal claims in education, especially when based on large-scale observational data, require careful attention to validity threats and to the limits of generalization.

The literature reviewed so far points to a coherent but still incomplete picture: while environmental and sustainability education is consistently associated with positive outcomes, the stronger empirical evidence tends to come from specific interventions or localised programmes rather than from broader school sustainability profiles. On the one hand, sustainability-related learning outcomes are now firmly established in the literature as multidimensional educational outcomes, covering concerns, attitudes, agency, intended participation and behaviour. On the other hand, the evidence also indicates that schools may influence these outcomes through multiple and partly overlapping channels, including formal policy, classroom climate, participatory experiences, didactics and broader

institutional culture. Nevertheless, the empirical record remains mixed. While a number of studies document associations between school characteristics and students' environmental outcomes, others provide more robust evidence through interventions, longitudinal designs or quasi-experimental strategies. Yet this more robust evidence typically concerns limited programmes or localised treatments rather than whole-school sustainability profiles. For this reason, although the literature provides substantial support for the idea that education and schooling can matter for environmental outcomes, it leaves open important questions about how far whole-school sustainability orientations shape students' attitudes and behaviours when more comparable counterfactuals are considered. This point provides the basis for the next subsection, which turns more explicitly to the research gap and the specific question addressed by the present thesis.

1.3. Research gap and research question

The literature reviewed in the previous subsection provides a reasonably consistent starting point for the present study. As discussed above, environmental outcomes among students should not be treated as a single dimension, but as a set of related but distinct constructs, including concern about environmental threats, pro-environmental attitudes, willingness to act and reported behaviours, which do not necessarily move together. The evidence further suggests that schooling may shape these outcomes through multiple pathways, with behavioural indicators that appear more difficult to interpret. At the same time, school-level factors such as environmental policy, didactics, participation opportunities and classroom climate, may all contribute to students' environmental orientations, though their influence depends considerably on how sustainability efforts are defined and operationalized (Wasilewska, 2023; Ambasz et al., 2025; Boeve-de Pauw & Van Petegem, 2018).

This body of work, however, reveals also important conceptual and methodological limitations. As the methodological literature cautions, causal claims in education, especially when based on non-experimental or large-scale assessment data, require careful attention to validity, comparability and the assumptions needed to construct credible counterfactuals (Rutkowski & Delandshere, 2016). Against this standard, three limitations stand out. A first limitation concerns the overall design of much of the existing evidence. A large share of the literature on environmental education and school sustainability remains based on correlational analyses, cross-sectional data or qualitative case studies, which makes it difficult to distinguish genuine school effects from pre-existing differences in students' family background or prior dispositions (Ambasz et al., 2025). This limitation is especially relevant when the aim is to compare schools with stronger or weaker environmental orientations, since possible differences in student outcomes may partly reflect selection processes and compositional inequalities rather than the independent influence of school. Existing research itself points in this direction, as school socioeconomic composition, parental education and other background factors repeatedly emerge as important correlates of students' environmental attitudes and behaviours (Mónus, 2022; Braun et al., 2018). A second limitation concerns the scope and comparability of the available evidence. Many studies focus on single countries, specific school systems or localized settings, while much of the international evidence relies on earlier or different datasets, such as previous ICCS cycles, TIMSS 2019 or PISA-based analyses (Isac et al., 2025). A third limitation concerns the definition of the treatment itself. The literature does suggest that schools matter, but it does not define school environmental proactivity in a consistent way: some studies focus on eco-school labels, others on classroom climate, school policy, participation opportunities or specific educational modules, which makes comparison across studies less straightforward and

confirms that comprehensive school-level environmental profiles remain difficult to operationalize (Penrod et al., 2025; Boeve-de Pauw & Van Petegem, 2018). Much of the stronger evidence comes from limited targeted interventions, such as school clubs, targeted programmes or specific certification schemes, rather than from broader school sustainability profiles. This pattern holds in both longitudinal and experimental studies and in programme-based evaluations (Olsson et al., 2022; Jaime et al., 2023; Salazar et al., 2024; Houmam & Aomar, 2023). As a result, relatively few studies simultaneously focus on secondary school students, operationalize school-level environmental proactivity in an exhaustive way and estimate effects through a counterfactual logic.

While the literature provides substantial support for the idea that education and schools may influence environmental outcomes, it has not yet established with sufficient rigour whether differences in school-level environmental orientation translate into differences in student outcomes under more comparable conditions of analysis. In response to this gap, the present thesis addresses the following research question: *To what extent do school-level environmental policies and practices influence students' environmental attitudes and behaviours, after having controlled for individual characteristics?* The focus on both attitudes and behaviours is intended to capture a more complete picture of students' environmental orientation by considering both their dispositions and their reported practices, while also making fuller use of the information available in the dataset.

1.4. Contribution and structure of the thesis

Building on the research gap identified above, this subsection clarifies the specific contribution of the thesis and presents the structure of the chapters that follow.

The thesis contributes to the literature in several ways. Regarding its empirical focus, it investigates school-level environmental policies and practices rather than isolated activities or short-term interventions, shifting attention towards a more complete dimension of school environmental proactivity. It also provides an updated assessment based on ICCS 2022, a recent dataset that is particularly relevant given the increased prominence of education for sustainable development in the most recent cycle. In this respect, to capture more directly the sustainability-related knowledge dimension of the ICCS 2022 assessment framework, the study further includes a specific ESD subscale, whose use represents an additional contribution, by allowing a more focused examination of ESD-related proficiency. Methodologically, the thesis adopts a counterfactual perspective and implements a propensity score matching design, an approach that reduces model dependence and enhances the internal validity of causal effect estimates by achieving transparent and verifiable balance between treated and non-treated students on the major observable covariates. Unlike standard regression-based approaches, PSM does not rely on functional form assumptions to control for confounders but instead builds a comparison group that is directly comparable to the treated group in terms of observed characteristics. By controlling for individual, classroom and school-level characteristics prior to estimating the treatment effect, this approach provides a more credible basis for assessing the extent to which school-level environmental policies and practices are independently associated with differences in students' environmental attitudes and behaviours. Finally, the thesis carries policy-relevant implications, as it provides evidence on whether school-level environmental policies and practices can realistically promote sustainability-related attitudes and behaviours among secondary students, and therefore whether they deserve greater attention in educational policy design.

Following this introductory chapter, the thesis proceeds through four chapters: Chapter 2 describes the data used in the analysis, including the data source, the main variables and the descriptive statistics. Chapter 3 presents the methodological framework of the study, outlining the causal logic of the analysis, the main identification challenges and the counterfactual strategy adopted. Chapter 4 reports the empirical results, presenting the main treatment effects, sensitivity analysis and their interpretation. Finally, Chapter 5 ends by summarizing the main findings, acknowledging the limitations of the study and suggesting directions for future research.

2. Data

2.1. Data source and description

The data for this study are drawn from the International Civic and Citizenship Education Study (ICCS) 2022, conducted by the International Association for the Evaluation of Educational Achievement (IEA). ICCS 2022 represents the third cycle of this international survey, following the previous implementations in 2009 and 2016. The main objective of the study is to investigate the ways in which young people are prepared to undertake their roles as citizens in the 21st century. The ICCS 2022 International Database provides comparable data from 22 countries and two benchmarking entities across Europe, Latin America and Asia.

The target population for ICCS 2022 consists of students in their eighth year of schooling (typically Grade 8), selected through a two-stage stratified cluster sampling design. In the first stage, schools were selected with a probability proportional to their size, measured by the number of students enrolled in the target grade, and in the second stage classrooms were randomly sampled within the selected schools. Therefore, all students enrolled in the sampled classes were selected to participate in the study. Additionally, a representative sample of teachers teaching the target grade within the selected schools was also surveyed. In line with this nested sampling design, the school principals of the sampled schools were also surveyed, providing contextual information on school characteristics and processes related to civic and citizenship education. Overall, ICCS 2022 gathered and analysed data from approximately over 80000 students, 40000 teachers and 3000 school principals.

The ICCS 2022 data were collected using a comprehensive set of instruments designed to measure both learning outcomes and contextual factors. Learning outcomes were assessed through the Student Civic Knowledge Test, which evaluated students' civic knowledge, understanding and reasoning using multiple-choice and constructed-response items, as well as additional computer-enhanced tasks. The cognitive test is structured around two main assessment dimensions: content domains and cognitive domains. The framework distinguished four content domains (Civic institutions and systems, Civic principles, Civic participation and Civic roles and identities) and two cognitive domains (Knowing, Reasoning and applying). A major innovation in this third cycle is the reconfiguration of the "Civic principles" domain, where sustainability was formally added as a dedicated subdomain. This enhanced coverage makes ICCS 2022 particularly well aligned with the aims of the present thesis, as it reinforces sustainability-related civic principles within a cross-national assessment framework. In parallel, contextual data were gathered through a series of questionnaires. These included an International Student Questionnaire, which assessed student background, attitudes

Data

and civic engagement; a Teacher Questionnaire; a School Questionnaire completed by principals; and Regional Student Questionnaires specifically tailored for the European and Latin American contexts.

For the purpose of this research, data derived from the International Student Questionnaire, the European Regional Student Questionnaire and the Student Civic Knowledge Test were combined at the student level. Additionally, the Education for Sustainable Development (ESD) scale was integrated into the dataset, a derived sub-scale computed by the European Commission's Joint Research Centre from a special extraction of ICCS 2022 data (European Commission, 2024). The analysis was restricted to European education systems, including non-EU countries such as Norway and Serbia. Brazil, Chinese Taipei and Colombia were therefore excluded from the sample to improve cross-system comparability by focusing on education systems operating within a more broadly shared regional policy and curricular context. As a result, this geographic restriction reduced the final analytical sample to 21 education systems and 68,391 student observations.

2.2. Key variables

2.2.1. Unit of analysis

Even though the sample selection was described previously, it is worth highlighting a key methodological aspect of the data structure. In this study, the individual student serves as the primary unit of analysis, as all cognitive and non-cognitive outcomes are measured at this level. In contrast, the treatment variable is defined at the institutional level. Since students are nested within educational institutions, the treatment status represents a shared school-level characteristic. Therefore, this analysis examines how passive exposure to a specific school-level setting impacts individual-level student outcomes.

2.2.2. Treatment

The treatment variable of this study aims to capture the environmental proactivity of educational institutions. To operationalize this concept, we utilized data derived from the School Questionnaire, precisely drawing on the question 10, which asks principals: “To what extent are the following practices implemented at this school?”. Among the set of practices listed in this item, we specifically selected the four initiatives that are the most visible and understandable to students, on the grounds that student-visible practices are more likely to shape the everyday environmental ethos of the school and, in turn, students’ orientations: (i) the provision of waste recycling bins (item A), (ii) the adoption of energy-saving practices (item D), (iii) the promotion of activities designed to encourage students’ environmental-friendly behaviours (item E) and (iv) the maintenance of school gardens (item I).

Q10 To what extent are the following practices implemented at this school?
(Please tick only one box in each row.)

	To a large extent	To a moderate extent	To a small extent	Not at all	Not applicable
IC4G10A a) Differential waste collection	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
IC4G10B b) Waste reduction (e.g. [encouraging waste-free lunches, limiting the use of plastic disposable products])	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
IC4G10C c) Purchasing of environmentally friendly items (e.g. [recycled paper for printing, biodegradable cutlery and dishes])	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
IC4G10D d) Energy-saving practices	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
IC4G10E e) Activities to encourage students' environmental-friendly behaviours (e.g. posters, leaflets)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
IC4G10F f) Use of [fair trade] products (e.g. [tea or coffee in the staffroom, canteen food])	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
IC4G10G g) Use of local food for meals in the canteen.....	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
IC4G10H h) Re-allocation of intact and non-consumed foods to charities or those in need.....	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
IC4G10I i) Educational [school gardens]	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Figure 2.1 – ICCS 2022 School Questionnaire – Q10: To what extent are the following practices implemented at this school?

2.2.3. Outcomes

To provide a comprehensive evaluation of the impact of proactive environmental school policies, the analysis contains multiple outcome variables, categorized into two distinct domains: non-cognitive and cognitive. A detailed mapping of all the selected variables, along with their original ICCS codes and sources, is provided in the following Descriptive Statistics section (**Table 2.1**).

Non-Cognitive Outcomes: Attitudes and Behaviours

The first set of outcome variables measures students' self-reported attitudes toward sustainability and their behaviours. To capture the multidimensionality of these aspects, we included a set of both continuous scales and categorical variables.

Three continuous scales were chosen from the Student Questionnaire to measure attitudinal and behavioural constructs. The first, Positive Attitudes Toward Environmental Protection, assesses the extent to which students believe in the necessity of preserving the natural world and prioritizing environmental policies. The second, Environmental Activism, captures students' expected future participation in environmental protection activities. Finally, the Sustainable Behaviours scale, derived from the European regional module, measures students' engagement in eco-friendly habits.

In addition to the continuous scales, we analysed four categorical variables to capture specific environmental practices and attitudes. Two variables measure what students consider important for being a responsible adult citizen: participating in activities to protect the environment and making personal lifestyle changes to become more environmentally friendly. The remaining two variables, drawn from the European regional module, examine the frequency with which students purchased or avoided specific products over the previous twelve months, specifically refusing products with a negative environmental impact and choosing green alternatives.

Cognitive Outcomes: Knowledge and Competence

The second domain evaluates the impact of green policies on students' actual learning and knowledge. To operationalize this dimension, we relied on the standardized civic knowledge measures included in the ICCS study. Given the complex test design of large-scale assessments, student proficiency is not represented by a single score, but rather by a set of five Plausible Values (PVs). In strict accordance with the methodological guidelines for international large-scale assessments (Wu, 2005; von Davier et al., 2009), these five values were never averaged at the student level prior to the analysis. Instead, they were treated as multiple imputations to properly account for measurement error and prevent the underestimation of variance associated with single point estimates.

Finally, as an additional robustness check to isolate cognitive gains specifically related to sustainability, we incorporated the Education for Sustainable Development Score. This ad-hoc subscore was derived from the specific subset of ICCS cognitive items classified under the ESD domain (Carrasco & Torres Iribarra, 2024). Our methodological contribution lies in incorporating this targeted sustainability-related outcome into the empirical strategy, allowing us to examine whether green school policies are associated with students' ESD-related knowledge beyond overall civic knowledge.

2.2.4. Covariates

To ensure the validity of the propensity score matching and to satisfy the conditional independence assumption, a comprehensive set of confounding variables was included in the model. These covariates were selected based on theoretical relevance and previous literature regarding environmental education and engagement (Gifford & Nilsson, 2014; Isac et al., 2022). As with the outcome variables, a detailed summary statistics of these covariates will be presented in the Descriptive Statistics section (**Table 2.2**). The selected covariates can be grouped into the following three main categories.

Student Socio-Demographic and Economic Background

To control for individual baseline differences, we controlled for students' demographic and socioeconomic characteristics. Previous literature emphasizes that individual background factors act as strong and consistent predictors of both civic proficiency and environmental attitudes (Franzen & Vogl, 2013; Gifford & Nilsson, 2014). Female students and those from more advantaged socioeconomic families typically demonstrate stronger values, higher levels of environmental awareness and willingness to act (Isac et al., 2022; Wasilewska, 2023). Conversely, students with an immigrant background may face structural and linguistic barriers that often reflect in lower civic knowledge scores and environmental attitudes compared to their native peers (Isac et al., 2014; Isac et al., 2025). To rigorously control for these dynamics within our propensity score model, we incorporated the student's gender and age, their socio-economic status and their immigrant background.

School and Classroom Context

Since the treatment occurs at the school level, we must control for contextual and structural factors that might differ systematically between proactive and non-proactive schools. Previous research indicates that geographical location, in particular the urban-rural difference, can shape environmental attitudes, with urban residents typically expressing higher levels of environmental concern, although rural populations often display different pro-environmental behaviours (Gifford & Nilsson, 2014; Isac

et al., 2025; Mónus, 2022). Existing literature finds that socioeconomic background aggregated at the school level acts as an important determinant of students' consumption choices and pro-environmental behaviours (Mónus, 2022). To account for these factors, we included the school's urbanicity and the proportion of its students from disadvantaged socio-economic backgrounds, as reported by the principal, as a measure of its socioeconomic composition. At the classroom level, students' perception of openness in classroom discussion was added to account for broader differences in learning environments. As recent research highlights, an open classroom climate not only supports general civic learning and democratic engagement (Campbell et al., 2024) but also acts as a key pedagogical setting that promotes students' readiness and engagement for climate action (Penrod et al., 2025). Controlling for this factor ensures that the estimated effect of structural green policies is not confounded by systematic differences in teaching and classroom dynamics.

Country-Fixed Effects

Finally, recognizing that educational systems, environmental policies and civic curricula vary drastically across nations (Franzen & Vogl, 2013; Isac et al., 2022), country-level heterogeneity was addressed by estimating the propensity score model separately for each participating country. This country-by-country approach ensures that treated and control students are compared strictly within the same national context, preventing macro-level differences from biasing the counterfactual analysis. As a sensitivity check, country dummy variables were also included as covariates in a pooled specification, whose results are discussed in **Chapter 4**.

2.3. Descriptive statistics

2.3.1. Data Preparation

Before conducting the descriptive and empirical analyses, a rigorous data preparation process was implemented to clean the dataset and define the final analytical sample. Following the guidelines of the ICCS 2022 Framework, we addressed the presence of structural missing data and invalid responses. In particular, international missing value indicators, special codes used by the IEA to flag omitted or not administered items, were systematically recoded as missing values to prevent them from distorting the statistical estimations. The data cleaning procedure was executed by applying specific logical bounds based on the structure of the original variables. For continuous indices and derived scales, observations were recoded to missing if their values exceeded the 100 threshold; similarly, categorical and Likert-scale items were strictly limited to their logical upper bounds, ranging from 2- to 5-point items. Only observations with complete and valid information across the key treatment, outcomes and covariates were retained for the PSM procedure. This data cleaning process ensures that the following summary statistics and counterfactual estimations are based on a robust and comparable analytical sample.

2.3.2. Summary Statistics

The descriptive statistics of the analytical sample are presented in two separate tables. **Table 2.1** reports the means and proportions for the cognitive and non-cognitive outcome variables, while **Table 2.2** outlines the distribution of the selected covariates across the treated and control groups. To guarantee the reproducibility of the study, the original ICCS 2022 variable codes are provided alongside their descriptive labels.

Table 2.1 presents the distributions of both cognitive and non-cognitive outcomes. As outlined in the ICCS 2022 Technical Report, the continuous variables were originally standardized to a mean of 500 and a standard deviation of 100 for Plausible Values and ESD score and a mean of 50 and SD of 10 for the other scales (Schulz et al., 2024). The deviations in our sample reflect the exclusion of certain countries and the definition of the treatment boundaries. Furthermore, while our main analyses properly estimate the treatment effect utilizing all five PVs simultaneously through the recommended estimation procedures, Table 2.1 reports the mean of only the first plausible value (PV1CIV) for illustrative purposes. Given their definition, the remaining four plausible values show a similar distribution.

Table 2.1 – Descriptive statistics of outcome variables

Panel A: Continuous Variables							
Variable Description	ICCS Code	Mean T	Mean NT	Missing (%)	T	Missing (%)	NT
Civic Knowledge (First Plausible Value)	PV1CIV	514.18	514.79	0		0	
ESD Learning Score	esd_score	501.97	502.98	0.43		1.03	
Environmental Attitudes	S_ATTENV	49.83	49.38	3.38		4.56	
Environmental Activism	S_ENVACT	50.33	48.97	5.06		6.92	
Sustainable Behaviours	E_SUSBEH	50.63	49.71	4.37		8.64	

Panel B: Categorical Variables							
Variable Description	ICCS Code	T (%)	NT (%)	Missing (%)	T	Missing (%)	NT
Importance of protecting the environment	IS4G22I			3.61		4.88	
- Very important (1)		40.45	35.36				
- Quite important (2)		41.25	41.92				
- Not very important (3)		11.23	14.11				
- Not important at all (4)		3.46	3.73				
Importance of eco-friendly lifestyle	IS4G22K			3.68		4.79	
- Very important (1)		32.71	28.26				
- Quite important (2)		44.81	44.53				
- Not very important (3)		14.75	17.67				
- Not important at all (4)		4.06	4.74				
Frequency of refusing harmful products	ES4G10B			5.19		9.40	
- Often (1)		16.29	14.20				
- Sometimes (2)		33.59	31.96				
- Rarely (3)		23.71	23.13				
- Never (4)		21.22	21.31				
Frequency of buying green products	ES4G10E			5.60		9.80	
- Often (1)		22.75	20.61				
- Sometimes (2)		36.57	33.42				
- Rarely (3)		20.53	20.45				
- Never (4)		14.54	15.71				
Observations (N)		14810	47071				

Looking at the baseline data, a dual pattern stands out: while cognitive outcomes are balanced between treated and control students (e.g., PV1CIV means of 514.18 and 514.79 and ESD Score of 501.97 and 502.98, respectively), proactive schools show higher means in non-cognitive dimensions, such as Environmental Activism (50.33 vs. 48.97) and Sustainable Behaviours (50.63 vs. 49.71). Nevertheless, given the standardized nature of these scales, these absolute differences have limited explanatory power on their own. The trend is reflected in categorical outcomes, where treated students are consistently more likely to select the highest response categories across all four attitudinal and practical items.

Table 2.2 outlines instead the distribution of the selected student- and school-level covariates to assess the sample's baseline comparability. Basic demographic traits are highly consistent across the sample, with an average age of 14.4 years and balanced gender groups. However, systematic differences arise in socio-economic and geographic dimensions: students in treated schools generally belong to slightly more advantaged backgrounds (average NISB of 0.08 versus -0.01), are slightly

Data

more likely to be native (86.81% versus 84.70%), and are more frequently located in urban areas (29.05% versus 23.37%), with proactive schools also reporting lower overall rates of socioeconomic disadvantage.

Table 2.2 – Descriptive statistics of selected covariates

Panel A: Continuous Variables							
Variable Description	ICCS Code	Mean T	Mean NT	Missing (%)	T	Missing (%)	NT
Student Age	S_AGE	14.40	14.48	0.22		0.53	
Socioeconomic Background	S_NISB	0.08	-0.01	1.79		2.55	
Open Classroom Climate	S_OPDISC	49.57	49.85	2.03		2.69	
Panel B: Categorical Variables							
Variable Description	ICCS Code	T (%)	NT (%)	Missing (%)	T	Missing (%)	NT
Girl	SD_GENDER	49.94	48.67	0.57		1.28	
Urban Location	C_URBAN	29.05	23.37	0.06		0.46	
Immigration Status	S_IMMIG			3.87		4.26	
- At least one parent born in country (1)		86.81	84.70				
- Born in country, parents born abroad (2)		5.75	6.81				
- Student and parents born abroad (3)		3.57	4.22				
School Disadvantage	IC4G24C			1.65		1.52	
- None (1)		5.57	5.21				
- 1% to 10% (2)		56.85	54.60				
- 11% to 30% (3)		26.09	27.75				
- 31% to 60% (4)		7.72	8.35				
- More than 60% (5)		2.12	2.58				
Observations (N)		14810	47071				

Identifying these baseline imbalances provides the fundamental rationale for implementing the PSM; these descriptive statistics highlight structural differences between the groups, which will be addressed and re-evaluated in a dedicated post-matching balance table.

3. Methodology

3.1. Causal framework and identification strategy

The central objective of this study is to estimate the effect of school-level green policies and practices on students' environmental attitudes and behaviours, isolating it from the influence of pre-existing individual and family characteristics. To address this question, the analysis adopts a counterfactual impact evaluation approach, which allows for the estimation of treatment effects in the absence of experimental data.

The fundamental problem of causal inference lies in the impossibility of simultaneously observing the same individual in two different states (Holland, 1986). The theoretical ideal would be to observe the same student in two parallel scenarios: one in which they attend a school with a strong environmental orientation, and one in which, all other conditions being equal, they do not. The difference in outcomes between these two states would represent the true causal effect of the school's environmental profile. Since only one of the two states is observable for each student, the counterfactual outcome is, by definition, missing. The counterfactual approach tries to reconstruct this unobserved scenario statistically by identifying a control group that is as similar as possible to the treated group in all relevant observable characteristics, differing only in their exposure to the treatment.

The data used in this study come from an observational survey, the ICCS 2022 Student Questionnaire, rather than a controlled experiment. In an observational setting, assignment to treatment is not random but reflects systematic differences between schools and their student bodies. This creates a serious risk of selection bias: schools with stronger environmental orientations may systematically differ from other schools not only in their practices, but also in the characteristics of their student body. For instance, schools in more affluent or educated communities may be more likely to implement sustainability initiatives, while their students may already hold more favourable environmental attitudes due to family influence rather than school influence. A simple comparison of means between students attending green and non-green schools would therefore risk attributing to school practices what is in fact the product of pre-existing background differences. In this context, a matching-based strategy is especially well-suited because treatment assignment is non-random and the treated and control groups are likely to differ systematically on a range of pre-treatment characteristics. The purpose of the method is therefore not to recreate experimental identification in a strict sense, but to improve the credibility of the comparison by reducing observable imbalance between the two groups. A detailed discussion of its implementation follows in **Section 3.3**.

3.2. Operationalization of variables

3.2.1. Treatment variable: school environmental proactivity

As described in the previous chapter, the treatment variable is constructed from four items of the ICCS 2022 School Questionnaire (Question 10, items A, D, E, and I), capturing the extent to which schools implement specific environmental practices as reported by their principals.

Since PSM requires a binary treatment indicator, these items were aggregated and dichotomized according to a threshold-based classification. This operationalization is conceptually justified for the present study, because the research question concerns school environmental proactivity as a broader institutional orientation rather than the isolated presence of single initiatives. The threshold-based classification therefore aims to identify schools in which environmental engagement is consistent across multiple practices to plausibly reflect a school-level profile. A school is defined as a "Proactive Green School" and assigned to the treatment group (coded as 1) if the principal reported the highest level of implementation ("To a large extent") for at least three of the four practices. This majority-rule threshold was chosen to ensure that treatment status reflects a comprehensive and consistently implemented environmental strategy, rather than partial compliance with individual initiatives.

A preliminary decision concerned the handling of missing data across the four items. Two approaches were considered: a strict specification, requiring valid responses to all four items, and a neutral specification, requiring valid responses to at least three. The neutral approach was adopted as the main specification, referred to as *TREAT_PROACT_HvsALL_NEUT*, for two reasons. First, it recovers approximately 22,000 additional observations relative to the strict specification (see **Table A.1, Panel A**), increasing the analytical sample by approximately 56% and substantially improving external validity. Second, the majority-rule logic underlying the treatment definition is mathematically insensitive to a single missing value: if three indicators already meet the threshold, the school's classification is determined regardless of the fourth response. Schools falling below this threshold, including those with moderate, low, or mixed implementation profiles, are assigned to the control group (coded as 0). An alternative specification, *TREAT_PROACT_HvsNO2_NEUT*, was also considered, in which the control group is restricted to schools with consistently low or mixed profiles, excluding those with moderate levels of implementation. Since the differences in raw outcome gaps between the two specifications were not substantial, as reported in **Table A.1, Panel B**, the main specification was preferred as it retains a larger and more representative control group, thus maximising comparability and statistical power. As a descriptive validity check, a mirror specification, *TREAT_APATH_34*, identifying schools with systematically low environmental

engagement, was examined. In this case, the treatment coding is reversed: schools are assigned to the treated group (coded as 1) if the principal reported low or no implementation for at least three of the four practices, while actively engaged schools form the control group. Across all outcomes, this specification yields gaps in the expected negative direction (**Table A.1, Panel B**), corroborating the directional consistency of the main treatment variable.

3.2.2. Outcome variables

The analysis examines four categories of outcome variables, reflecting the multidimensional nature of students' environmental orientations: environmental attitudes, sustainable behaviours, general civic knowledge and ESD scores. As described in the previous chapter, the attitudinal and behavioural outcomes are measured on four-point ordinal scales, while the two cognitive scales are continuous standardized measures provided directly by ICCS 2022. Since the cognitive outcomes and the continuous scales required no further transformation prior to analysis, the methodological discussion in this section focuses exclusively on the dichotomization of the categorical attitudinal and behavioural variables.

To enable a robust estimation of the treatment effects and facilitate their interpretation, four alternative dichotomization strategies for these categorical variables were considered, each reflecting a different interpretation of the construct:

- **DIC1 (1 vs. 2,3,4)** contrasts students who selected the top response category ("Very important" or "Often") against all others, isolating those with maximal engagement and measuring the treatment's capacity to generate the strongest possible environmental orientation.
- **DIC2 (1,2 vs. 3,4)** applies the standard positive-versus-negative split, grouping the two positive response categories ("Very important"/"Quite important" or "Often"/"Sometimes") against the two negative ones, capturing the general direction of attitudes without distinguishing degrees of intensity.
- **DIC3 (1 vs. 3,4)** contrasts only the top response category against the two clearly negative ones ("Not very important"/"Not important at all" or "Rarely"/"Never"), excluding moderately positive respondents from the analysis entirely. This produces a sharper contrast between strongly committed and disengaged students, removing the ambiguity introduced by intermediate responses.
- **DIC4 (1 vs. 4)** compares only the extremes of the distribution, excluding all intermediate responses, and measures the effect of treatment on pure attitudinal polarization.

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Among these four alternatives, DIC3 was selected as the main specification. Although dichotomization inevitably reduces some of the information contained in the original response scales, this choice is justified since it allows the analysis to focus on substantively clearer contrasts between stronger and weaker environmental orientations. DIC 3 in particular, by excluding moderately positive responses, produces the most analytically meaningful contrast: the comparison is between students who express a clear and strong environmental orientation and those who do not, without the noise introduced by ambiguous middle categories. The relative explanatory performance of the four dichotomizations across outcome variables is reported in **Table A.1, Panel B**.

3.3. The Propensity Score Matching procedure

Propensity score matching relies on the framework introduced by Rosenbaum and Rubin (1983) who demonstrated that, in observational studies, an aggregate balancing variable derived from observed covariates can be used to improve comparability between treated and “not-treated” control units. PSM operationalizes this idea by summarizing all observable characteristics that influence the probability of treatment assignment into a single index, the propensity score, defined as the conditional probability of receiving treatment given a set of observed covariates. By matching treated and control students on the basis of this score, PSM constructs a comparison group that is statistically balanced with respect to observable confounders, effectively approximating the conditions of a randomized experiment and enabling the estimation of the Average Treatment Effect on the Treated (ATT), whose definition is discussed below. While PSM does not resolve the problem of unobserved heterogeneity, a limitation discussed further in the following section, it represents a methodologically appropriate strategy for estimating school-level effects in the absence of experimental or longitudinal data, especially when working with large-scale international assessment datasets where randomization is neither feasible nor available.

The propensity score was estimated through a logistic regression model in which the binary treatment, that is school environmental proactivity, is regressed on a set of observable covariates at the student, classroom and school level. As discussed in the previous chapter, the covariates were selected on the basis of the theoretical and empirical literature on the determinants of students' environmental outcomes and are intended to capture the main sources of systematic difference between students attending proactive and non-proactive schools. The logit model was estimated incorporating the sampling weights provided by ICCS 2022 (*TOTWGTS*), so that the estimated propensity scores adequately reflect the complex survey design and the population structure underlying the data.

Following the estimation of the propensity scores, matching was performed using the nearest neighbour algorithm with a 1:1 ratio and replacement, implemented through the *psmatch2* command in Stata. Under this procedure, each treated student is matched to the control unit whose estimated propensity score is closest in absolute distance. Allowing replacement, meaning that the same control unit may be matched to more than one treated unit, reduces bias while sacrificing some degree of efficiency, and is advisable when the treated group is substantially larger than the control group. A caliper of 0.01 was imposed to prevent poor-quality matches: treated units for which no control counterpart could be found within this threshold were discarded, ensuring that matched units are genuinely comparable rather than merely the closest available option. Alternative caliper values of

Methodology

0.025 and 0.05 were also tested and yielded no changes in sample size or composition, confirming the robustness of the matching procedure to this specification choice.

Once the matched sample has been constructed, the treatment effect of interest is the Average Treatment Effect on the Treated (ATT), estimated as the average difference in outcomes between treated students and their matched controls across all retained pairs. For the continuous outcome variables, the ATT is expressed in scale-score units. For the dichotomized categorical outcomes, it represents the difference in the probability of selecting the top response category between treated and matched control students.

3.4. Methodological Validity and Limitations

The validity of PSM as an identification strategy rests on three core assumptions. The first is the Conditional Independence Assumption (CIA), also known as unconfoundedness, which requires that, conditional on the observed covariates included in the propensity score model, treatment assignment is independent of potential outcomes. In this setting, it implies that, once student-level, classroom-level and school-level characteristics are controlled for, attending a proactive green school can be treated as if it were randomly assigned. While this assumption is impossible to verify empirically, its plausibility depends on the richness of the covariate set, which in this study was designed to capture the main observable sources of systematic difference between students attending proactive and non-proactive schools. An additional feature of this research design that supports the plausibility of the CIA relates to the nature of the treatment variable: school environmental proactivity is operationalized through principal reports rather than student self-assessments, which reduces the risk of common-method bias that arises when both treatment and outcome are self-reported and drawn from the same respondent. The second assumption is common support, which requires that for every treated unit there exists at least one comparable control unit with a non-negligible probability of treatment. This condition was enforced through the caliper restriction and the common support option in *psmatch2*, which excludes treated units for whom no sufficiently close match exists in the control group. The third assumption is the Stable Unit Treatment Value Assumption (SUTVA), which requires that the treatment status of one student does not affect the outcomes of others. Given the school-level nature of the treatment, some degree of within-school spillover cannot be entirely excluded, however this risk is partially mitigated by the fact that the treatment is defined at the institutional level rather than as an individual intervention.

The covariate balance was assessed via the *pstest* command in Stata. For each outcome specification, the post-matching mean bias and median bias were examined relative to the unmatched sample. A reduction in both measures indicates that the matching procedure successfully balanced the distribution of covariates between treated and control groups. The detailed balance statistics for the main specification are reported in the Results chapter.

Given the multi-country structure of the ICCS 2022 data, the PSM was estimated separately for each participating country, providing a set of country-specific local ATTs successively aggregated into a Global ATT through a weighted average, where the weight assigned to each country is proportional to its share of treated students on common support. The associated standard error was derived analytically from the country-level standard errors and weights. This country-by-country approach was preferred over a pooled estimation with country fixed dummies as the main specification, as it

avoids imposing a common propensity score model across highly heterogeneous national contexts. The pooled model with country dummies was nevertheless estimated as a sensitivity check and the comparison between the two sets of results is reported in the Results chapter.

As an additional extension of the analysis, the study also examines whether attending a proactive green school produces broader cognitive effects. Two additional outcomes are considered for this purpose. The first is the general Civic Knowledge scale, measured through the five plausible values provided by ICCS 2022, which tests whether school environmental proactivity is associated with spillover effects on students' wider civic and institutional knowledge, that is, whether the benefits of a green school environment extend beyond pro-environmental dispositions. The second is the ESD score, which instead provides a more targeted test: it examines whether green school practices specifically strengthen students' alignment with environmental values and sustainability-oriented knowledge, above what is captured by the attitudinal and behavioural outcomes. Together, these two cognitive outcomes allow the analysis to explore both the extent and the specificity of any school-level green effect. The robustness of the main findings was further examined through the alternative treatment specifications discussed in **Section 3.2** and the caliper sensitivity analysis described in **Section 3.3**.

Several methodological limitations of the present study should be acknowledged before turning to the results. The most fundamental limitation lies in the nature of the data: since ICCS 2022 is an observational and cross-sectional survey, the analysis lacks the longitudinal dimension that would be necessary to observe students' baseline levels prior to exposure to the school environment, making it impossible to rule out that pre-existing differences between students, not fully captured by the observed covariates, partially account for the estimated effects. Residual confounding from factors such as teacher quality, parental motivation, or local community norms cannot be ruled out by construction. A related concern involves the measurement of the outcome variables: since attitudinal and behavioural outcomes are derived from student self-assessments, the estimates may tend to reflect more socially desirable answers rather than true differences in students' dispositions and practices, potentially overstating the magnitude of any estimated effect. A further limitation arises from the interpretation of treatment effects on the continuous outcome scales, which are used in their original standardized form with a mean of approximately 50. Given this standardization, the estimated ATTs are expected to be modest in absolute terms and expressed in scale-score units, making their magnitude difficult to communicate intuitively and to compare across outcomes. Regarding the treatment variable, the composite and threshold-based nature of the green school indicator introduces sensitivity to operationalization choices, even if alternative specifications were considered and, as

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shown in **Section 3.2**, yield consistent results. Finally, the country-by-country aggregation strategy, while appropriate given the institutional heterogeneity of the participating systems, implies that the Global ATT should be read as a general cross-national tendency rather than as a country-specific causal estimate, and its generalizability to individual educational contexts remains limited.

For these reasons, the estimates produced in this study should be interpreted as more reliable than simple observational comparisons, while still falling short of the level of causal certainty associated with experimental designs.

4. Results

4.1. Covariate balance

Since the primary identification strategy relies on country-specific Average Treatment Effects on the Treated (ATT) subsequently aggregated into a Global ATT, covariate balance was rigorously assessed at the country level. Across the large majority of national samples, post-matching standardized bias dropped substantially relative to the unmatched sample and Rubin's B remained within acceptable limits, confirming adequate comparability between treated and control groups within each educational system (see **Table A.2**). One exception is the Netherlands, where the very limited number of treated units on common support (ranging from N=3 to N=6 depending on the specific outcome

Table 4.1 – Covariate Balance Diagnostics - Pooled Sample with Country Fixed Effects

Variable	Sample	Mean Treated	Mean Control	%Bias	%Reduct bias	t-stat	p> t
Sex	Unmatched	0.508	0.499	1.8		1.81	0.071
	Matched	0.508	0.497	2.2	-22.2	1.79	0.073
Age	Unmatched	14.388	14.475	-14.5		-14.73	0.000
	Matched	14.388	14.383	0.9	93.8	0.76	0.450
NISB	Unmatched	0.103	0.011	9.4		9.53	0.000
	Matched	0.104	0.091	1.2	86.7	1.03	0.301
Immigrant (2nd gen.)	Unmatched	0.059	0.070	-4.5		-4.46	0.000
	Matched	0.059	0.065	-2.7	40.6	-2.23	0.026
Immigrant (1st gen.)	Unmatched	0.036	0.042	-3.0		-3.04	0.002
	Matched	0.036	0.032	2.1	30.7	1.86	0.063
Open Classroom Climate	Unmatched	49.695	49.996	-2.8		-2.83	0.005
	Matched	49.697	49.836	-1.3	53.8	-1.07	0.287
Urban Location	Unmatched	0.289	0.237	11.9		12.33	0.000
	Matched	0.289	0.294	-1.0	91.8	-0.79	0.432
School Disadv. (2)	Unmatched	0.583	0.559	4.9		4.93	0.000
	Matched	0.583	0.576	1.4	71.0	1.16	0.244
School Disadv. (3)	Unmatched	0.268	0.283	-3.3		-3.38	0.001
	Matched	0.268	0.298	-6.9	-106.4	-5.64	0.000
School Disadv. (4)	Unmatched	0.074	0.082	-3.2		-3.23	0.001
	Matched	0.074	0.055	6.8	-110.5	6.11	0.000
School Disadv. (5)	Unmatched	0.018	0.024	-3.9		-3.85	0.000
	Matched	0.018	0.021	-2.1	46.1	-1.80	0.072

Overall Balance Summary

Sample	Ps R ²	LR chi ²	p>chi ²	Mean Bias	Med Bias	Rubin's B	R
Unmatched	0,008	490,46	0.000	5,7	3,9	21,8	0,99
Matched	0,002	86,42	0.000	2,6	2,1	11,3	1,1

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variable) prevented an adequate balance; this country therefore carries minimal weight in the Global ATT estimate and its country-specific results should be interpreted with caution.

As a supplementary aggregate check at the overall sample level, **Table 4.1** reports the overall balance diagnostics estimated on the pooled sample with country fixed effects. At the aggregate level, mean bias decreases from 5.7 to 2.6, median bias from 3.9 to 2.1, and Rubin's B falls from 21.8 to 11.3, well below the conventional threshold of 25%. Across most covariates, the matching procedure substantially reduces pre-existing differences between treated and control students. Two exceptions are School Disadvantage categories 3 and 4, where post-matching bias increases substantially relative to the unmatched sample. A minor increase is instead observed for Sex (from 1.8 to 2.2), even if its absolute value remains marginal. However, given that balance is assessed rigorously at the country level and that the overall summary statistics remain well within acceptable bounds, this does not compromise the validity of the main estimates.

Overall, the diagnostics confirm that the matching procedure successfully mitigated observable selection bias across national contexts, providing a credible basis for interpreting the estimated ATTs in the following sections.

4.2. Main results: Global ATT

Table 4.2 reports the Global Average Treatment Effects on the Treated estimated for all outcome variables. Briefly recalling the estimation strategy outlined in **Chapter 3**, the Global ATT is computed as a weighted average of country-specific local ATTs, with weights proportional to the share of treated students on common support in each country, and standard errors derived analytically from country-level standard errors and weights. The treatment variable is TREAT_PROACT_HvsALL_NEUT, identifying schools where the principal reported the highest level of implementation for at least three of the four environmental practices. For the continuous outcome variables, the ATT is expressed in scale-score units. For the categorical outcomes, it represents the difference in the probability of selecting the top response category under the DIC3 specification.

Table 4.2 – Main Results: Global ATT on Students' Outcomes

Panel A: Non-Cognitive Outcomes					
Outcome Variable	ATT	Std. Error	t-statistic	p-value	N Treated on Support
<i>Continuous scales</i>					
Environmental Attitudes	0.397***	0.140	2.840	0.005	13,348
Environmental Activism	0.332**	0.141	2.358	0.018	13,131
Sustainable Behaviours	0.323**	0.141	2.285	0.022	13,149
<i>Categorical outcomes (DIC3: top category vs. two negative categories)</i>					
Importance of protecting the environment	0.008	0.008	0.968	0.333	7,584
Importance of eco-friendly lifestyle	0.019**	0.010	2.002	0.045	7,107
Frequency of refusing harmful products	0.002	0.008	0.244	0.807	8,429
Frequency of buying green products	0.005	0.009	0.557	0.578	7,954
Panel B: Cognitive Outcomes					
Outcome Variable	ATT	Std. Error	t-statistic	p-value	N Treated on Support
<i>Civic Knowledge (Plausible Values)</i>					
Civic Knowledge - PV1	1.614	1.359	1.188	0.235	13,596
Civic Knowledge - PV2	1.721	1.365	1.261	0.207	13,596
Civic Knowledge - PV3	2.433*	1.351	1.800	0.072	13,596
Civic Knowledge - PV4	1.845	1.353	1.364	0.173	13,596
Civic Knowledge - PV5	2.077	1.356	1.532	0.125	13,596
<i>ESD Score</i>					
ESD Learning Score	2.426*	1.354	1.793	0.073	13,560

*Note: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

Across outcome categories, the results point to a clear distinction between non-cognitive and cognitive domains. For the non-cognitive continuous outcomes, the analysis identifies small but positive and statistically significant treatment effects across all three scales. Students attending

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proactive green schools score on average 0.397 points higher on the Environmental Attitudes scale, 0.332 points higher on Environmental Activism and 0.323 points higher on Sustainable Behaviours relative to their matched counterparts, with all three estimates significant at the 5% level. Among the categorical non-cognitive outcomes, the picture is more mixed: only the Importance of eco-friendly lifestyle yields a statistically significant effect ($ATT = 0.019$, $p = 0.045$), indicating that students in proactive green schools are approximately 1.9 percentage points more likely to consider personal lifestyle changes for environmental purposes as very important. The remaining three categorical outcomes, Importance of protecting the environment, Frequency of refusing harmful products and Frequency of buying green products, do not reach statistical significance.

Turning to the cognitive outcomes, no statistically significant effects are found. Across the five plausible values for Civic Knowledge, ATT estimates range from 1.614 to 2.433 scale-score points, but none reach conventional significance thresholds, with p-values ranging from 0.072 to 0.235. Similarly, the ESD Score yields an ATT of 2.426 points ($p = 0.073$), which does not reach the 5% threshold. These cognitive results are consistent with the absence of a broad spillover effect: attending a proactive green school appears to shape students' environmental identities and orientations but does not translate into measurable gains on civic knowledge assessments. Taken together, these findings suggest that school-level environmental practices operate primarily through attitudinal and behavioural channels, shaping an ecological mindset among students, while leaving general and sustainability-specific cognitive performance largely unaffected.

4.3. Sensitivity Analysis and Robustness Checks

To assess the robustness of the main findings, three complementary sensitivity checks were conducted. The first concerns the estimation strategy: while the main results are based on country-specific local ATTs subsequently aggregated into a Global ATT, an alternative specification was estimated on the pooled sample incorporating country fixed effects directly in the logit model. **Table 4.3** reports the comparison between the two sets of estimates.

Table 4.3 – Sensitivity Analysis: Main Specification vs. Country Fixed Effects Specification

Panel A: Non-Cognitive Outcomes						
	Main (Global ATTs)	ATT	Specification from local	Sensitivity (Pooled with Country FE)		Check
Outcome Variable	ATT	SE	p-value	ATT	SE	p-value
<i>Continuous scales</i>						
Environmental Attitudes	0.397***	0.140	0.005	0.362***	0.138	0.009
Environmental Activism	0.332**	0.141	0.018	0.160	0.138	0.246
Sustainable Behaviours	0.323**	0.141	0.022	0.331**	0.138	0.017
<i>Categorical outcomes (DIC3)</i>						
Importance of protecting the environment	0.008	0.008	0.333	0.008	0.008	0.345
Importance of eco-friendly lifestyle	0.019**	0.010	0.045	0.013	0.009	0.154
Frequency of refusing harmful products	0.002	0.008	0.807	-0.006	0.008	0.488
Frequency of buying green products	0.005	0.009	0.578	0.005	0.009	0.565
Panel B: Cognitive Outcomes						
	Main (Global ATTs)	ATT	Specification from local	Sensitivity (Pooled with Country FE)		Check
Outcome Variable	ATT	SE	p-value	ATT	SE	p-value
<i>Civic Knowledge (Plausible Values)</i>						
Civic Knowledge - PV1	1.614	1.359	0.235	-0.591	1.389	0.670
Civic Knowledge - PV2	1.721	1.365	0.207	0.460	1.386	0.740
Civic Knowledge - PV3	2.433*	1.351	0.072	-0.299	1.384	0.829
Civic Knowledge - PV4	1.845	1.353	0.173	-0.203	1.376	0.882
Civic Knowledge - PV5	2.077	1.356	0.125	-0.390	1.381	0.777
<i>ESD Score</i>						
ESD Learning Score	2.426*	1.354	0.073	0.252	1.372	0.854

Note: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results are broadly consistent across the two specifications for the non-cognitive continuous outcomes: Environmental Attitudes (ATT = 0.362, $p = 0.009$) and Sustainable Behaviours (ATT = 0.331, $p = 0.017$) remain statistically significant and comparable in magnitude. Environmental Activism, however, loses statistical significance in the pooled specification (ATT = 0.160, $p = 0.246$),

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suggesting that this estimate is more sensitive to the modelling choice and should be interpreted with greater caution. Among the categorical outcomes, the Importance of eco-friendly lifestyle, significant at the 5% level in the main specification, does not reach significance in the pooled model ($p = 0.154$), indicating that this result is also less robust. For the cognitive outcomes, the pooled specification yields ATT estimates close to zero or slightly negative for all five Civic Knowledge plausible values, and a substantially reduced ESD Score effect ($ATT = 0.252$, $p = 0.854$), further confirming the absence of cognitive spillover effects.

The second sensitivity check concerns the definition of the treatment variable. As discussed in **Section 3.2** and reported in **Table A.1, Panel A**, the alternative specification `TREAT_PROACT_HvsNO2_NEUT`, which restricts the control group to schools with consistently low or mixed profiles, excluding moderate implementers, yields raw outcome gaps closely comparable to those of the main specification. The mirror specification `TREAT_APATH_34`, identifying schools with systematically low environmental engagement, produces negative gaps across all outcomes, confirming the directional consistency of the main treatment variable.

The third sensitivity check concerns the dichotomization of the categorical outcomes. As shown in **Table A.1, Panel B**, the raw outcome gaps under DIC1, DIC2 and DIC4 are broadly consistent with those under the main DIC3 specification, with the direction of effects preserved across all four dichotomizations. The magnitude varies as expected given the different thresholds, but no substantive change is observed.

Taken together, these checks suggest that the core finding of positive and significant effects on non-cognitive continuous outcomes and absence of cognitive effects is robust across the main analytical choices. Two outcomes, Environmental Activism and the Importance of eco-friendly lifestyle, show sensitivity to the estimation strategy and should be treated as suggestive rather than definitive.

4.4. Discussion of the results

The findings presented in this chapter call for interpretation in light of both the theoretical framework and the empirical literature reviewed in **Chapter 1**. The domain-specific pattern that emerges, namely positive and significant effects on non-cognitive outcomes and lack of detectable effects on cognitive ones, is consistent with theoretical expectations and aligns with the broader literature on how school-level environmental characteristics operate.

The positive effects on environmental attitudes, activism and sustainable practices are coherent with the socialization perspective developed in the literature review. Schools function as institutional environments in which constant exposure to norms and values gradually shapes students' dispositions, and the present estimates support this view. The evidence that passive organizational practices, such as the provision of recycling bins, energy-saving measures and school gardens, are associated with small but significant gains is broadly consistent with what Cheah and Huang (2019) describe as the role of the broader civic and sustainability-oriented school culture in promoting environmental citizenship. Moreover, the stronger consistency of effects for attitudinal than for behavioural outcomes mirrors a broader pattern noted in the literature. As Ambasz et al. (2025) observe, translating educational exposure into concrete action is generally harder than shifting attitudes. This distinction is also reflected in ICCS-based research showing that these different environmental dimensions do not necessarily move together (Wasilewska, 2023), as well as in intervention-based studies reporting differentiated effects across them (Braun et al., 2018).

The absence of significant cognitive effects is equally interpretable within established frameworks. The practices captured in ICCS 2022 are primarily organizational and symbolic features of the school environment and, as Boeve-de Pauw and Van Petegem (2018) suggest, educational effects depend not only on such organizational features, but also on how environmental education is pedagogically implemented through school policy, didactics and the presence of on-site natural elements. In the absence of active instructional strategies such as curriculum integration, dedicated ESD teaching and participatory learning, organizational green practices are unlikely to produce measurable gains on standardized knowledge assessments. This is consistent with Olsson et al. (2022), who show that action competence for sustainability develops in relation to active ESD teaching rather than to the passive school environment, and with van de Wetering et al. (2022), whose meta-analysis highlights substantial heterogeneity in effects sizes across all environmental outcomes. Given that much of this evidence comes from intervention-based research, the extent to which such conclusions can be generalized to broader school profiles is limited.

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Within the school effectiveness framework, this pattern is equally expected. As Isac et al. (2014) argue in the context of citizenship education, schools shape a wide range of student outcomes through the interaction of multiple factors: opportunities to learn, democratic climate and participatory experiences, none of which operates in isolation. A school's environmental orientation is therefore just one contributing factor and, given the nature of the organizational practices considered, a modest net contribution to outcome variation is theoretically expected. Despite its size, this contribution is consistently positive across the non-cognitive domain and non-negative in the cognitive one, suggesting that school environmental practices do not generate trade-offs with academic learning while producing valuable gains in sustainability-related orientations. This is a meaningful observation, particularly given that Mónus (2022) shows school socioeconomic composition and parental background to be strong correlates of students' environmental outcomes, suggesting that detecting an independent school effect above and beyond these compositional factors is of considerable significance. It should also be noted that the Global ATT masks considerable heterogeneity across national contexts, as the country-specific local ATTs vary substantially in both magnitude and direction. This suggests that the effectiveness of school environmental practices may depend on institutional, cultural and policy factors that differ across educational systems, a question that calls for dedicated investigation in future work.

Returning explicitly to the research question, the evidence supports a positive answer, subject to important qualifications. Under comparable conditions of observation and after controlling for individual, classroom and school-level characteristics, students attending proactive green schools display modestly but consistently more favourable environmental attitudes and behaviours than their matched counterparts. The effect is domain-specific and modest in magnitude, but it is robust across the main analytical choices, consistent with recognized theoretical expectations and interpretable within the existing empirical literature.

5. Conclusion

This thesis aims to answer the following research question: *to what extent do school-level environmental policies and practices influence students' environmental attitudes and behaviours, after having controlled for individual characteristics?* The data are from the ICCS 2022 Student Questionnaire, and the analysis is implemented by means of a counterfactual approach based on propensity score matching to isolate the direct effect of a school's green orientation.

Turning to the empirical findings, the results reveal a domain-specific pattern. For non-cognitive outcomes (environmental attitudes and self-reported behaviours), the analysis identifies a small but positive and statistically significant relationship associated with the presence of a school environmental approach. This result should not be underestimated. Although the effect size is contained, it aligns with theoretical expectations and demonstrates that the school environment acts as a valid pro-environmental "*nudge*" through daily visibility, even if it does not fundamentally reshape teaching and learning processes. By contrast, for cognitive learning outcomes, no statistically significant relationship was found for either the general Civic Knowledge scale or even the specific ESD subscale, the introduction of which represents a contribution of this study. This result was also expected and in line with theoretical expectations: the type of school-level environmental practices captured in ICCS 2022 are passive organizational or symbolic factors (features that students only partially perceive and that primarily reflect the school's ethos rather than classroom pedagogy). As a result, they may help shape attitudes and behaviours but are insufficient to produce measurable cognitive gains, which would require an active ESD that goes beyond the presence of green practices alone.

To properly address these findings, it is necessary to situate the analysis within the broader school effectiveness framework. In this theoretical model, student outcomes are not the product of a single input but rather reflect the joint contribution of a complex interaction among multiple factors, including family background, peer dynamics, student characteristics, and school resources. Within this perspective, a school's environmental profile represents only one channel among many and, because of the typically low intensity and limited visibility of the practices analysed, its net contribution is expected to be modest relative to more central drivers of learning, because any single mechanism can explain only a limited portion of outcome variation. Nevertheless, a modest effect, if robust and obtained at low cost, may still be meaningful when the policy objective is to promote sustainable orientations and behaviours.

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These findings should be interpreted within the broader policy framework outlined in the initial chapters, namely the global urgency to drive environmental behavioural change and the strategic role assigned to schools by European sustainability strategies, including the European Green Deal, the GreenComp sustainability competence framework, the European Climate Pact and the 2024 Education and Training Monitor, all of which position schools as central actors in developing students' sustainability-related competences for the green transition. As educational systems are increasingly expected to fulfil this role, a central challenge for policymakers and administrators is to identify malleable school factors, features that can be changed through feasible interventions, unlike fixed variables such as family background.

In this context, school environmental practices represent a promising example: they are typically non-costly, comparatively easy to implement, and unlikely to generate negative trade-offs for academic learning. Moreover, the evidence shows that their estimated impact is non-negative in the cognitive domain and potentially beneficial in the non-cognitive domain, which is essentially a success, as the primary goal of these initiatives is to orient students toward sustainability. Therefore, for systems aiming to move toward sustainability goals, their implementation is highly recommended and supported by a favourable cost-benefit analysis. At the same time, the absence of cognitive returns indicates that policymakers should not expect school-level environmental practices to substitute for instruction-focused ESD strategies if the goal is measurable learning gains.

5.1. Limitations and further research

The empirical evidence produced must be, however, interpreted considering several limitations, which are discussed in methodological detail in **Chapter 3** and are briefly recalled here. First, the analysis is based on cross-sectional data from the ICCS 2022 assessment. As the data captures a single point in time, it lacks longitudinal pre-post observations to verify the baseline levels of students before entering the school, limiting the observation of outcomes evolution over time. Second, the reliance on self-reported measures for environmental behaviours and attitudes may introduce reporting bias, where students report socially desirable behaviour rather than their actual daily actions. Third, the continuous outcome scales are used in their original standardized form, which makes the estimated ATTs modest in absolute terms and their practical interpretation not straightforward. An alternative approach would involve dichotomizing these scales at a theoretically motivated threshold to estimate the probability of exceeding it, which would provide a more directly interpretable measure of the treatment effect. This would however introduce additional analytical challenges, including the identification of a defensible threshold and the construction of adequately balanced groups. Fourth, an important methodological limitation concerns the reliability and the specific definition of the treatment variable. Since the green school orientation is not a naturally occurring binary state but a composite indicator operationalized for this study by aggregating specific survey items, this introduces potential concerns regarding construct validity. The findings may be sensitive to how this treatment was defined, meaning that altering the inclusion criteria or the cut-off thresholds could potentially affect the estimated impacts. Finally, while the PSM was rigorously specified to maximize explanatory power using all available covariates, the estimates remain dependent on this specific modelling choice and the observational nature of the data. Despite the matching, the influence of unobserved heterogeneity, such as teacher qualification or parental motivation, cannot be fully excluded and remains a potential source of bias.

These limitations, combined with the currently limited literature using ICCS 2022 database to specifically assess school-level environmental orientations, define significant directions for future research. While the findings generally align with the broader literature on green schools, further investigation is needed to validate and expand upon this initial evidence. Future research could be developed in the following six domains: (i) replicating this analysis using future waves of the ICCS, or alternative International Large-Scale Assessments datasets, to confirm the reliability and generalizability of these patterns; (ii) using longitudinal or quasi-experimental designs capable of tracking students over time, allowing for more robust causal estimates; (iii) improving measurement through richer indicators of intensity and implementation quality, and combining surveys with more

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objective proxies (audits, observations, participation records); (iv) explicitly measuring pedagogical mediation (teacher training, curriculum integration, classroom activities) to test whether instructional channels explain cognitive outcomes; (v) exploring heterogeneity across countries and school contexts, clarifying under which institutional conditions low-cost green practices translate into stronger impacts; and (vi) exploring threshold-based dichotomizations of the continuous outcome scales to yield more directly interpretable effect size estimates.

Beyond these directions for future research, the present study also defines a more personal agenda for future work. The findings reported here represent a first step in a larger research programme that I intend to pursue further on the basis of the present design. A natural next step would be to investigate more directly the mechanisms through which school environmental practices produce their effects, examining whether attitudinal and behavioural gains are mediated by factors such as open classroom climate, student participation or the development of an environmental identity. A closely related direction concerns the role of extra-school contexts: family background, local civic engagement and environmental awareness may either reinforce or weaken the effects of school-level practices, and disentangling these contributions would deepen the understanding of how green schools operate in practice. Turning to a more applied perspective, I aim to extend this research towards the design of realistic, scalable and low-cost school-based interventions, translating empirical findings into actionable recommendations for school administrators and policymakers. Finally, integrating a more formal cost-benefit analysis, linking the average implementation cost of green practices to the size of the estimated effects, would provide a stronger basis for assessing their policy value relative to alternative investments in sustainability education.

In conclusion, this work shows that school-level environmental practices appear capable of producing small but significant gains in attitudes and behaviours, while cognitive gains appear to require complementary instructional investments. Nevertheless, this study provides meaningful empirical evidence that such structural practices represent a strategic, low-risk entry point for educational systems. Implementing such practices allows decision-makers to build an active environmental citizenship with minimal resources, designing sustainability policies that are both realistic and effective.

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7. Appendix

Table A.1 – Sample Composition and Outcome Gaps by Treatment Specification

Panel A: Treatment Specifications – Sample Composition			
Specification	N Treated	N Controls	N Missing
TREAT_PROACT_HvsALL_NEUT (main)	14810	47071	6510
TREAT_PROACT_HvsNO2_NEUT (alternative)	14810	37763	15818
TREAT_APATH_34_NEUT (mirror)	6487	55394	6510
TREAT_PROACT_HvsALL_STRICT (strict version)	14810	24793	28788

Panel B: Raw Outcome Gaps by Treatment Specification and Dichotomization			
Outcome / Dichotomization	Raw Gap HvsALL	Raw Gap HvsNO2	Raw Gap APATH
Environmental Attitudes (cont.)	0.44	0.51	-0.44
Environmental Activism (cont.)	1.36	1.37	-1.74
Sustainable Behaviours (cont.)	0.93	0.96	-1.12
Importance of protecting the environment (cat.)			
- DIC1 (1 vs 2,3,4)	4.80	4.87	-8.17
- DIC2 (1,2 vs 3,4)	3.52	3.49	-4.07
- DIC3 (1 vs 3,4) [main]	6.91	6.91	-10.15
- DIC4 (1 vs 4)	1.67	1.76	-3.03
Importance of eco-friendly lifestyle (cat.)			
- DIC1 (1 vs 2,3,4)	4.27	4.33	-6.85
- DIC2 (1,2 vs 3,4)	4.01	3.84	-4.84
- DIC3 (1 vs 3,4) [main]	7.72	7.58	-11.02
- DIC4 (1 vs 4)	3.32	3.26	-5.01
Frequency of refusing harmful products (cat.)			
- DIC1 (1 vs 2,3,4)	1.51	1.65	-2.75
- DIC2 (1,2 vs 3,4)	1.66	1.94	-3.57
- DIC3 (1 vs 3,4) [main]	2.39	2.66	-4.52
- DIC4 (1 vs 4)	3.44	3.93	-7.56
Frequency of buying green products (cat.)			
- DIC1 (1 vs 2,3,4)	1.26	1.20	-2.15
- DIC2 (1,2 vs 3,4)	2.95	2.84	-6.02
- DIC3 (1 vs 3,4) [main]	3.06	2.93	-5.46
- DIC4 (1 vs 4)	4.27	4.46	-9.64

Note. Raw gaps = Mean T – Mean NT (for continuous) or % T – % NT (for categorical), computed before matching. Negative gaps for the APATH specification confirm directional consistency of the main treatment. DIC3 (marked [main]) was selected as the primary dichotomization for categorical outcomes. HvsALL: proactive vs all others. HvsNO2: proactive vs low/mixed. APATH: apathetic vs non-apatetic (reversed coding).

Table A.2 - Country-Level Covariate Balance Diagnostics (Pre- and Post-Matching)

Country	Mean Bias		Median Bias		Rubin's B	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
Bulgaria	7,77	5,41	5,05	5,87	35,59	18,44
Croatia	11,08	4,81	9,57	2,86	38,45	23,23
Cyprus	16,47	7,71	15,11	7,82	73,91	31,96
Denmark	16,06	6,73	2,76	6,18	92,66	26,45
Estonia	18,7	9,22	9,93	6,1	58,85	23,79
France	18,33	2,58	8,23	2	69	9,92
Germany, DNW	9,48	5,6	10,13	4,63	35,33	20,83
Germany, DSH	20,56	8,14	28,45	6,89	57,45	36,01
Italy	11,37	2,17	5,07	1,43	47,2	10,82
Latvia	14,79	4,82	11,52	4,26	49,26	19,17
Lithuania	8,54	3,64	5,81	3,17	31,28	16,25
Malta	18,86	2,99	17,94	2,11	69,84	13,55
Netherlands	63,2	32,82	62,51	30,4	156,17	105,67
Norway	13,09	4,16	8,73	4,05	55,26	13,57
Poland	13,29	2,77	9,94	3,52	59,68	10,66
Romania	12,96	6,29	7,89	5,15	41,66	19,56
Serbia	18,43	6,44	12,96	7,24	69,92	24,15
Slovak Republic	10,92	3,91	8,51	2,47	44,66	16,29
Slovenia	4,75	3,33	4,19	2,3	17,27	12,33
Spain	7,58	6,19	5,34	7,01	41,28	21,53
Sweden	11,79	10,16	3,55	6,88	67,11	36,49

Note. U = Unmatched; M = Matched. Mean Bias and Median Bias are expressed as percentages. Rubin's B is the absolute standardized difference of the propensity score means; values below 25 indicate adequate balance. The Netherlands (highlighted) presents post-matching Rubin's B well above the threshold due to the very limited number of treated units on common support (ranging from N=3 to N=6 depending on the specific outcome variable) and should be interpreted with caution. DNW and DSH denote the German federal states of North Rhine-Westphalia and Schleswig-Holstein respectively.