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Climate Change Education and the Knowledge/Action Gap

Research Report

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Contents

Summary

This report investigates the relationship between climate change education (CCE) and pro-environmental behaviour (PEB), with a specific focus on what prompts children and young people aged 3–19 to act on their climate knowledge. Through a structured review of recent peer-reviewed literature, the review identifies the characteristics of effective interventions, evaluates the behaviours most targeted, and explores the contextual and methodological factors that influence outcomes. These are summarised in a table at the end of this section.

The findings reveal several important patterns. CCE interventions that actively engage learners, through experiential, inquiry based, or emotionally resonant approaches, consistently produce stronger behavioural outcomes than more passive, knowledge-based methods. Programmes delivered over multiple weeks or months also appear to be more effective than short, one-off sessions, suggesting that sustained exposure and reinforcement are critical for embedding pro-environmental behaviours. Interventions that offer real-world opportunities for action, whether within schools or communities, further enhance learner motivation and commitment to climate-friendly practices.

Despite these promising findings, the evidence base remains limited in scope and uneven in coverage. The majority of studies rely heavily on self-reported outcomes, which are vulnerable to social desirability bias and may reflect intentions rather than actual behaviours. Very few studies incorporate observational measures or longitudinal, leaving questions about the durability of behavioural change largely unanswered. Only a minority of interventions investigated mediating or moderating factors, such as environmental consciousness, gender, or school context that could help explain why some programmes are more successful than others. This stands in contrast to adult-focused climate behaviour research, where such mechanisms are more consistently studied.

The review also identifies significant geographic and socioeconomic imbalances. Most CCE research has been conducted in a high-income, urban settings, particularly in Europe and North America. By contrast, low- and middle-income countries, as well as rural contexts, remain underrepresented, despite being disproportionately vulnerable to the impacts of climate change. This gap raises concerns about equity and transferability; interventions shown to be effective in high-income contexts may not translate easily to settings with fewer resources, different cultural frameworks, or distinct environmental challenges. Moreover, socioeconomic status was rarely measured or analysed, despite evidence from wider educational research that it strongly shapes access to, and capacity for, pro-environmental action.

Behaviourally, most interventions focus on conservation-related outcomes such as recycling, waste reduction, and community activism. While these are valuable entry points, relatively few studies addressed systemic lifestyle behaviours such as energy conservation, mobility and transportation, or food consumption that carry greater long-term implications for climate mitigation. This reflects a broader limitation in climate education, where the scope of behaviour change is often constrained by what can feasibly be enacted within the school setting.

Overall, the review underscores both the potential and limitations of current CCE practice. It shows that climate education can indeed foster meaningful behavioural change among children and young people, particularly when interventions are engaging, sustained, and action oriented. However, the lack of longitudinal data, the reliance on self-report, and the narrow geographical and behavioural scope of existing studies limit the strength and generalisability of current conclusions.

For policy and practice, the findings emphasize several key priorities for climate change education:

- Climate change education must be equitably accessible to all learners, especially in rural and underserved communities.
- Longitudinal evaluation should be embedded in educational programmes to assess the persistence of climate-related behaviours over time.
- Behavioural targets should be broadened to include high-impact lifestyle choices such as mobility, energy use, and consumption.
- Climate literacy should be integrated across different academic disciplines to ensure a holistic understanding.
- Young people should be actively involved in designing and leading climate-related interventions.
- Educational initiatives should be aligned with broader climate policy frameworks to enhance coherence and impact.

Addressing these priorities is essential for climate education to make a sustained, equitable, and globally relevant contribution to preparing learners for climate action.

Summary of the studies included in our structured review, their interventions, and the strength of the results concerning pro-environmental action under specific conditions

Intervention			Conditions		Outcome			Author(s) and year of publication
Type	**Description**	**Duration**	**Age**	**Country**	**Type**	**Description**	**Result**	
Active learning	Climate change workshops	Once a week (45 mins) over 4 weeks	12-16	Lithuania	Vicarious behaviour towards conservation	Support and engagement in climate activism	+ in a qualitative study	Balundė and Poškus
	Continuing professional development programme	6 months	8-11	Ireland		Strategic action through improved attitudes of sustainability	▲	Murphy et al.
	Clean air contest	50 minutes	14-18**	USA	Mobility and transportation	Clean air as a result of being conscious of car pollution	+ in a qualitative study	Stafford and Brain
Active learning (including an action)	Programme addressing learners' awareness, emotions, attitudes, norms, and sustainable choices	5 consecutive school hours for 45 mins each	16-17**	Germany	Consumerism	Sustainable consumption behaviour	▲	Betzler and Kempen
	Using active learning (AL) tools in classrooms (versus passive learning (PL) tools and a control)	4 weeks	8-11**	India		Environmentally Sustainable Consumption Behaviour (ESCB)	▲ (Passive learning +)	Sharma and Gupta
	Programme using visuals and interactive social learning to improve learners' sustainable consumption habits	4 weeks	8-11**	India	Waste avoidance and recycling	Waste management behaviour and other sustainable behaviours	▲	Sharma
	Using active learning tools in classrooms (versus passive learning tools and a control)	4 weeks	8-11**	India		Environmentally Sustainable Consumption Behaviour (ESCB)	▲ (Passive learning +)	Sharma and Gupta
	After-school programme combining climate education, photovoice (digital storytelling), and youth-led community action	1 hour weekly for 15 weeks	10-12	USA	Vicarious behaviour towards conservation	Climate-related personal and community action	▲	Trott. 2019
	After-school programme combining climate education, photovoice (digital storytelling), and youth-led community action	1 hour weekly for 15 weeks	10-12	USA		Climate-related personal and community action	▲	Trott, 2021
Involving teachers and communities	Educational programme that uses interactive activities and thermal imaging cameras	5 activities for 30mins over 5–6-week interval	9-14**	UK	Vicarious behaviour towards conservation	Increases learners' motivation and engagement in science, technology, engineering and mathematics (STEM) and climate literacy	▲	Kumar et al.

Intervention			Conditions		Outcome			Author(s) and year of publication
Type	**Description**	**Duration**	**Age**	**Country**	**Type**	**Description**	**Result**	
Deliberative discussion and interaction with scientists or science	Emotional and cognitive engagement through visiting a food waste facility	90 minutes	11-12	Norway	Waste avoidance and recycling (mixed results)	Recycling and litter avoidance	+ in a qualitative study	Gabrielsen et al
	Mass experiment-based on plastic pollution	Week 39 of the year	7-16	Denmark		Waste management	▲ for throwing litter on the ground behaviour, but with a ceiling effect. Seven other behaviours (five positive impact, two decrease, one no change)	Oturai et al.
	Half-day environmental fieldtrip presented by trained education staff	Half day	7-13	New Zealand	Vicarious behaviour towards conservation	PEB actions learners could complete on their own	▲	Whitburn et al.
	Half-day environmental fieldtrip presented by trained education staff	Half day	7-13	New Zealand	Wildlife conservation	Support for local conservation and/or animal care	▲	Whitburn et al.
Nudges	Set of stickers placed on elements	A month	2-17	Brazil	Consumerism AND Energy conservation	Consumption of water and paper and resources	+ in a qualitative study	Franceschini and Rocha
Place-based learning	Introduction of EE in 2008. Effect of the place (urban-rural differences)	One time survey	11-19	Saint Lucia	Vicarious behaviour towards conservation	Reported environmental behaviour	▲	Kanada et al.
	School provides hands-on, experiential learning through botanical gardens and conservation-focused spaces.	2 years	12-18**	Thailand		Caring for the environment and increased interest in climate change	▲	Pongsophon
	Introduction of EE in 2008. Effect of the place (urban-rural differences)	One time survey	11-19	Saint Lucia	Consumerism	Reported environmental behaviour	▲	Kanada et al.
	Introduction of EE in 2008. Effect of the place (urban-rural differences)	One time survey	11-19	Saint Lucia	Waste avoidance and recycling	Reported environmental behaviour	▲	Kanada et al.
	Biodiversity enhancement educational programme	Once weekly for 3-7 months	6-10	England	Wildlife conservation	Agency through small manageable actions	+ in a qualitative study	Christodoulou and Grace
	School provides hands-on, experiential learning through botanical gardens and conservation-focused spaces.	2 years	12-18**	Thailand		Caring for the environment and increased interest in climate change	▲	Pongsophon

▲: Indicates statistically significant positive effect ($p < 0.05$)

+: Indicates positive impact

**: Indicates assumed from the full text.

1. Introduction

As the impacts of climate change intensify, its consequences (such as biodiversity loss, rising sea levels, and global temperature increases) are becoming increasingly visible, urgent, and alarming (Salisu, Umar & Zakari, 2022). In response, education has emerged as a crucial tool for fostering environmental awareness and promoting action to protect the natural world since the 1960s (van de Wetering et al., 2022). The UNESCO Intergovernmental Conference held in Tbilisi, Georgia, in October 1977 outlined the initial goals of environmental education: to promote awareness and understanding of environmental issues, foster ethical responsibility, and encourage behavioural change. In 1992, the Earth Summit in Rio De Janeiro first introduced Education for Sustainable Development (ESD) to broaden the scope of Environmental Education (EE) to encompass social and economic sustainability, aiming for a more holistic and interconnected approach to learning for a more sustainable future (Kopnina, 2012; Nevin, 2008). Today, Climate Change Education (CCE) sits within and reinforces these broader educational frameworks but focuses more specifically on building climate literacy and equipping learners with the knowledge, skills, and motivation to engage in mitigation, adaptation, and informed climate action (Rocha et al., 2020; UNESCO, 2015).

While learning should ideally be a lifelong process, targeting children and adolescents may be particularly valuable. This emphasis is reflected in our study, which aims to explore what prompts learners to act on their climate education (i.e., knowledge, skills, and decision-making) and to engage in pro-environmental behaviours. Our research focuses specifically on interventions aimed at learners aged 3–19, seeking to understand which elements of climate education are most effective in fostering behavioural change. During childhood, heightened brain plasticity, fewer fixed beliefs, and a natural openness to exploration make young learners especially receptive to new ideas and behaviours (Gualtieri & Finn, 2022). Adolescents and young adults are widely recognized as highly impressionable, particularly within social and developmental psychology. This developmental stage represents a critical period for the formation of enduring attitudes, driven by heightened sensitivity to social influence, evolving cognitive judgment, and increased openness to change (Krosnick & Alwin, 1989). After this period, core attitudes and susceptibility are considered harder to change, underscoring the importance of educational interventions for children and adolescents (Galeotti et al., 2024).

1.1. Climate Change Education

CCE has been a curriculum priority, particularly since 2022 following the launch of the UK's Sustainability and Climate Change Strategy (Department for Education, 2023a). The strategy aims to make the UK a world leader in sustainability and climate education by 2030, embedding climate literacy and action across all levels of the education system (Department for Education, 2023b). Achieving these goals will require addressing well-documented enablers such as action-oriented learning and barriers like negative social norms to ensure CCE is effective (Huoponen, 2023). However, challenges remain, such as the field of research literature not yet encompassing all age groups, developmental stages, and contexts, which can hinder translating policy ambition into consistent, evidence-based practice across diverse educational settings.

CCE has also been prioritised by global actors. For instance, UNESCO (2024) member states endorsed a common agenda for education and climate change, urging countries to strengthen CCE in order to support transitions to low-carbon and climate-resilient economies and societies. This includes equipping all learners with the knowledge, skills, values and attitudes to adapt to a more sustainable future. Another example is the Eco-Schools programme, which operates in 95 countries, and takes a whole school, cross-subject approach to environmental education (Foundation for Environmental Education, n.d.).

Globally, CCE programmes have employed a variety of educational approaches, resulting in a wide range of outcomes (van de Wetering et al., 2022). Interactive methods appear to be the most used; however, this preference often stems from belief in their value rather than from clear evidence of their comparative effectiveness (Galeotti et al., 2024). Emerging research suggests that more active forms of engagement tend to produce stronger pro-environmental behaviour (PEB) (Świątkowski et al., 2024), with factors such as social influence, environmental education, and additive interventions all being identified as particularly effective. Conversely, approaches situated in Eco-Schools or outdoor settings have shown a comparatively weaker impact on actual behavioural change (Świątkowski et al., 2024). Moreover, tailoring interventions to the age and developmental stage of participants has been highlighted as crucial for maximising their effectiveness (van de Wetering et al., 2022).

These programmes vary significantly in terms of design, geographic setting, educational subject areas (e.g., science, geography, civics), participant ages, intervention types, and outcome measures. Outcomes include both proximal determinants (e.g., attitudes, emotions, knowledge) and observable behavioural changes. Interventions also differ in duration, delivery method (e.g., classroom-based, whole-school, online), and the extent to which they are sensitive to local socio-cultural contexts. These are key variables examined in this review.

1.2. Pro-environmental behaviours

Pro-environmental behaviours are usually defined as individual or collective actions that seek to minimise negative environmental impacts or contribute to ecological sustainability (Steg & Vlek, 2009). PEB encompasses a wide spectrum of activities, from easily observable, low-cost actions such as recycling and reducing waste, to more complex lifestyle changes such as shifting transport modes, reducing energy consumption, or adopting sustainable consumption patterns (Kollmuss & Agyeman, 2002; Stern, 2000). Research suggests that PEB is not only influenced by knowledge acquisition but also by values, attitudes, emotions, and social norms, highlighting the importance of embedding CCE interventions within broader psychological and sociocultural frameworks (Bamberg & Möser, 2007; Chawla & Cushing, 2007). Furthermore, behaviours differ in terms of their effort, frequency, and visibility, with conservation-related actions often being more frequently studied due to their feasibility in school contexts, while high-impact behaviours such as dietary change or energy reduction remain underexplored (Whitburn et al., 2019; Gifford & Nilsson, 2014). For CCE to translate into meaningful action, interventions must therefore

target not only knowledge and awareness but also the motivational and contextual factors that enable sustained engagement in diverse forms of PEB.

1.3. Why is it important to research Climate Change Education

Over recent decades, research into Environmental Education (EE), Education for Sustainable Development (ESD), and Climate Change Education (CCE) has expanded significantly in terms of output, scope, and methodological diversity (Ardoin et al., 2017). This area has been extensively explored by researchers, policymakers, and practitioners, who have contributed both individual programme evaluations and influential systematic reviews (e.g., Ardoin et al., 2017; Galeotti et al., 2024). However, these interventions have not consistently yielded positive PEB outcomes, with many studies identifying persistent barriers, particularly those related to social influences such as peers, media, and family (Huoponen, 2023).

One reason for these mixed results may lie in how these CCE outcomes are measured. Much of the existing evidence is based on self-report data; particularly self-reported intentions and attitudes, not actual behaviours (Galeotti et al., 2024; van de Wetering et al., 2022). This can overstate behavioural impact and fail to capture long term change. Furthermore, research appears to be disproportionally focused on high-income urban contexts, leaving a gap in our understandings of how CCE functions outside these environments. This is surprising, given that populations in high-income rural and lower income areas are likely to be directly involved in activities affecting the environment (Galeotti et al., 2024) and therefore this limitation hinders the development of universally effective strategies.

Earlier theoretical frameworks suggested that, for example, ignorance and uncertainty were key obstacles to PEB (de Kwaadsteniet et al., 2007; Gifford, 2011), and that these could be addressed through education aimed at enhancing knowledge and clarifying effective actions (Ajaps & McLellan, 2015). However, this perspective has been increasingly challenged by more recent studies and reviews, including Uzzell (2000), which highlight the knowledge–action gap, demonstrating that increased climate understanding does not necessarily lead to behavioural change, particularly among children and adolescents (Liu & Green, 2024).

Given these mixed outcomes, there is a clear need for further research to identify which educational interventions have been most effective in fostering meaningful and lasting PEB. Understanding what prompts young learners to translate climate knowledge into action and identifying the characteristics of the successful underlying interventions that facilitate this shift is crucial (Rashed et al., 2025). Such evidence can help educators and policy makers in implementing impactful CCE. Without this evidence, climate education risks remaining merely informative rather than transformative, falling short of its potential to drive real-world climate action.

1.4. Why our research is necessary

We note that while previous meta-analyses have identified how interventions can influence PEB's in children and adolescents, few have specifically examined which curricular and

extracurricular approaches are most effective, or what elements within these interventions prompt learners to take action. Studies such as van de Wetering et al. (2022) focus primarily on climate related knowledge, an emphasis reflected across much of the literature, where few studies quantitatively measured behavioural and attitude changes. This narrow scope limits our understanding of what actually drives action among young people. This disproportionate focus on knowledge may partly explain the limited effectiveness of CCE in fostering lasting behavioural outcomes, especially when considering the action-knowledge gap that has repeatedly been identified in the literature. Aeschbach et al. (2025) highlights that the majority of CCE interventions identified in the literature are conducted within the subjects of natural sciences, whereas few interventions were conducted within the realm of social sciences. A stronger emphasis on social sciences is seen as key to promoting more holistic climate literacy, particularly by addressing the social drivers of climate change and encouraging informed action (Shwom et al., 2017). This disciplinary imbalance is mirrored in the types of behaviours targeted. As noted by Galeotti et al. (2023), most interventions focus on low-impact actions such as recycling and energy saving, while fewer address high-impact behaviours like transport and food choices.

Much of the available CCE literature takes a broad view of education, often extending beyond the boundaries of formal education. Previous research, such as Świątkowski et al. (2024), examines environmental education using inclusion criteria that does not specifically focus on formal education. As a result, the interventions reviewed often reflect the broadest interpretation of education and are not always applicable or easily integrated into formal school curricula. Recognizing the role that formal educational systems can play allows us to focus on their potential of offering sustainable and scalable CCE (OECD, 2024). The almost universal reach of educational systems makes them a key factor in influencing behaviour, norms, and values. By prioritising solution oriented CCE in compulsory schooling, education systems can potentially reach many young people at a critical developmental age and lay the foundation for widespread, long-term change (Periera & Freire, 2021).

Turning our attention to publication dates, recent reviews and meta-analysis such as Świątkowski et al. (2024) and van de Wetering et al. (2024) examined studies published between 1970 and 2021. As a result, the most recent empirical research in this area is absent from existing reviews, highlighting the need to synthesize the latest developments in CCE, specifically between the years 2020-2025. Furthermore, it is important to include research conducted post Covid-19 pandemic due to the significant cultural, social, and educational shifts that have taken place globally. Covid-19 significantly reshaped learning environments by accelerating the integration of digital technologies and the prioritisation of social-emotional learning. These shifts have had, and will likely continue to have, a profound impact on learner engagement, teacher practices, curriculum delivery, and the overarching aims of education (Jacob & Stanojevich, 2024).

1.5. Research aim and research questions

This study aims to identify the key factors that prompt children and young people (aged 3–19) to act on their climate education (specifically their knowledge, skills, and decision-making capacities) to engage in meaningful and sustained pro-environmental behaviour. In line with the aim of the study, the core research question has been identified as follows:

What prompts learners to act on their climate education (i.e. knowledge, skills, and decision-making) to engage in pro-environmental behaviours?

Research questions

1. Which features of climate change education interventions are associated with positive pro-environmental behaviour outcomes among 3-19 year-olds?
2. How do proximal determinants (e.g., knowledge, attitudes, emotions, agency) relate to observed or self-reported PEB in these interventions?
3. What role does the educational context (e.g., subject area, curriculum level, setting, and local culture) play in the effectiveness of interventions?
4. What types of behaviours (e.g., recycling, energy saving, activism, dietary or transport change) are targeted and how are they measured?
5. How do duration and frequency of exposure to climate change education affect the outcomes?

2. Method

This review systematically examined empirical studies published between 2020 and 2025 that explore the determinants and outcomes of pro-environmental behaviours (PEB) among learners aged 3 to 19 within formal education settings. The objective was to identify educational interventions and contextual factors that promote meaningful and sustained behavioural change in response to climate education.

2.1. Operational definitions

To ensure consistency across included studies, key constructs were operationally defined based on both theoretical frameworks and their application within the empirical literature:

- Pro-environmental behaviour was defined following Kollmuss & Agyeman (2002) as any behaviour consciously aimed at minimising negative impacts on the natural and built environment. This concept of PEB was further categorised into five different domains by Dewi and Dian (2018) and Kaiser et al. (2007) as:
    - Vicarious behaviour towards conservation.
    - Energy conservation.
    - Consumerism.
    - Mobility and transportation.
    - Waste avoidance/recycling.
- The definition of anti-environmental behaviour is not clear-cut; however, it refers to actions that actively degrade environmental quality by damaging, contaminating, or inhibiting the regeneration of natural resources due to human activities (Frías-Armenta & Martín, 2010).
- Education, for the purposes of this review, is defined as an intervention or determinant delivered by educators employed or contracted by formal educational institutions, or who meet national Ministry of Education standards. The intervention must occur within formal schooling contexts, including integrated curricular activities, recognised extracurricular programming, or any stage of formal education.

2.2. Search strategy and inclusion criteria

A comprehensive literature search was conducted across the Scopus and Web of Science databases for articles published between 2020 and 2025. The search included terms such as *children*, *pro-environmental behaviour*, *sustainable behaviour*, and *education*, alongside relevant synonyms. The complete search strategy is available in Appendix 1.

Studies were included if the title and abstract met the following criteria:

- Participants were aged between 3 and 19 years: This reflects the standard age range of early childhood to upper secondary education across OECD and EU contexts (OECD, 2023; European Union, 2025).

- Educational setting: The studies include curricular or extracurricular educational activities conducted in schools or training programmes targeting specific communities or relevant stakeholders (Galeotti et al., 2024).
- Behavioural outcome: The selected studies used a variety of quantitative methods to assess[1] PEB outcomes, including self-reported behaviours, behavioural observations, or pre/post-intervention assessments.
- Focus on determinants: The included studies describe programmes or interventions under analysis, such as the integration of specific topics into the curriculum, school-based programmes involving passive or active learning activities, or training initiatives (Galeotti et al., 2024).

During the initial screening phase, all studies were screened by three independent researchers. Discrepancies were resolved through consensus discussion to ensure consistency and reliability in the selection process. Studies which met all inclusion criteria at this stage were subsequently subjected to full-text screening. The full-text screening used further inclusion and exclusion criteria.

Full-text screening applied additional criteria:

- ≥70% of participants were aged 3–19.
- The study was conducted within a formal educational setting.
- Empirical study design with theoretical grounding, methodology, and results reported
- Behavioural outcome reported (not just knowledge or attitudes).
- Duration of the intervention was stated or inferable.
- Determinants of PEB were described or measured.

Studies were excluded if they lacked behavioural measures (i.e., they measured only knowledge or attitude without behaviour) or did not meet empirical research standards defined as including a theoretical foundation, a clearly described methodology, results, and conclusions (Huoponen, 2023). Ultimately, 16 reports met all inclusion criteria, encompassing a total of 17 distinct studies (one report contained two separate studies) that evaluated educational interventions aimed at fostering pro-environmental behaviour (Figure 1).

[1] Please note that in this report “assess” and “assessment” are often used in the general sense of the word they are not being used to refer to public examinations or aspects of qualifications.

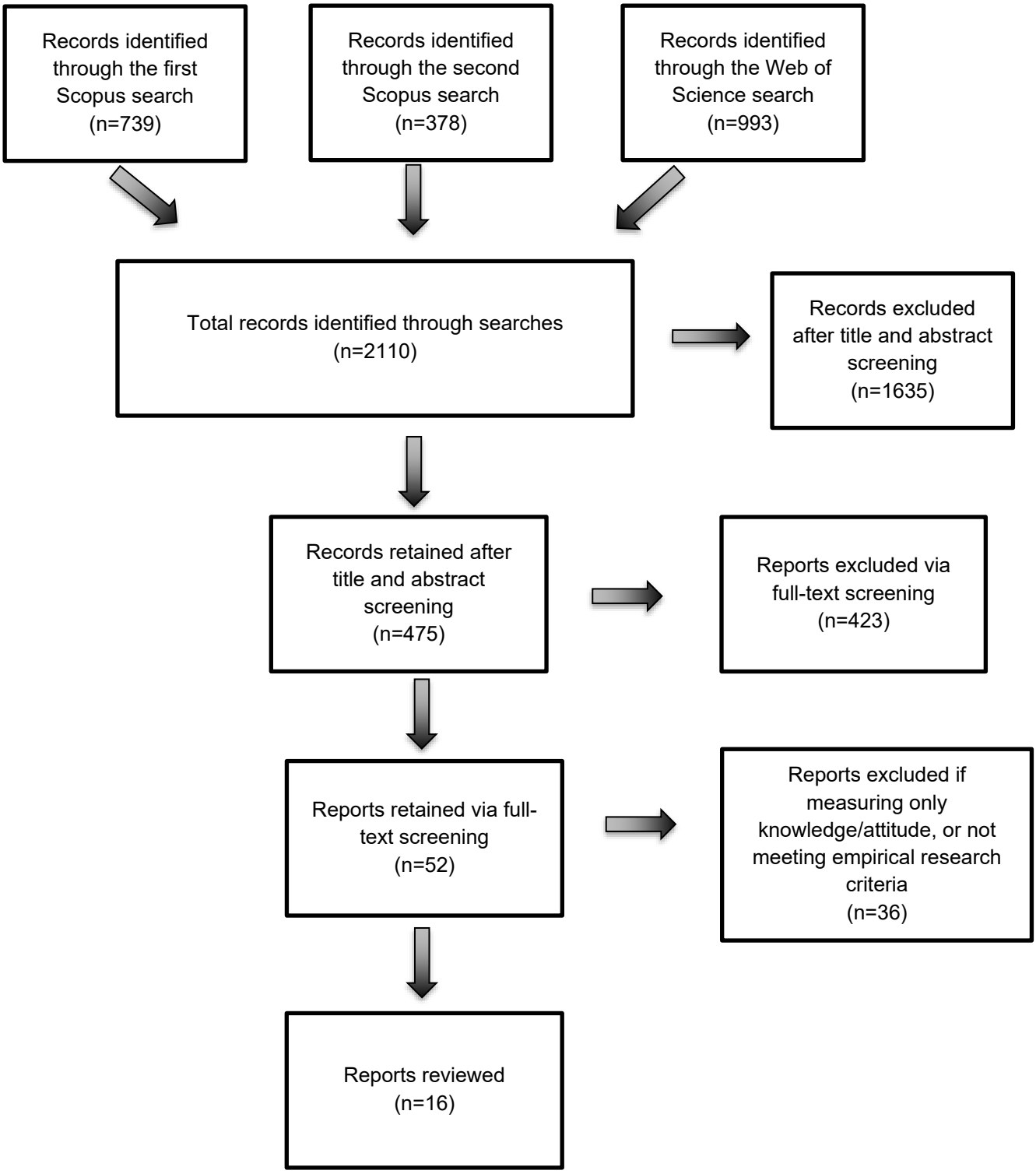

Figure 1 Search and selection of reports

Note: Two Scopus searches were undertaken to incorporate the full breadth of relevant literature.

2.3. Generating categories and coding procedure

Data were systematically extracted using a pre-established coding framework encompassing study design, participant characteristics, intervention details, and behavioural outcomes. Coding was conducted collaboratively between the researchers, with iterative refinement of codes and classification categories. Discrepancies were resolved through joint review. The extracted data is given in Appendix 3.

2.3.1. Educational interventions

Educational interventions were coded by the degree of learner engagement and instructional format (Zelezny, 1999):

- ***"Deliberative discussion and interaction with scientists or science"*** code included structured interactions for learners to engage directly with scientists or science (Galeotti et al., 2024). LaCombe and Danoff-Burg (2013) described a litter disposal program in which participants learned about littering's environmental and economic impacts through facilitated discussions and then followed by a local clean-up event.
- ***"Active learning"*** is characterised by learners' active participation in tasks and subsequent reflection on their experiences, through which they construct knowledge (Doolittle et al., 2023). Rooted in constructivist theory, active learning aims to promote higher-order thinking and deep, meaningful understanding through a learner-centred approaches. For instance, Monroe et al. (2017) describe a CCE programme where learners analysed real-world case studies, discussed alternative adaptation strategies, and reflected on their choices, thereby fostering critical thinking about sustainability challenges.
- ***"Active learning (including an action)"*** follows the principles of active learning but explicitly incorporates pro-environmental actions as a part of the intervention. For example, Sharma (2022) studied a programme in which primary school learners engaged in interactive activities on sustainable consumption and then implemented waste reduction practices in their classrooms, such as reusing paper waste. This direct link between learning and behavioural practice reinforced both ecological understanding and sustainable habits.
- ***"Place-based education (PBE)"*** refers to a broad set of teaching practices that emphasises learners' connection to their local environment, particularly its physical dimension, as well as cultural and social dimensions (Yemini, Engel & Ben Simon, 2023). It emphasises learning that is situated in the physical and socio-cultural characteristics of a place, often extending beyond the classroom to include outdoor, and service-oriented activities in a particular locality (Semken, 2012; Smith, 2017). For example, Gruenewald and Smith (2008) describe a watershed education project in which learners investigated the ecological health of their local river through water quality monitoring, oral histories, and community partnerships, thereby integrating environmental science with local cultural knowledge.
- ***"Nudges"*** referred to interventions that altered the decision-making environment without restricting individual freedom to encourage pro-environmental behaviour, such as posters and stickers in campus laundry areas promoting cold-water washing or light-use reminders (Frantz et al., 2016).

- ***"Involving teachers and communities"*** included teachers and communities in climate change education often focused on grounding learning in local environmental issues, fostering emotional connections and real-world problem solving (Kranz et al., 2022). For example, Kendall et al. (2021) studied the UNITE programme, where teachers trained in sustainable practices promoted the use of fuel-efficient stoves in communities around Uganda's Kibale National Park.

For further information see Appendix 2.

2.3.2. Measurement of behaviour

Pro-environmental behaviours were coded into six thematic categories based on established typologies in environmental psychology and education research:

- ***"Vicarious behaviours towards conservation"*** included environmentally supportive actions that involve influencing others, seeking information, or making indirect contributions to environmental protection (Dewi & Dian, 2018; Kaiser et al., 2007). At the simplest level this might include making a social media post promoting waste avoidance.
- ***"Wildlife conservation"*** code covered protecting plant and animal species and their habitats (National Geographic Education, 2025).
- ***"Waste avoidance and recycling"*** were initially coded as separate behavioural categories, subsequently combined into the single category defined as actions that minimize waste generation and promote the reuse or proper disposal of materials (Kaiser et al., 2007). This was due to the frequent integration of these behaviours within interventions. Many educational programmes such as Sharma (2022) addressed waste management holistically, making it difficult to distinguish between avoidance and recycling behaviours in practice, as they were often conceptualised and implemented together. Waste avoidance can include only buying the food that you need and no more.
- ***"Consumerism"*** code referred to eco-conscious purchasing behaviours (e.g., choosing certified organic or seasonal produce or recycled goods) that prioritise environmental sustainability (Kaiser et al., 2007).
- ***"Mobility and transportation"*** encompassed the decisions individuals make regarding their modes of travel, with a particular emphasis on reducing carbon emissions through environmentally conscious transport choices. For example, choosing to cycle rather than go by car.
- ***"Energy conservation"*** referred to habitual reductions in energy use. These behaviours include actions such as switching off lights when leaving a room, turning down heating when not needed (Dewi& Dian, 2018; Kaiser et al., 2007).

Table 1 presents the studies included in the review and indicates how they were categorised according to types of pro-environmental behaviour, as well as types of interventions.

Methods of measuring pro-environmental behaviours were coded using:

- ***"Self-reported measures"*** which included questionnaires, interviews, or quizzes (Fernández-Ballesteros, 2004).

- ***"Observations"*** characterised by informal reports, trained observers, or sensor-based tools (Świątkowski et al., 2024).

2.3.3. Study and sample characteristics

- ***"Participant age ranges"*** were coded directly from study data; where not explicitly stated, education level was used as a proxy based on national education systems. Mean ages were recorded when available but were infrequently reported, a limitation consistent with previous reviews (Świątkowski et al., 2024).
- ***"Intervention duration"*** was coded based on the information provided in the write-up of each study. It was extracted from study documentation or estimated from contextual details when unspecified.

Table 2 presents the interventions used in studies investigating what prompts pro-environmental behaviour in certain conditions, which are also in our review.

2.3.4. Accounting for local context

Only country-level data were coded as the level of geographic specificity (e.g., city, region or school) varied considerably across studies, making it difficult to record more specific locations consistently. Initial attempts to differentiate urban vs. rural settings were discontinued due to insufficient reporting.

To account for broader contextual influences, the following national-level indicators were coded:

- ***"Gross National Income (GNI) per capita"*** was coded to reflect socioeconomic conditions relevant to education delivery and behavioural interventions (World Development Indicators, n.d.).
- ***"Climate Change Performance Index (CCPI)"*** was coded to estimate the policy environment's supportiveness of climate education and action (Castellarnau & Britto, 2024). Although CCPI does not measure education policy directly, it provides insight into the broader national commitment to climate goals, which may shape educational priorities. For further information see the Appendix 3.

3. Results

3.1. Demographics: Geographical distribution, age range, and local context

Figure 2 illustrates the global distribution of CCE interventions included in this review. Our review included 16 articles (17 studies) across 12 countries, with each country contributing between 1 and 3 studies. The majority were conducted in the United States (n = 3). At a continental level, Europe accounted for the highest number of studies (n = 7), followed by North America (n = 4), Asia (n = 3), Oceania (n = 2), and South America (n = 1). This concentration of research in the Global West underscores a significant geographical imbalance in the existing body of CCE literature.

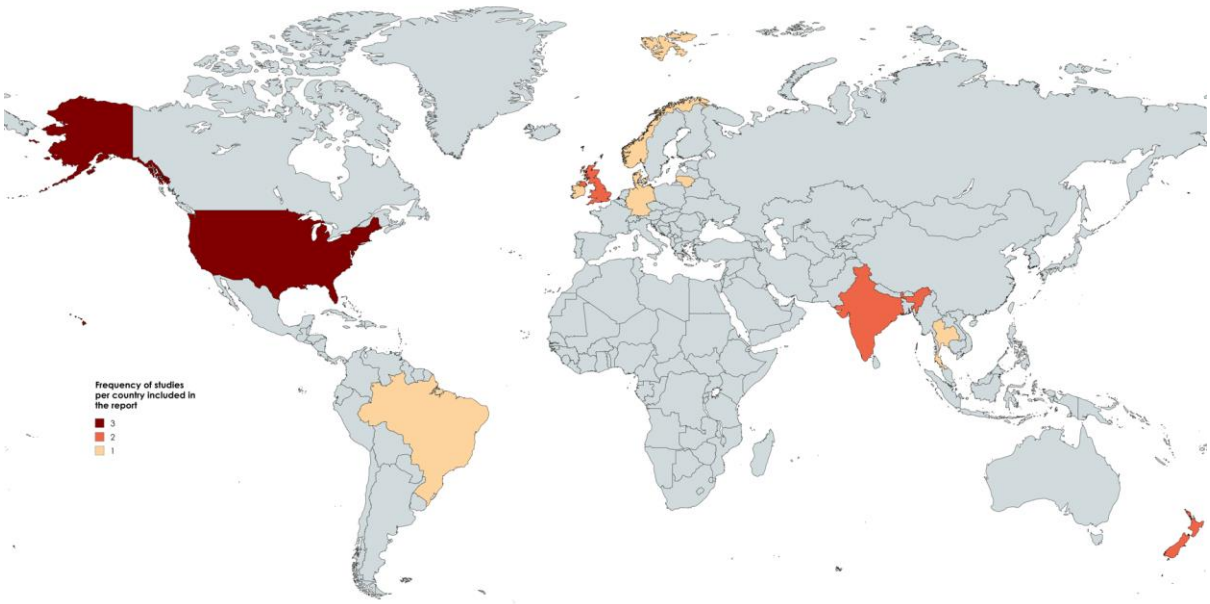

Figure 2 World map of the number of studies included in our review, conducted in each country

Note: Created with World Map - Simple | MapChart

Participants ranged in age from 3 to 19 years, with most interventions targeting those aged 9 - 12 years old (Table 1, Table 2). This gives a focus on a developmental window during which environmental attitudes and behaviours can be effectively shaped. However, older adolescents were underrepresented, suggesting a gap in the current literature and a need for further research targeting this critical age group.

To assess national context, countries were classified using GNI per capita, following World Bank categories (World Bank, n.d.1; n.d.2). GNI classifies countries into four income groups: low, lower-middle, upper-middle, and high (Fantom & Serajuddin, 2016). The classifications for 2025 are:

- High-income countries: GNI per capita of $13,935 or more.
- Upper-middle-income countries: GNI per capita between $4,496 and $13,935.
- Lower-middle-income countries: GNI per capita between $1,136 and $4,496.
- Low-income countries: GNI per capita of $1,136 or less.

Most studies were conducted in high-income countries (n = 12), with limited representation from upper-middle (n = 3) and lower-middle income nations (n = 2) (Table 3). This disproportionate focus on economically developed contexts raises equity concerns, as findings from high-income contexts may not easily transfer to resource-constrained settings. Lower-income countries, despite their greater vulnerability to climate impacts and lower contributions to global emissions, remain clearly underrepresented in the literature (Winkler, 2005).

In addition to economic status, the Climate Change Performance Index (CCPI) was used to provide insight into national engagement with climate policy and action. The CCPI evaluates and ranks countries using standardised criteria of Greenhouse Gas Emissions, Renewable Energy, Energy Use, and Climate Policy (Burck, Uhlich, Bals, Höhne, & Nascrimiento, 2023). Among the included countries, CCPI scores ranged from 40.58 to 78.37, with 8 out of 17 scoring above 60, suggesting relatively strong national-level climate engagement (Table 3). One country has no CCPI rating. However, the presence of CCE studies from both high and low-performing countries reveals no consistent alignment between climate policy ambition and the volume of CCE research. This misalignment highlights the need for closer integration of educational research with national climate priorities to enhance policy relevance and effectiveness (Muccione et al., 2025).

3.2. Methodological processes and output quality

The methods used to evaluate the impact of CCE interventions varied considerably across studies. Self-reported behaviours were the most common outcome measure (n = 9), with fewer studies employing observed behaviours (n = 4) or both methods (n = 4) (Appendix 3). Most interventions used a pre-post design (n = 10), measuring behavioural changes over time (Appendix 3). Many pre-post evaluations rely on self-reported data; while practical, reliance on self-reported data introduces potential biases and can affect the reliability of post intervention findings (Latkin et al.,2017). Using questionnaires as an example, those administered directly after interventions are more likely to result in higher self-reported behaviour due to social pressure or a desire to please researchers or teachers (Galeotti et al., 2023). To mitigate demand characteristics, some studies employed repeated or follow-up measures to introduce a time gap between the intervention and evaluation. However, only a minority of the studies (n = 4) included such follow-ups, limiting the ability to assess the long-term retention or durability of behavioural outcomes.

Table 1 Studies included in the review, categorised by intervention type and pro-environmental behaviour type

Intervention types	Pro-environmental behaviour outcomes	Author (target population; Duration of the intervention)
Deliberative discussion and interaction with scientists or science	Vicarious behaviours towards conservation	Whitburn et al., 2023 (ages 7-13; half day)
	Waste avoidance and recycling	Oturai et al., 2022 (ages 7-16; Week 39 of the year) Gabreilsen et al., 2025 (ages 11-12; 90 minutes)
Active learning (including an action)	Consumerism	Betzler & Kempen, 2023 (ages 16-17; 5 consecutive school hours for 45 mins each) Sharma & Gupta, 2025 (ages:8-11**; 5- week intervention using active and passive learning tools in classroom settings)
	Vicarious behaviours towards conservation	Trott, 2019: 2021 (ages 10-12; 1 hour weekly for 15 weeks)
	Waste avoidance and recycling	Sharma, 2022 (ages 8-11; 5 weeks) Sharma & Gupta, 2025 (ages:8-11**; 5- week intervention using active and passive learning tools in classroom settings)
Active learning	Mobility and transportation	Stafford and Brain, 2022 (ages 14-18**; 50 minutes)
	Vicarious behaviours towards conservation	Balundė & Poškus, 2025 (ages 12-16; Once a week (45 mins) over 4 weeks.) Murphy et al., 2024 (ages 8-11; 6 months)
Place-based learning	Consumerism	Kanada et al. 2022 (ages 11-19, Introduction of government initiative for EE)
	Vicarious behaviours towards conservation	Pongsophon, 2024 (ages 12-18 **; 2014-2016) Kanada et al. 2022 (ages 11-19, Introduction of government initiative for EE)
	Waste avoidance and recycling	Kanada et al. 2022 (ages 11-19, Introduction of government initiative for EE)
	Wildlife conservation	Christodoulou & Grace, 2025 (ages 6-10; Once weekly for 3-7 months) Pongsophon, 2024 (ages 12-18**; 2014-2016)
Involving teachers and communities	Vicarious behaviours towards conservation	Kumar et al., 2023 (ages 9-14; 5 activities for 30mins over 5-6-week interval)
Nudges	Consumerism	Franceschini & Rocha, 2020 (ages 2-17; One day**)
	Energy conservation	Franceschini & Rocha, 2020 (ages 2-17; One day**)

** : Assumed from the full text.

Table 2 Interventions used in studies investigating what prompts pro-environmental action in certain conditions

Intervention			Conditions		Outcome type	Author
Type	**Description**	**Duration**	**Age in years**	**Country**		
Deliberative discussion and interaction with scientists or science	Environmental fieldtrip presented by trained education staff	Half day	7-13	New Zealand	**Vicarious behaviour towards conservation**	Whitburn et al.
	Environmental fieldtrip presented by trained education staff	Half day	7-13	New Zealand	**Wildlife conservation**	Whitburn et al.
	Mass experiment based on plastic pollution	1 Week	7-16	Denmark	**Waste avoidance and recycling**	Oturai et al.
	Emotional and cognitive engagement via visiting a food waste facility	90 minutes	11-12	Norway		Gabrielsen et al.
Active learning (include an action)	Programme addressing learners' awareness, emotions, attitudes, norms, and sustainable choices	5 consecutive school hours for 45 mins each	16-17*	Germany	**Consumerism**	Betzler & Kempen
	After-school programme combining climate education, photovoice (digital storytelling), and youth-led community action	1 hour weekly for 15 weeks	10-12	USA	**Vicarious behaviour towards conservation**	Trott (2019)
	After-school programme combining climate education, photovoice (digital storytelling), and youth-led community action	1 hour weekly for 15 weeks	10-12	USA	**Vicarious behaviour towards conservation**	Trott (2021)
	Programme using visuals and interactive social learning to improve learners' sustainable consumption habits	4 weeks	8-11*	India	**Waste avoidance and recycling**	Sharma
	Each of the following in classrooms: 1. Using active learning tools 2. Using passive learning tools 3. Control group	4 weeks	8-11*	India	**Consumerism AND Waste avoidance and recycling**	Sharma & Gupta
Active learning	Climate change workshop	Once a week (45 mins) over 4 weeks	12-16	Lithuania	**Vicarious behaviour towards conservation**	Balundė & Poškus
	Teachers' continuing professional development programme	6 months	8-11	Ireland		Murphy et al.
	Clean air contest	50 minutes	14-18*	USA	**Mobility and transportation**	Stafford & Brain
Place-based learning	Royal patronage level school programme	2 years	12-18*	Thailand	**Vicarious behaviour towards conservation**	Pongsophon
	Biodiversity enhancement educational programme	Once weekly for 3-7 months	6-10	England	**Wildlife conservation**	Christodoulou & Grace
	Effect of place (urban-rural differences)	Stand- alone survey after 5 years of EE (although frequency in that time is unclear	11-19	Saint Lucia	**Vicarious behaviour towards conservation AND Consumerism AND Waste avoidance and recycling**	Kanada et al.
Involving teachers and communities	Educational programme that uses interactive activities and thermal imaging cameras	5 activities for 30mins over 5-6 weeks	9-14*	UK	**Vicarious behaviour towards conservation**	Kumar et al.
Nudges	Set of stickers placed on elements	One month	2-17	Brazil	**Consumerism** / **Energy conservation**	Franceschini & Rocha

*Estimates

3.3. Intervention processes

The majority of CCE programmes reviewed employed pedagogical approaches centred on active and experiential learning (Table 1). Most interventions centred on ***active learning (including actions)*** (n=5), ***active learning*** (n=3), and ***placed based learning*** (n=3). These approaches were typically characterised by experiential, emotional, or inquiry-based educational activities, sometimes coupled with opportunities for learners to take direct climate related actions. The duration of these interventions ranged widely, from single school day activities to weekly sessions over several months, and, in some cases, long-term educational initiatives, for example spanning up to six months. Other intervention types are also represented in the review. ***Deliberative discussion and interaction with scientists or science*** (n = 4) were generally short-term, often structured as one-day visits to scientific or environmental sites. Only one study incorporated ***involving community or teacher involvement***, delivered over five sessions across a six-week period, highlighting its relative underuse despite potential benefits. One study utilised ***nudges***, using visual prompts such as stickers to influence behaviour; behavioural outcomes were assessed over five months.

Overall, intervention lengths varied considerably, from brief 50-minute sessions to multi-month programmes, highlighting the diversity of CCE delivery in both intensity and format. While a smaller number of studies (n = 7) implemented short-term interventions (less than one day), the majority (n = 10) extended over several weeks, suggesting that longer-duration interventions may be more conducive to fostering pro-environmental behaviour.

3.4. Pro-environmental behaviour outcomes

The majority of the reviewed studies reported clear positive effects on PEB. Of the seven quantitative studies identified, six showed statistically significant improvements in PEB. Although, Balundė & Poškus (2025) found a non-significant increase. Furthermore, Oturai et al. (2022) investigated several PEB and found that one showed a statistically significant improvement following the intervention, while five others increased without reaching statistical significance, two decreased, and one showed no change. All four qualitative studies indicated that the interventions had a positive impact on PEB. Additionally, six mixed-methods studies reported statistically significant improvements in PEB following the interventions. However, a passive learning intervention (in a mixed methods study) showed a non-significant increase in PEB. (This accounts for more results than the total number of studies included in the review, as one study reported separate findings for passive learning and active learning conditions.) For further details see Table 3.

Our study measures a range of PEB outcomes, with the most common being ***vicarious behaviours towards conservation*** (n = 8) such as climate-related personal and community action, support for activism, and increased engagement in science, technology, engineering and mathematics (STEM) and climate literacy. This was followed by ***waste avoidance and recycling*** (n = 5), ***consumerism*** (n=4) and ***wildlife conservation*** (n = 3) focusing on caring for the environment through small manageable actions (e.g., encompassed litter reduction and recycling). Fewer studies focused on outcomes related to ***energy conservation*** (n = 1),

and ***mobility and transportation*** (n = 1), suggesting that conservation-related behaviours remain the primary focus of climate change education research, with limited attention to everyday consumption and mobility behaviours, which are critical for long-term climate action. A few studies (n = 4) measured multiple behavioural outcomes, capturing a broader range of behavioural changes.

Active learning, in different forms generally prompted various types of PEB. Specifically, climate change workshops, resulted in a small increase in PEB, although the effect size was very small and statistically non-significant for ***vicarious behaviour towards conservation*** (i.e. support and engagement in climate activism) (Balundė & Poškus, 2025). A continuing professional development programme for teachers, resulted in a statistically significantly positive increase in learners' ***vicarious behaviour towards conservation*** via strategic action and improved attitudes towards sustainability (Murphy et al., 2024). A clean air contest had a positive impact on ***mobility and transportation*** related action, with clean air awareness arising from increased consciousness of car pollution (Stafford & Brain, 2022).

Active learning (including an action), in different formats typically elicited some types of PEB. A programme addressing learners' awareness, emotions, attitudes, norms, and sustainable choices, resulted in a statistically significantly positive improvement in ***consumerism***, specifically sustainable consumption behaviour (Betzler & Kempen, 2023). Using active learning tools in classrooms (versus passive learning tools and a control), resulted in a statistically significantly positive improvement in ***consumerism*** and ***waste avoidance and recycling***, in this case Environmentally Sustainable Consumption Behaviour (ESCB; Sharma & Gupta, 2025). (Passive learning had a positive impact on PEB which was not statistically significant.) A programme using visuals and interactive social learning to improve learners' sustainable consumption habits, resulted in a statistically significantly positive improvement in ***waste avoidance and recycling***, including waste management behaviour and other sustainable behaviours (Sharma, 2022). Specifically, an after-school programme combining climate education, photovoice (digital storytelling), and youth-led community action, resulted in a statistically significantly positive improvement in ***vicarious behaviour towards conservation***, namely climate-related personal and community action (Trott, 2019, 2021).

Involving teachers and communities, in this case interactive activities and thermal imaging cameras, resulted in a statistically significantly positive improvement in ***vicarious behaviour towards conservation***, increasing learners' motivation and engagement in STEM and climate literacy (Kumar et al., 2023).

Several approaches to ***deliberative discussion and interaction with scientists or science*** led to different expressions of PEB. Specifically, visiting a food waste facility, had a positive impact on ***waste avoidance and recycling***, including recycling and litter avoidance (Gabrielsen et al., 2025). Relatedly, a mass experiment based on plastic pollution resulted in a statistically significantly positive outcome for throwing litter on the ground, that is a form of ***waste avoidance and recycling***, while simultaneously affecting seven other behaviours (five with positive impact, two with a decrease in PEB, and one with no change) (Oturai et al., 2022). A half-day environmental fieldtrip presented by education staff, had a statistically significantly positive outcome on ***vicarious behaviour towards conservation***, specifically PEB actions learners could complete independently (Whitburn et al., 2023). It also, had a

statistically significantly positive outcome on ***wildlife conservation***, namely support for local conservation and/or animal care.

Nudges, in this case a set of stickers placed on objects in a school, positively impacted ***consumerism*** and ***energy conservation***, specifically the consumption of water, paper, and other resources (Franceschini & Rocha, 2025).

Place-based learning often stimulated several forms of PEB. The introduction of EE in 2008 and the effect of place (urban-rural differences), had a statistically significantly positive outcome on ***vicarious behaviour towards conservation***, as evidenced by reported environmental behaviour (Kanada et al., 2022). Relatedly, a school programme, had a statistically significantly positive outcome on ***vicarious behaviour towards conservation***, namely caring for the environment and increased interest in climate change (Pongsophon, 2024). The introduction of EE in 2008 and the effect of place (urban-rural differences), had a statistically significantly positive outcome on ***consumerism***, in this instance reported environmental behaviour (Kanada et al., 2022). It also had a statistically significantly positive outcome on ***waste avoidance and recycling***, as shown in reported environmental behaviour (Kanada et al., 2022). A biodiversity enhancement educational programme, positively impacted ***wildlife conservation***, fostering agency through small manageable actions (Christodoulou & Grace, 2025). Similarly, a school programme, had a statistically significantly positive outcome on ***wildlife conservation***, specifically caring for the environment and increased interest in climate change (Pongsophon, 2024).

These above results are displayed in Table 4.

Table 3 Overview of key characteristics of studies in our review

Author, Year (Title of the study)	Research design	Intervention type	Intervention description	Duration of intervention	Target population (mean and age)	Country	Outcome type	Outcome	GNI	CCPI
Balundė and Poškus, 2025 (Fostering interest in and support for climate change activism among adolescents)	Quantitative study Self-reported	Active learning	Climate change workshops	Once a week (45 mins) over 4 weeks	No M age (ages 12-16)	Lithuania	Vicarious behaviour towards conservation	Support and engagement in climate activism (Positive impact)	$26,950	63.1
Betzler and Kempen, 2023 (Strengthening sustainable consumption behaviour in high school students: Evaluation of an experiential training intervention targeting psychological determinants)	Quantitative study Self-reported	Active learning (including an action)	Programme addressing learners' awareness, emotions, attitudes, norms, and sustainable choices	5 consecutive school hours for 45 mins each	17.1 ± 0.63 (ages 16-17 estimate)	Germany	Consumerism	Sustainable consumption behaviour (Significantly positive*)	$54,960	64.9
Christodoulou and Grace, 2025 (Becoming 'Wild Citizens': Children's articulation of environmental citizenship in the context of biodiversity loss)	Qualitative study Self-reported	Placed-based learning	Biodiversity enhancement educational programme	Once weekly for 3-7 months (differs between each school refer to Table 1)	No M age (ages 6-10)	England	Wildlife conservation	Agency through small manageable actions (Positive impact)	$48,610	69.3
Franceschini and Rocha, 2025 (Design for sustainable behaviour: an exploratory study in schools' washrooms)	Qualitative study Observed and self-reported	Nudges	Set of stickers placed on the items in school washrooms as reminders	A month	No M age (ages 2-17)	Brazil	Consumerism AND Energy conservation	Consumption of water and paper and resources (Positive impact)	$9,950	57.3
Gabrielsen et al., 2025 ("It was a real wake-up call for the pupils." How can collaboration with external actors outside school influence education for sustainable development?)	Qualitative study Observed and self-reported	Deliberative discussion and interaction with scientists or science	Emotional and cognitive engagement through visiting a food waste facility	90 minutes	No M age (ages 11-12)	Norway	Waste avoidance and recycling	Recycling and litter avoidance (Positive impact)	$98,280	68.2

Author, Year (Title of the study)	Research design	Intervention type	Intervention description	Duration of intervention	Target population (mean and age)	Country	Outcome type	Outcome	GNI	CCPI
Kanada et al., 2022 (Linking environmental knowledge, attitude, and behaviour with place: a case study for strategic environmental education planning in Saint Lucia	Quantitative study Self-reported	Place-based learning	Introduction of EE in 2008. Effect of the place (urban-rural differences)	One time survey (the survey was conducted between April 2013 and January 2014)	No M age (age 11-19)	Saint Lucia	Vicarious behaviour towards conservation AND Consumerism AND Waste avoidance and recycling	Reported environmental behaviour (action) (Significantly positive*)	$12,800	No rating
Kumar et al., 2023 (Using empirical science education in schools to improve climate change literacy)	Mixed methods research Observed and self-reported	Involving teachers and communities	Educational programme that uses interactive activities and thermal imaging cameras	5 activities for 30mins over 5–6-week interval	No M age (ages 9-14**)	United Kingdom	Vicarious behaviour towards conservation	Increases learners' motivation and engagement in STEM and climate literacy (Significantly positive*)	$48,610	69.3
Murphy et al., 2024 (The influence of a teachers' professional development programme on primary school pupils' understanding of and attitudes towards sustainability)	Mixed methods research Self-reported	Active learning	Continuing professional development programme	6 months	No M age (ages 8-11)	Ireland	Vicarious behaviour towards conservation	Strategic action through improved attitudes of sustainability (Significantly positive*)	$77,920	57.17
Oturai et al., 2022 (How can we test plastic pollution perceptions and behaviour? A feasibility study with Danish children participating in the mass experiment)	Quantitative study Self-reported	Deliberative discussion and interaction with scientists or science	Mass experiment-based on plastic pollution	Week 39 of the year	No M age (ages 7-16)	Denmark	Waste avoidance and recycling	Waste management (Significantly positive* increase for throwing litter on the ground behaviour*) (Ceiling effect) Seven other behaviours (five positive impact, two decrease, one no change)	$73,790	78.37
Pongsophon, 2024 (Cultivating environmental consciousness)	Mixed methods research Self-reported	Placed-based learning	Royal patronage level school programme	2014-2016	No M age (ages 12-18**)	Thailand	Wildlife conservation AND Vicarious behaviours towards conservation	Caring for the environment and increased interest in climate change (Significantly positive*)	$7,120	59.2

Author, Year (Title of the study)	Research design	Intervention type	Intervention description	Duration of intervention	Target population (mean and age)	Country	Outcome type	Outcome	GNI	CCPI
Sharma, 2022 (Understanding the impact of social learning forms on environmentally sustainable consumption behaviour among school children)	Quantitative study Observed	Active learning (including an action)	Programme using visuals and interactive social learning to improve learners' sustainable consumption habits	4 weeks	No M age (ages 8-11**)	India	Waste avoidance and recycling	Waste management behaviour and other sustainable behaviours (Significantly positive*)	$2,650	68
Sharma and Gupta, 2025 (Analysing the impact of educational tools on fostering sustainable consumption in children)	Mixed methods research Observed And self-reported	Active learning (including an action)	5-week intervention using active learning tools, passive learning tools and a control group in classroom settings	4 weeks	No M age (ages 8-11**)	India	Consumerism AND Waste avoidance and recycling	Environmentally Sustainable Consumption Behaviour (ESCB) (AL-Significantly positive*) (PL-Positive impact)	$2,650	68
Stafford and Brain, 2022 (Building teen empowerment through a clean air contest: implications for designing education outreach)	Qualitative study Self-reported	Active learning	Clean air contest	50 minutes	No M age (ages14-18**)	USA	Mobility and transportation	Clean air as a result of being conscious of car pollution (Positive impact)	$83,660	40.58
Trott. 2019 (Children's constructive climate change engagement: Empowering awareness, agency, and action)	Mixed methods research Self-reported	Active learning (including an action)	After-school programme combining climate education, photovoice (digital storytelling), and youth-led community action	1 hour weekly for 15 weeks (avg. attendance 11/12 weeks)	No M age (ages 10-12)	USA	Vicarious behaviour towards conservation	Climate-related personal and community action (Significantly positive*)	$83,660	40.58
Trott, 2021 (Youth-led climate change action: multi-level effects on children, families, and communities)	Mixed methods research Self-reported	Active learning (including an action)	After-school programme combining climate education, photovoice (digital storytelling), and youth-led community action	1 hour weekly 15 weeks	No M age (ages 10-12)	USA	Vicarious behaviour towards conservation	Climate related personal and community action (Significantly positive*)	$83,660	40.58

Author, Year (Title of the study)	Research design	Intervention type	Intervention description	Duration of intervention	Target population (mean and age)	Country	Outcome type	Outcome	GNI	CCPI
Whitburn et al., 2023 (Do environmental education fieldtrips strengthen children's connection to nature and promote environmental behaviour or wellbeing?)	Quantitative study Self-reported	Deliberative discussion and interaction with scientists or science	Half-day environmental fieldtrip presented by trained education staff	Half day	10.70 ± 1.42 (ages 7-13)	New Zealand	Vicarious behaviour towards conservation	PEB actions learners could complete on their own (Significantly positive*)	$46,280	51.06
Whitburn et al., 2023 (Do environmental education fieldtrips strengthen children's connection to nature and promote environmental behaviour or wellbeing?)	Quantitative study Observed	Deliberative discussion and interaction with scientists or science	Half-day environmental fieldtrip presented by trained education staff	Half day	10.70 ± 1.42 (ages 7-13)	New Zealand	Wildlife conservation	Support for local conservation and/or animal care (Significantly positive*)	$46,280	51.06

*: Indicates statistically significant positive effect ($p < 0.05$)

**: Assumed from the full text.

Notes:

M: Mean

Gross National Income (GNI) per capita

Climate Change Performance Index (CCPI)

Table 4 Interventions, and the strength of results on pro-environmental action in certain conditions

Intervention			Conditions		Outcome		Author(s) and year of publication
Type	**Description**	**Duration**	**Age**	**Country**	**Type**	**Description**	
Active learning	Climate change workshops	Once a week (45 mins) over 4 weeks	12-16	Lithuania	Vicarious behaviour towards conservation	Support and engagement in climate activism (Positive impact)	Balundė and Poškus
	Continuing professional development programme	6 months	8-11	Ireland		Strategic action through improved attitudes of sustainability (Significantly positive*)	Murphy et al.
	Clean air contest	50 minutes	14-18**	USA	Mobility and transportation	Clean air as a result of being conscious of car pollution (Positive impact)	Stafford and Brain
Active learning (including an action)	Programme addressing learners' awareness, emotions, attitudes, norms, and sustainable choices	5 consecutive school hours for 45 mins each	16-17**	Germany	Consumerism	Sustainable consumption behaviour (Significantly positive*)	Betzler and Kempen
	Using active learning tools in classrooms (versus passive learning tools and a control)	4 weeks	8-11**	India		Environmentally Sustainable Consumption Behaviour (ESCB) (Significantly positive*) (Passive learning-Positive impact)	Sharma and Gupta
	Programme using visuals and interactive social learning to improve learners' sustainable consumption habits	4 weeks	8-11**	India	Waste avoidance and recycling	Waste management behaviour and other sustainable behaviours (Significantly positive*)	Sharma
	Using active learning tools in classrooms (versus passive learning tools and a control)	4 weeks	8-11**	India		Environmentally Sustainable Consumption Behaviour (ESCB) (Significantly positive*) (Passive learning-Positive impact)	Sharma and Gupta
	After-school programme combining climate education, photovoice (digital storytelling), and youth-led community action	1 hour weekly for 15 weeks	10-12	USA	Vicarious behaviour towards conservation	Climate-related personal and community action (Significantly positive*)	Trott, 2019
	After-school programme combining climate education, photovoice (digital storytelling), and youth-led community action	1 hour weekly for 15 weeks	10-12	USA		Climate related personal and community action (Significantly positive*)	Trott, 2021
Involving teachers and communities	Educational programme that uses interactive activities and thermal imaging cameras	5 activities for 30 mins over 5–6-week interval	9-14**	UK	Vicarious behaviour towards conservation	Increases learners' motivation and engagement in STEM and climate literacy (Significantly positive*)	Kumar et al.

Intervention			Conditions		Outcome		Author(s) and year of publication
Type	**Description**	**Duration**	**Age**	**Country**	**Type**	**Description**	
Deliberative discussion and interaction with scientists or science	Emotional and cognitive engagement through visiting a food waste facility	90 minutes	11-12	Norway	Waste avoidance and recycling	Recycling and litter avoidance (Positive impact)	Gabrielsen et al
	Mass experiment-based on plastic pollution	Week 39 of the year	7-16)	Denmark		Waste management (Significantly positive* increase for throwing litter on the ground behaviour*) (Ceiling effect) Seven other behaviours (five positive impact, two decrease, one no change)	Oturai et al.
	Half-day environmental fieldtrip presented by trained education staff	Half day	7-13	New Zealand	Vicarious behaviour towards conservation	PEB actions learners could complete on their own (Significantly positive*)	Whitburn et al.
	Half-day environmental fieldtrip presented by trained education staff	Half day	7-13	New Zealand	Wildlife conservation	Support for local conservation and/or animal care (Significantly positive*)	Whitburn et al.
Nudges	Set of stickers placed on elements	A month	2-17	Brazil	Consumerism AND Energy conservation	Consumption of water and paper and resources (Positive impact)	Franceschini and Rocha
Place-based learning	Introduction of EE in 2008. Effect of the place (urban-rural differences)	One time survey	11-19	Saint Lucia	Vicarious behaviour towards conservation	Reported environmental behaviour (action) (Significantly positive*)	Kanada et al.
	Royal patronage school level programme	2 years	12-18**	Thailand		Caring for the environment and increased interest in climate change (Significantly positive*)	Pongsophon
	Introduction of EE in 2008. Effect of the place (urban-rural differences)	One time survey	11-19	Saint Lucia	Consumerism	Reported environmental behaviour (action) (Significantly positive*)	Kanada et al.
	Introduction of EE in 2008. Effect of the place (urban-rural differences)	One time survey	11-19	Saint Lucia	Waste avoidance and recycling	Reported environmental behaviour (action) (Significantly positive*)	Kanada et al.
	Biodiversity enhancement educational programme	Once weekly for 3-7 months	6-10	England	Wildlife conservation	Agency through small manageable actions (Positive impact)	Christodoulou and Grace
	Royal patronage school level programme	2 years	12-18**	Thailand		Caring for the environment and increased interest in climate change (Significantly positive*)	Pongsophon

*: Indicates statistically significant positive effect ($p < 0.05$)

**: Indicates assumed from the full text.

3.5. Mediators and moderators

Four studies identified moderating variables that influenced PEB outcomes. Two studies (Whitburn et al., 2023) highlighted the importance of ***connection to nature***, which was positively associated with both conservation actions and general everyday pro-environmental behaviours (Figure 3, Figure 4). ***School context*** is also a moderating factor for two studies. Franceschini and Rocha (2025) identified the ***school context (school type)*** (Figure 5) as a moderating factor influencing the effectiveness of interventions on pro-environmental behaviour. They highlighted outcomes varied between private and state schools in Brazil, with private school learners demonstrating a greater reduction in toilet paper consumption following the intervention. Balundė and Poškus (2025) identified ***school context (school differences)*** and ***gender*** as moderators, noting that girls exhibited higher engagement and interest in interventions than boys (Figure 7). Oturai et al. (2022) identified the ***age*** and ***participation level*** as a moderating factor influencing PEB (Figure 8). They suggested an advantage of increased attention to the role of age and learners, participation level when designing and measuring this type of intervention.

Only one study (Pongsophon, 2024) identified a mediating factor: ***environmental consciousness*** which is a construct combining values, knowledge, and beliefs. Environmental consciousness was shown to mediate the relationship between school-level and learner-level factors and PEB outcomes (Figure 6). This finding underscores the complex psychological pathways through which CCE interventions influence behaviour.

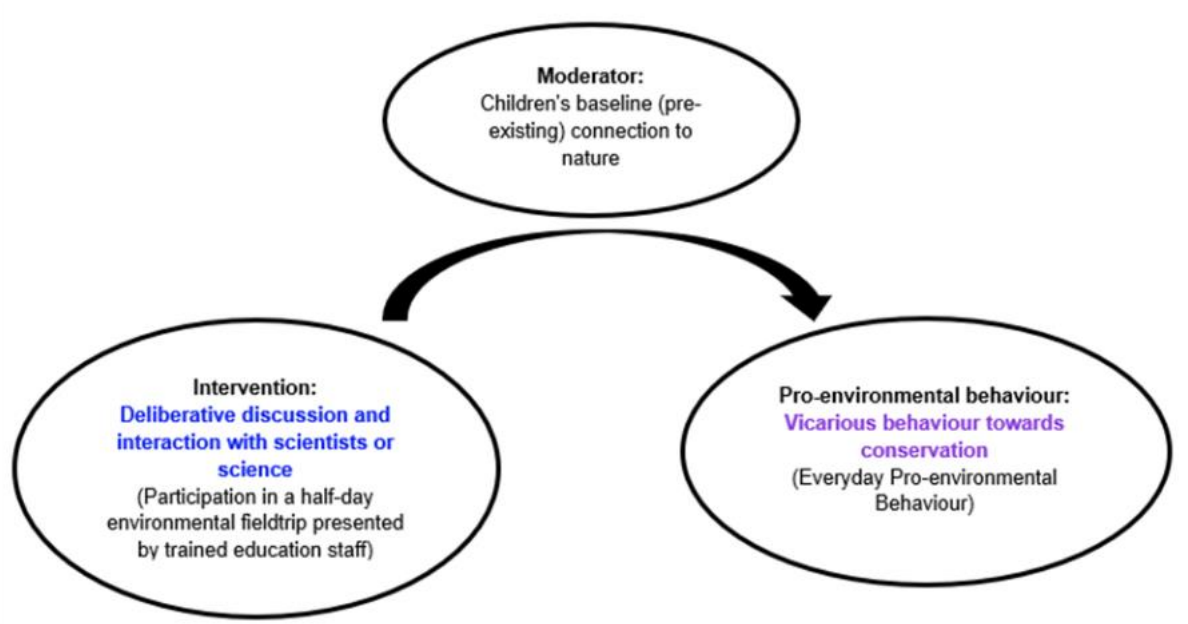

Figure 3 Do environmental education fieldtrips strengthen children's connection to nature and promote environmental behaviour or wellbeing? (Whitburn et al., 2023)

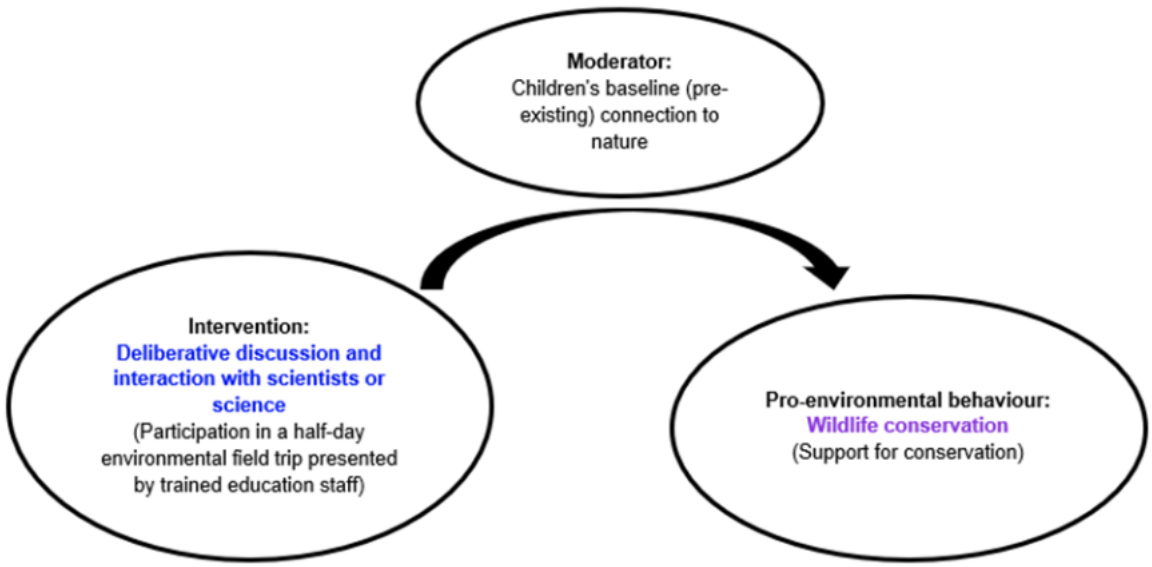

Figure 4 Do environmental education fieldtrips strengthen children's connection to nature and promote environmental behaviour or wellbeing? (Whitburn et al., 2023)

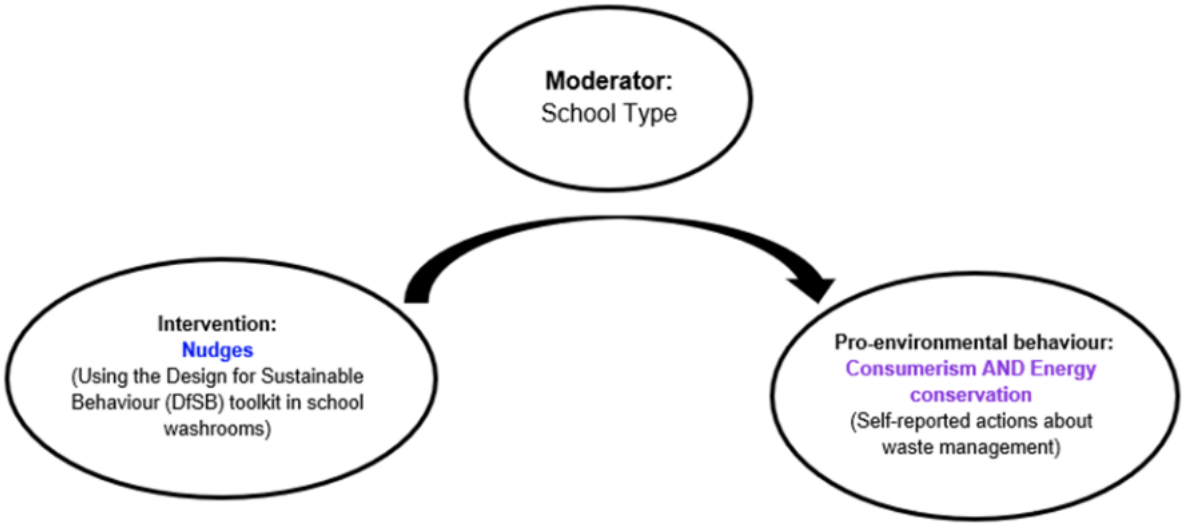

Figure 5 Design for sustainable behaviour: An exploratory study in schools' washrooms (Franceschini & Rocha, 2025)

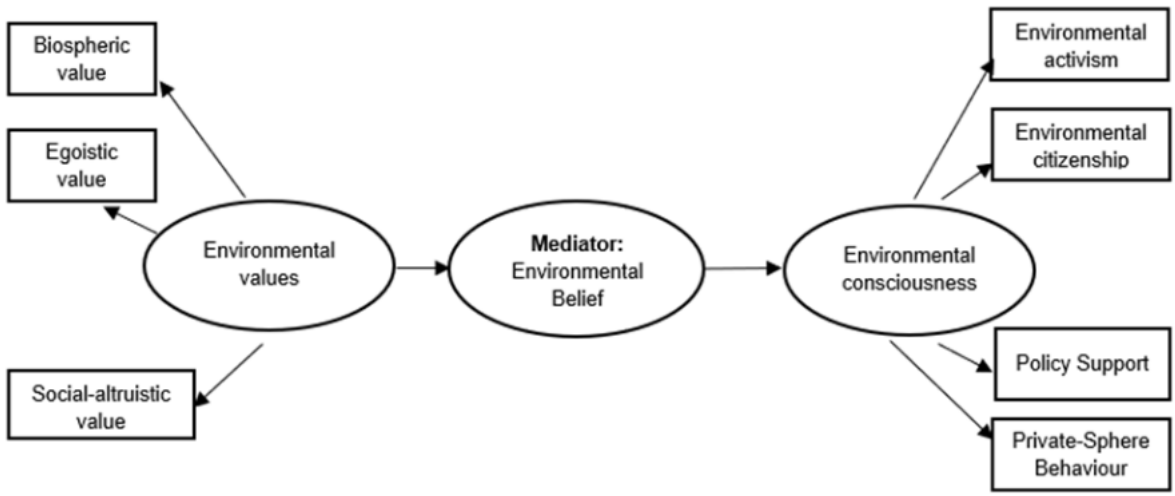

Figure 6 Cultivating environmental consciousness evaluating plant genetics conservation through school botany programmes in Thailand (Pongsophon, 2024)

Note: Diagram of the first phase of the study: qualitative case studies to build a hypothetical model (New Ecological Paradigm - Value-Belief-Norm theory)

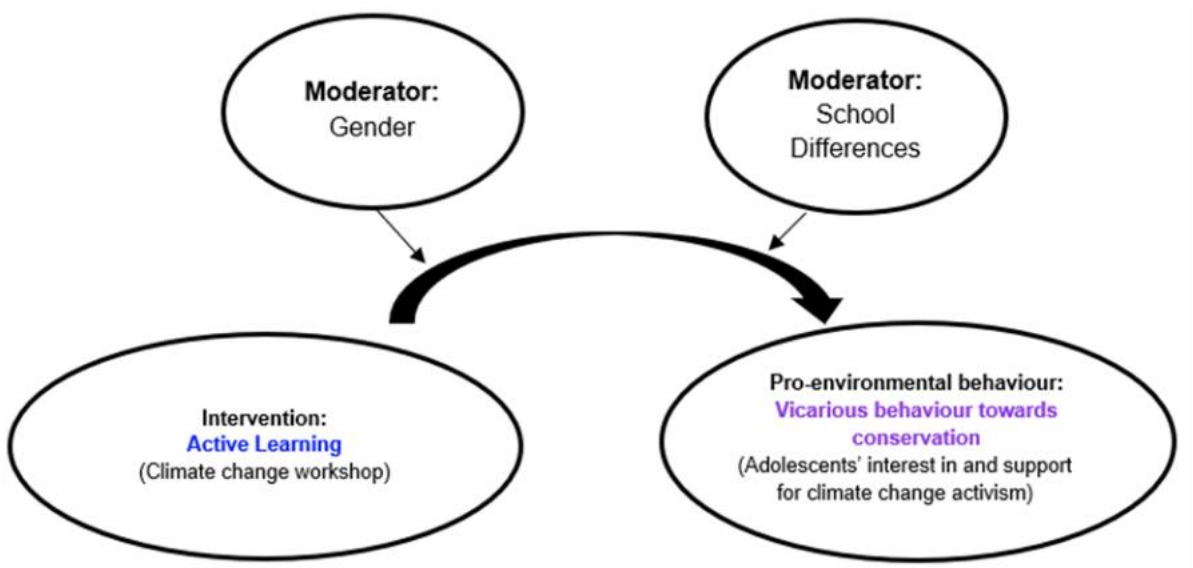

Figure 7 Fostering interest in and support for climate change activism among adolescents (Balundė & Poškus, 2025)

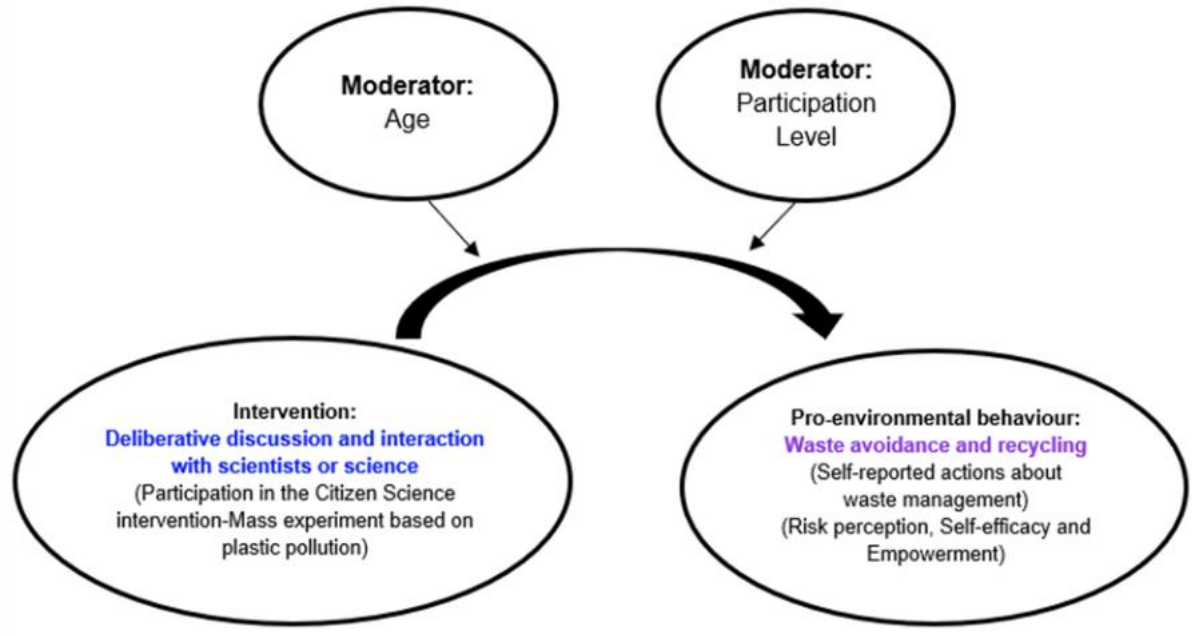

Figure 8 How can we test plastic pollution perceptions and behaviour? A feasibility study with Danish children participating in the mass experiment (Oturai et al., 2022)

4. Discussion

This review aimed to identify what prompts children and young people to act on their climate education by engaging in pro-environmental behaviours. Based on our review of 16 articles (comprising 17 studies - one article has two studies), we draw several conclusions that both align with and contribute to the broader strategic goals of international climate change education. Drawing on these studies across diverse contexts, it examined not only the types of interventions implemented but also the specific behaviours they targeted, how they were measured, and the extent to which those behaviours were sustained. The findings reveal both promising practices and significant limitations in the current evidence base. In this discussion, we synthesise these findings in relation to broader literature, with focused commentary on intervention design, behavioural outcomes, socioeconomic and geographical context (including rural settings), and the underexplored roles of mediating and moderating factors.

4.1. Scope and gaps in the literature

Research on educational interventions promoting pro-environmental behaviour among children remains limited. From an initial pool of 2110 articles, only 16 met our inclusion criteria. This narrow yield contrasts with recent reviews such as Świątkowski et al. (2024), who identified 65 relevant studies, and van de Wetering et al. (2022), who reported 169. This discrepancy likely stems from our more stringent inclusion criteria including a limited date range.

Despite broader recent reviews, studies specifically targeting children and adolescents remain relatively sparse compared to the extensive literature on adult-focused PEB interventions. For instance, Colombo et al. (2023) reviewed 44 studies addressing adult PEB, while Dioba et al. (2024) included 38 studies focused on barriers to adult PEB.

Across the reviewed interventions, a wide range of educational approaches and behavioural outcomes were reported, providing insight into the conditions under which climate change education is most likely to foster tangible action. However, patterns in the literature reveal important conceptual and geographical gaps, which may make it difficult to draw generalisable conclusions.

4.2. Methodological limitations

The majority of studies in our review relied on self-reported measures of PEB, with fewer incorporating observed behavioural outcomes. Self-report methods are prone to biases such as social desirability and may reflect intentions rather than actual behaviours. For example, Corral-Verdugo (1997) found that while beliefs predicted self-reported behaviours, observed behaviours were more closely linked to practical competencies, underscoring the value of including the observational methods in future research.

Our review also highlighted a notable lack of longitudinal research, which is a concern similarly raised by Liu and Green (2024). Longitudinal studies are resource-intensive and logistically challenging, with difficulties in maintaining high-quality data when individuals miss out on waves of data collection, thus increasing the risk of attribution bias (Hulshoff Pol &

Brouwer, 2025). However, longitudinal studies have been recognised as important vehicles for obtaining high-quality evidence about the determinants of behaviour (Sanson & Smart, 2011) through providing rich information and accounting for time effects in comparison to cross-sectional studies (Liu & Green, 2024). A longitudinal study in our review (Gabrielsen et al., 2025) followed learners for two years, with teachers reporting continued engagement in recycling and litter reduction well beyond the intervention period. Such findings reinforce the value of longitudinal studies in CCE, as PEB's were shown to persist beyond the initial intervention period. This reinforces the need for longitudinal research design, which were rare in our sample (n = 4), to strengthen claims about behavioural durability.

4.3. Interventions

The interventions included in this review varied substantially in both format and duration.

4.3.1. Active learning including an action

Five studies included in our structured literature review featured interventions that we classified as active learning including an action. These involved learners engaging directly in tasks, including pro-environmental actions, reflecting on their experiences and constructing knowledge through participation. More specifically, the following interventions were found to generally prompt PEB: a programme addressing learners' awareness, emotions, attitudes, social norms, and sustainable choices (Betzler & Kempen, 2023); after-school programmes combining climate education, photovoice (digital storytelling), and youth-led community action (Trott, 2019; 2021); a programme employing visuals, interactive storytelling, and social learning to improve sustainable consumption habits (Sharma, 2022); as well as a demonstrations, pausing lectures, simulated consumption scenarios (Sharma & Gupta, 2025). Our findings echo those of Arık and Yılmaz (2020), who conducted a meta-analysis demonstrating that active learning- defined as a constructivist pedagogical approach within environmental education - was more effective in promoting pro-environmental behaviour than traditional instructional methods. Their analysis drew upon literature published between 2000 and 2015. However, it is important to note that their review does not explicitly state whether the interventions analysed involved learners undertaking pro-environmental actions as part of the learning process. As such, while the theoretical underpinnings and pedagogical strategies may be comparable, other aspects of the research may differ. The importance of such real-world engagement in fostering motivation and ownership is supported by Mebert et al. (2020), who found that collaboration and applying content to real problems enhanced learner engagement.

4.3.2. Active learning

Active learning (n=3) interventions emphasised inquiry, discussion, and experiential formats without always requiring immediate behavioural action. They included activities such as teachers' continuing professional development programme (Murphy et al., 2024), climate change workshop (Balundė & Poškus, 2025), and clean air-contest competition (Stafford & Brain, 2022) which are targeting attitudes and norms. All three interventions prompted PEB, of varying forms, although only one of the two quantitative studies resulted in a statistically significant result. Our findings reflect those of Arık and Yılmaz (2020), mentioned above.

4.3.3. Deliberative discussion and interaction with scientists or science

Four studies adopted strategies involving deliberative discussion and interaction with scientists or science. Whitburn et al. (2023) demonstrated significant improvements in learners' PEB levels, including wildlife conservation and everyday self-reported behaviours, through nature-based field trips that combined lectures and guided discussions with trained educational staff at zoos and wildlife sanctuaries. Gabrielsen et al. (2025) found that the visible and tangible real-life experiences which are conducted with the collaboration of external actors made a deep impact on pupils participating in an out-of-school education programme. However, Oturai et al. (2002) found no main effects of the Mass Experience (Citizen Science) intervention on the reported pro-environmental behaviour, emphasizing the high baseline of the learners. These findings confirm prior research suggesting that environmental education conducted by trained staff and scientists encourages learners' engagement in PEB (Collado et al. 2013, Stern et al., 2008). In contrast, Hemby et al. (2023) notes that access to environmental education fieldtrips is largely limited to urban and suburban regions within the US, with rural regions and even some urban communities facing barriers such as cost, transportation, limited awareness, cultural factors, and curriculum requirements. These challenges may partly explain why deliberative discussion and interaction with scientists or science were less commonly represented within our review.

4.3.4. Place-based learning

Placed-based learning (n=3) situated climate education in learners' immediate environments, offering experiential opportunities tied to biodiversity, conservation and everyday practice. Pongsophon (2024) found that a programme offering hands-on learning in botanical gardens, integrated within school settings, generally encouraged care for the environment and increased interest in climate change. Similarly, Christodoulou and Grace (2025) identified that a biodiversity initiative where learners recorded living organisms in school grounds, planned biodiversity enhancements, and explored the concept of "environmental citizenship" typically fostered agency through small, manageable actions. Both interventions involved learners engaging directly with a physical place and participating in social interactions within that setting. Kanada et al. (2022) proposed the place-based learning as a strategic intervention to enhance PEB among learners. These elements can contribute to individuals forming emotional bonds with their environment, leading to a sense of place or "place attachment" and place attachment is known to positively influence pro-environmental behaviour (Daryanto & Song, 2021). Therefore, our findings are in line with those of prior research.

4.3.5. Nudges

Despite their potential, nudge-based interventions (n=1) were the least represented in our reviewed studies. Franceschini and Rocha (2025) highlighted the use of stickers to promote PEB, specifically consumerism and energy conservation. Their research was consistent with that of Thapa and Lyford (2018) and Luerson et al. (2012), which identified an increase in learners' motivation to perform desired behaviours, help them visualise progress, and sustain behavioural change over time by using stickers as nudges.

4.3.6. Involving teachers and communities

Within our review, only one study, by Kumar et al. (2023), highlighted the use of involving teachers and communities; while the intervention is centred on science education, it demonstrates the successes of projects developed by teachers, parents, and the local community. Kumar et al.'s (2023) project saw increases in both climate and heat-related knowledge, as well as heightened interest in STEM subjects using infrared cameras. Despite this, it is recognised that, for interventions like this to be scaled successfully across vast regions, the correct financial incentives for local schools and communities are necessary, as well as providing intellectual support for teachers. This result confirms prior studies suggesting that how community centred approaches often stem from local challenges, fostering a sense of ownership, emotional connection between learners and the topic, and action among learners and helping them to solve the local communities' problems (Świątkowski et al., 2024; Kranz et al., 2022).

4.3.7. Variability in intervention type and duration

Interestingly, the more sustained interventions were more likely to report positive behavioural outcomes. However, there was also a notable lack of follow-up assessments. Only four studies conducted post-intervention follow-ups to assess whether behaviours were sustained over time. This is a significant limitation: without repeated measures, it is difficult to know whether observed behaviours represent genuine change or temporary compliance due to demand characteristics. Interventions that did include delayed measurement provided more robust evidence of retention, suggesting that this should be a standard feature of future studies.

4.4. Pro-environmental behaviours

4.4.1. Vicarious behaviours toward conservation

Vicarious behaviours toward conservation (n = 8) were the most frequently measured behaviour within our review. This may be due to the broad and multidimensional nature of the definition, which encompasses a wide range of environmentally friendly actions that are easier to capture through qualitative indicators. Additionally, direct behavioural change is often challenging to capture in short term studies, whereas vicarious behaviour can be measured more immediately following an intervention. The dominance of survey-based methodologies may also contribute to this trend, as self-report instruments are particularly well suited to capturing vicarious behaviours (Koller et al., 2023). A strong example from our review is provided by Balundė and Poškus (2025), who measured participants' engagement in climate activism through self-report surveys administered immediately after the intervention, one week later, and followed up a month after. While the other studies examining vicarious behaviours toward conservation reported significant positive effects, Balundė and Poškus (2025) found only a very small, non-significant increase in pro-environmental behaviour following their intervention. They suggest that this lack of statistical significance may not indicate ineffectiveness, as the impact of such interventions could grow over time. This highlights the importance of considering both effect size and the potential for delayed behavioural change when evaluating the outcomes of educational interventions. Although the direct impact of vicarious behaviours may be modest, their importance is clear. Unlike individual actions, they promote peer engagement and encourage others, helping to spread environmental awareness through social influence (Larson et al., 2015). Moreover, by fostering vicarious experiences and behaviour, educational interventions can enhance self-efficacy, which in turn supports the spillover of pro-environmental attitudes into more challenging conservation behaviours, such as biodiversity protection (Gong et al., 2021; Lauren et al., 2016). Trott (2019; 2021) exemplifies this through workshops designed to deepen participants' understanding of the scientific and social dimensions of climate change, resulting in increased motivation to learn and act. Kanada et al. (2022) further explored vicarious conservation behaviours by examining learners' willingness to support environmental initiatives indirectly with notable differences observed between urban and rural cohorts and found that rural students were more likely to report high levels of environmental action despite low environmental knowledge.

4.4.2. Waste avoidance and recycling

Several studies also focused on waste avoidance and recycling which are often considered foundational pro-environmental behaviours. Waste avoidance and recycling (n=5) represent important steps in PEB, likely due to the regulatory frameworks that require institutions to implement formal waste management plans. These behaviours are often reinforced through visible infrastructure, either through clearly labelled recycling bins and designated storage or disposal facilities (Galeotti et al., 2024). Recycling and waste avoidance are relatively simple tasks, making them easy for researchers to observe, measure, and assess in educational settings. Notably, two of the three recycling-focused studies in our review used observational measures, strengthening the validity of the study. Sharma (2022) used this style of approach by giving learners a piece of paper and observing whether they disposed of it in the correct recycling bin or asked for a second sheet to continue their drawing, rather than flipping over the first sheet of paper. Kanada et al. (2022) found that learners in Saint Lucia reported

engaging in waste avoidance and recycling behaviours such as reusing or recycling items and choosing environmentally friendly products, though these actions were sometimes driven more by necessity than environmental knowledge. Similarly, Sharma and Gupta (2025) evaluated children's decisions to reuse paper and dispose of waste in recycling bins rather than trash cans, using these actions as indicators of environmentally conscious consumption. While other studies which focused on waste avoidance and recycling reported statistically significant results, Gabrielsen et al. (2025) conducted a qualitative study without quantitative analysis. Nevertheless, their findings indicated increased action competence and improved sustainable behaviour, highlighting that pupils' reflections on sustainability issues were notably promoted.

4.4.3. Consumerism

Consumerism (n=4) was explored in several studies, often focusing on learners' attitudes toward material consumption and their awareness of its environmental consequences. Kanada et al. (2022) highlighted that while recycling is a common behaviour, it may not reflect deeper systematic changes in consumption habits, indicating that consumerism remains a challenge for fostering truly sustainable lifestyles. Sharma and Gupta (2025) demonstrated that educational tools, particularly active learning methods, positively influenced children's choices to favour sustainable consumption, such as opting for cloth bags over plastic ones during simulated purchasing tasks. Complementing this, Betzler and Kempen (2023) showed that experiential training targeting emotional and rational drivers significantly improved learners' sustainable consumption practices, especially in food, fashion, and plastic use, with effects sustained over time. While other studies reported statistically significant results, Franceschini and Rocha (2025) conducted a qualitative study without quantitative analysis. While interview responses suggested the toolkit could promote more sustainable use of resources, the overall effectiveness was less than anticipated.

4.4.4. Wildlife conservation

Wildlife conservation (n=3) was typically supported through direct experiential learning, such as zoo visits and exploring local biodiversity. Actions tied to wildlife conservation are often difficult to observe and often reliant on self-reporting due to the complexity of the topic. Moreover, Larson et al. (2015) highlights how some behaviours are inherently more difficult to carry out than others due to social, structural and participation factors. For example, low impact behaviours related to waste management, vicarious behaviours and energy conservation are relatively easy to engage with and are relatively straightforward (Galeotti et al., 2024), whereas wildlife conservation behaviours, such as reducing meat consumption and avoiding products linked to habitat destruction, require more effort, deeper awareness and systemic support (Bujold et al., 2020).

4.4.5. Energy conservation and Mobility and transportation

Conversely, behaviours related to energy conservation (n=1), and mobility and transportation (n=1) were the least studied in our review, diverging from broader literature (Galeotti et al., 2024), which reports more emphasis on energy-related behaviours. Franceschini and Rocha (2025) addressed energy conservation through a design intervention using animal-themed stickers placed on light switches in school washrooms. Stafford and Brain (2022) conducted a qualitative study to address mobility and transportation behaviours. They found that a clean air contest fostered positive attitudes

among both learners and parents, and effectively engaged teens in promoting sustainable mobility behaviours such as carpooling, biking, and reducing engine idling.

4.5. Gaps in the behavioural outcomes studied

In terms of the behaviours targeted, most interventions focused on conservation-related actions such as recycling, waste reduction, or participation in environmental campaigns. While these are valuable entry points, few studies addressed more impactful or systemic behaviours such as energy consumption, transport choices, or food-related decisions. This mirrors a broader pattern in CCE where behavioural goals are often limited to what can feasibly be enacted within the school setting. However, there is a growing recognition that educational interventions must also tackle systemic and lifestyle-based behaviours to meaningfully address the climate crisis (UNESCO, 2021).

Moreover, measurement of behavioural outcomes was highly variable. Most studies relied on self-report, which introduces the potential for bias, especially when assessments are conducted immediately after an intervention. Only a handful of studies used observational methods or attempted to measure behaviour over time. As a result, the field lacks a clear understanding of which behaviours are most amenable to change, under what conditions, and for how long.

4.6. What prompts pro-environmental behaviour/action?

Across the reviewed studies, several forms of educational intervention were associated with positive pro-environmental behaviour. Active learning that included an action provided learners with concrete opportunities to translate knowledge into behaviour, often fostering a sense of ownership and responsibility. Active learning which did not include pro-environmental action approaches more broadly, emphasising inquiry, reflection, and discussion, were effective in shaping attitudes and intentions, although their impact on durable behavioural change was sometimes more limited. Place-based learning, which situated climate education in local environments, supported stronger connections to nature and community, encouraging care for the immediate surroundings and reinforcing a sense of environmental citizenship. Interventions involving interaction with scientists or science offered experiential engagement through field trips and real-world contexts, strengthening both environmental knowledge and motivation for action. Nudges, while less commonly employed, influenced everyday practices through subtle prompts in decision-making environments, often producing immediate though modest effects. Finally, interventions that actively involved teachers and communities embedded learning within wider social networks, enhancing relevance, emotional connection, and opportunities for sustained practice.

4.7. Factors influencing effectiveness of interventions (moderators and mediators of the studies)

4.7.1. Age and developmental factors

Although our review did not consistently identify age as a moderator, broader literature suggests that teenagers and young adults are less responsive to interventions than younger children, likely due to increased autonomy and peer influence during puberty (Foulkes et al., 2018; Liu & Green, 2024; Świątkowski et al., 2024). Our review noted that Oturai et al.

(2022) observed greater pro-environmental behavioural change among younger children (ages 7-12), particularly in litter-picking activities, whereas older participants (ages 13-16) exhibited no significant behavioural change (Figure 8). In the literature, Świątkowski et al.'s (2024) also supports these findings by identifying a negative correlation between age and intervention effectiveness. This result is further supported by Liu and Green (2024) in the literature, who also argued that older age in children is associated with fewer reported environmental actions, irrespective of their ecological beliefs or emotional affinity towards nature. Foulkes et al. (2018) argue this phenomenon is a consequence of adolescents entering a period of significant social reorientation at puberty where established habits, increased autonomy, and a greater reliance on peer influence rather than parental guidance results in greater anti-social actions.

4.7.2. Nature relatedness and school context

The most consistently identified factor influencing intervention effectiveness within our review was learners' level of nature relatedness, encompassing both emotional connection to nature and conscious awareness of environmental issues. In our review, Whitburn et al. (2023) revealed that children's pre-existing connection to nature significantly predicts their post intervention connection to nature and, in turn, PEB (Figure 3; Figure 4). This result has been echoed in previous studies like Whitburn et al. (2019), which concluded that the relationship between connection to nature and PEB was positive, significant, and moderately sized (r = 0.42); a relationship that held across geographic location, gender, and age group. Additionally, Pongsophon (2024) identified a similar mediator of PEB; environmental consciousness which has the ability to influence behaviour on both the learner and school level (Figure 6). This finding is further supported by Pereira and Forster (2015) in the literature, who reported that nature relatedness is emerging as a key influencing factor in recent interventions, likely because increased nature connection is frequently associated with concern for the natural environment.

As illustrated in the Figure 5 and Figure 7, our review also noted that school context played a pivotal role. Franceschini and Rocha (2025) identified school type as a moderating factor in the effectiveness of PEB. While only 7% of the learners in the private school reported personal behaviour change, this finding rose to 27% in the public school. However, comparatively lower levels of conservation behaviour observed in private school may reflect curricular emphasis, socio-cultural differences and the way sustainability is integrated into the school environment. Balundė and Poškus (2025) found that school of the learners had a moderate effect in PEB (Figure 7) and the levels of engagement in climate activism were consistently higher in some schools. They attributed this variation to a combination of school specific factors, including differing educational approaches, the presence of influential leaders within each school community and the emphasis placed on sustainability within the curriculum among others.

Additionally, Oturai et al. (2002) found that forms of active school involvement are moderating factors. They found that in fostering a supportive culture and providing opportunities for learner participation in sustainability-related activities had been shown to further strengthen PEB outcomes (Figure 8). These findings highlight the influential role schools play not only in delivering environmental outcomes but also in shaping the cultural and social conditions which can enable or constrain learners' PEB.

4.8. Socioeconomic and geographic considerations

Most of the reviewed studies were conducted in high-income, urban contexts, mirroring the trend seen in previous reviews (Galeotti et al., 2024). Notably, there were no studies from low-income countries, and only a few located in rural settings. This geographical bias is concerning, as low- and middle-income countries (LMICs) are often disproportionately affected by climate change (Hu et al., 2025). However, these regions face substantial challenges in implementing CCE, including limited financial resources, educational infrastructure disparities, and political instability (Elzen et al., 2022; Hu et al., 2025).

Hu et al. (2025) highlighted the importance of future research to explore the balance between resource investment and effective implementation, as well as to assess the potential spillover effects (both positive and negative) of interventions (Chausson et al., 2020). Strengthening these areas could improve the relevance and transferability of findings from high-income contexts to inform CCE policy development in LMICs. Moreover, Hu et al. (2025) suggest that interventions may have greater impact in LMICs due to lower baseline climate literacy. Conversely, in contexts where baseline levels of climate knowledge and awareness are already high, the ceiling effect may leave little room for significant observable change (Elf et al., 2019). According to our review, Oturai et al. (2022) highlighted that in high-performing countries such as Denmark, ceiling effects may constrain the observable impact of climate education interventions. Therefore, future research should prioritise scalable, context-sensitive interventions tailored to LMICs, where the potential for fostering pro-environmental behaviour change may be greatest.

While GNI appeared to align with the prevalence of CCE studies, no clear relationship was observed between a country's CCPI ranking and the presence or strength of climate education programmes. This suggests that strong national climate policies do not automatically translate into investment in youth education or behavioural change initiatives.

Importantly, only one of the studies explicitly examined the impact of rural versus urban settings, despite evidence that rural learners often have closer ties to nature and may experience different forms of climate vulnerability. A more nuanced understanding of how context such as access to green space, infrastructure, and environmental risk affects learner engagement is urgently needed. Similarly, SES was either not measured or not disaggregated in the reviewed studies. SES has been shown to influence not only access to environmental education but also the capacity to act on that education (Krasny & Tidball, 2012). Future research would benefit from systematically including SES and contextual variables in both design and analysis.

4.9. Limitations of the review and the field

The heterogeneity in study design, intervention type, outcome measures, and reporting standards makes cross-study comparison difficult. Many studies lacked detail on intervention duration, setting, participant demographics, or the precise nature of behavioural change. The field would benefit greatly from shared frameworks for reporting and evaluating PEB outcomes, as well as from clearer definitions of key constructs such as "engagement", "action", and "impact".

5. Conclusion

This review provides evidence that CCE can foster measurable PEB among children and young people. Robust research from the past five years shows that in certain conditions the following prompt PEB:

Deliberative discussion and interaction with scientists or science. The following examples were found in our study:

- An environmental fieldtrip led by trained education staff generally prompted learners to do PEB independently.
- Visiting a food waste facility engaged learners both emotionally and cognitively and widely provoked recycling and litter avoidance.

Active learning including a pro-environmental action. The following examples were found in our study:

- A programme addressing learners' awareness, emotions, attitudes, norms, and sustainable choices typically initiated sustainable consumption behaviour
- An after-school programme combining climate education, photovoice (digital storytelling), and youth-led community action usually led to climate-related personal and community action.
- A programme using visuals, interactive storytelling, and social learning aimed at improving learners' sustainable consumption habits often instigated waste management behaviour and other sustainable behaviours
- Using active learning tools in classrooms often prompted environmentally sustainable consumption behaviours.

Active learning which does *not* include a pro-environmental action. The following examples were found in our study:

- A teachers' continuing professional development programme emphasising real world sustainability challenges and cross-curricular integration usually brought about strategic action through improved attitudes of sustainability.
- Participating in a clean air contest often resulted in cleaner air due to increased awareness of vehicle emissions.
- A series of climate change workshops commonly triggered support and engagement in climate activism.

Place-based learning, that is direct engagement with a physical environment (often outdoors) and its culture. The following examples were found in our study:

- A programme offering hands-on learning in botanical gardens integrated into schools generally prompted caring for the environment and increased interest in climate change.
- A biodiversity programme of recording living things presents in school grounds, planning biodiversity enhancements, and expressing the meaning of "environmental citizenship" ordinarily fostered agency through small manageable actions.

Involving teachers and communities in solving local environmental problems together. The following example was found in our study:

- A co-created educational programme using interactive activities and thermal imaging cameras routinely increased learners' motivation and engagement in STEM and climate literacy.

Nudges, that is prompts to encourage preferred behaviours. The following example was found in our study:

- Stickers placed around the school reminding people to take actions like switch off lights mainly brought about reductions in the consumption of water, paper and other resources.

Furthermore, when interventions are divided into broad categories, there is no one-to-one relationship between the type of intervention and the prompted PEB.

Our review shows that the research base remains uneven in scope, method, and geography, with significant gaps in representation from low- and middle- income countries (LMICs) and rural contexts (Anderson, 2012; UNESCO, 2021). The absence of robust follow-up data further limits confidence in the durability of observed behavioural changes, echoing calls for longitudinal designs in environmental education research (Liu & Green, 2024; Sanson & Smart, 2011).

Crucially, the field must move beyond documenting “whether” an intervention works to examining “how” and “why” it works, integrating mediators, moderators, and contextual variables into study designs (Otto et al., 2020; Bamberg & Möser, 2007). Rural settings, LMIC contexts, and low-SES groups are especially underrepresented, despite their heightened climate vulnerability and potentially high responsiveness to targeted interventions (Hu et al., 2025; Elzen et al., 2022).

For policy and practice, our findings underline the need for:

1. Equitable access: ensuring CCE reaches rural and underserved learners.
2. Longitudinal follow-up: to test whether behaviours persist.
3. Systemic behavioural targets: moving beyond easily observable conservation acts to include high-impact lifestyle changes such as mobility, energy, and consumption
4. Integration with policy: aligning educational interventions with national climate strategies to enhance relevance and sustainability.

Addressing these priorities would ensure that climate education meaningfully contributes to preparing the next generation for sustained climate action in a rapidly changing world.

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Appendix 1 Details of the focus of the bibliographic search, the database searched, and the code employed

Focus	Database	Search code
Pro-environmental behaviour	Scopus	TITLE-ABS-KEY ((determinant OR antecedent OR driver OR influence OR predictor) AND (behaviour OR action) AND (pro-environmental OR green OR sustainable OR environmental OR eco-friendly) AND school AND (learner OR child OR children OR adolescent OR teenager OR pupil)) AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (DOCTYPE , "ar"))
	Scopus	TITLE-ABS-KEY((determinant OR antecedent OR driver OR influence OR predictor) AND (behaviour OR action) AND (pro-environmental OR "environmentally friendly" OR "environmentally responsible" OR ecological OR sustainable OR "environmental protection" OR "environmental commitment") AND school AND (learner OR child OR children OR adolescent OR teenager OR pupil)) AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE,"ar")) AND (LIMIT-TO (LANGUAGE,"English"))
	Web of science	TS=((determinant OR antecedent OR driver OR influence OR predictor) AND (behaviour OR action) AND ("pro-environmental" OR "green" OR "sustainable" OR "environmental" OR "eco-friendly" OR "environmentally friendly" OR "environmentally responsible" OR "ecological" OR "environmental protection" OR "environmental commitment") AND (school) AND (learner OR child OR children OR adolescent OR teenager OR pupil)) AND PY=(2020-2025) AND LA=(English) AND DT=(Article)
Anti-environmental behaviour	Scopus	TITLE-ABS-KEY ((determinant OR antecedent OR driver OR influence OR predictor) AND (behaviour OR action) AND (anti-environmental OR unsustainable OR "environmentally harmful" OR "environmentally irresponsible" OR "ecologically damaging") AND school AND (learner OR child OR children OR adolescent OR teenager OR pupil)) AND PUBYEAR > 2019 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))
	Web of science	TS=((determinant OR antecedent OR driver OR influence OR predictor) AND (behaviour OR action) AND (anti-environmental OR unsustainable OR "environmentally harmful" OR "environmentally irresponsible" OR "ecologically damaging") AND (school) AND (learner OR child OR children OR adolescent OR teenager OR pupil)) AND PY=(2020-2025) AND LA=(English) AND DT=(Article)

Appendix 2 Definition of terms for summarising information on interventions

Code/Term	Summary of Definition
Deliberative discussion and interaction with scientists or science	Some climate change education strategies involve engaging learners through discussions and interactions with scientists or science. For instance, LaCombe and Danoff-Burg (2013) used a trash disposal activity where participants learned about littering's environmental and economic impacts, followed by a local clean-up.
Active learning	A learner-centred approach grounded in constructivist theory, which involves a learning process (constructing knowledge) constituting meaningful activity, participation, engagement and reflection on the experience (Doolittle et al., 2023). The intention is to foster higher order thinking and deep learning. It involves a broad range of teaching activities.
Active learning (including an action)	As above but as part of the intervention the learners undertake a pro-environmental action.
Place-based learning	Refers to a broad set of teaching practices that emphasises learners' connection to their local environment, particularly its physical dimension, as well as cultural and social dimensions (Yemini et al., 2023). It emphasises learning that is situated in the physical, sociocultural characteristics of place, often extending beyond the classroom to include outdoor, and service orientated activities in a particular locality (Semken, 2012; Smith, 2017).
Nudges	A way to predictably influence behaviour without restricting choices or changing economic incentives (Thaler & Sunstein, 2008). Nudges modify the decision environment to encourage desired behaviours (Damgaard & Nielsen, 2018). E.g., include reminders, social comparison, and informational cues. For example, Frantz et al. (2016) used posters and stickers in campus laundry areas to promote cold water washing and reminders to turn off classroom lights.
Involving teachers and communities	Including teachers and communities in climate change education often stems from local environmental problems, helping learners connect emotionally with the topic and encouraging them to take action to solve real-world issues (Kranz et al., 2022). For example, Kendall et al. (2021) studied the UNITE programme, where teachers trained in sustainable practices promoted the use of fuel-efficient stoves in communities around Uganda's Kibale National Park.

Appendix 3 Data extraction

Table 5 Data extraction for Whitburn et al. (2023) study 1

Information	Whitburn et al., 2023
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Do environmental education fieldtrips strengthen children's connection to nature and promote environmental behaviour or wellbeing?
Hypothesis/research question/research aim	To examine 1. Whether short duration, environmental education fieldtrips in natural settings, can strengthen learners' connection to nature, promote positive changes in their PEB, and benefit psychological wellbeing 2. Whether learners' level of connection to nature prior to attending such programmes moderated their effectiveness of these interventions.
Study design	Longitudinal quasi-experimental design with a non-equivalent control group. Self-report multi-level mixed modelling. Pre-test, and post-test 4 weeks later.
Single or multicentre study; if multicentre, number of recruiting centres.	8 schools - 17 classes
Setting - countries	New Zealand
Setting - school subject(s) or topics	NA
Participants - level of education	Primary/Middle school (years 5-8) (aged 7-13)
Participants - number at the end of the study	210 (+47 for control group)
Determinant(s) - name(s) or descriptor	Participation in environmental education field trips.
Determinant(s) - technical name(s) or descriptor	Participation in environmental education fieldtrips. The education fieldtrips included a half-day, nature-based experience held outdoors.
Determinant(s) - measured by self-report (SR) or observation (O)	SR
Determinant(s) - extent/level	Participants in the fieldtrip had a statistically significant small increase in self-reported PEB.

Information	Whitburn et al., 2023
Intervention	Nature based experience held outdoors presented by trained education staff.
Mediator (Med), Moderator (Mod)	Mod
Mediator/moderator descriptor	Participants' baseline (pre-existing) connection to nature
Mediator/moderator more detailed descriptor	Moderation effect: participants' initial (baseline) connection to nature significantly moderated the effect of the fieldtrip on post-intervention connection to nature.
Mediator/moderator - measured by self-report (SR) or observation (O)	SR
Mediator/moderator extent/level	Higher levels of connection to nature
Behaviour - name(s) or descriptor	Everyday PEB
Behaviour - technical name(s) or descriptor	The PEB scale incorporates three behavioural domains: 1) Daily conservation actions - saving water/ energy and recycling (e.g., "I try to use less water when I shower or brush my teeth"); 2) Environmental citizenship/social behaviours involving influencing others (e.g., "I ask my friends to pick up trash if they drop it on the ground") and 3) Pro-nature behaviours with direct impact on plants or animals (e.g., "I put water outside for birds").
Behaviour - measured by self-report (SR) or observation (O)	SR
Behaviour - extent/level	Conservation support increased as well as everyday PEB
Duration of time - time between the measures of different parts of the study (data collection)	31 October 2017 and 15 August 2018
Duration of time - length of time exposure to determinant	Half day
In the case of pre-post intervention design studies what was measured pre-intervention?	Moderation effect: participant's initial (baseline) connection to nature
Impact of local context - description	Participants gave their ethnicity as New Zealand European (61.9 %), Māori (24.9 %), Pacific Peoples (25.3 %), Asian (11.7 %), and Middle Eastern, Latin American or African (5.4 %). Field trip takes place in local natural locations, i.e., zoos.

Information	Whitburn et al., 2023
Impact of local context	No explicit local context measured but can be inferred from location of Wellington Region of Aotearoa New Zealand
Facilitator	Trained education staff, in line with Ministry of Education (2015) guidelines at zoos and wildlife sanctuaries.

Table 6 Data extraction for Whitburn et al. (2023) study 2

Information	Whitburn et al., 2023
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	2
Article title	Do environmental education fieldtrips strengthen children's connection to nature and promote environmental behaviour or wellbeing?
Hypothesis/research question/research aim	To examine 1. Whether short duration, environmental education fieldtrips in natural settings, can strengthen learners' connection to nature, promote positive changes in their PEB, and benefit psychological wellbeing 2. Whether learners' level of connection to nature prior to attending such programmes moderated their effectiveness of these interventions.
Study design	Longitudinal quasi-experimental design with a non-equivalent control group. Observational token study.
Single or multicentre study; if multicentre, number of recruiting centres.	8 schools - 17 classes
Setting - countries	New Zealand
Setting - school subject(s) or topics	NA
Participants - level of education	Primary/Middle school (years 5-8) (aged 7-13)
Participants - number at the end of the study	210 (+47 for control group)
Determinant(s) - name(s) or descriptor	Participation in environmental field trips
Determinant(s) - technical name(s) or descriptor	Learners completed a half day nature field trip vs those that didn't
Determinant(s) - measured by self-report (SR) or observation (O)	SR
Determinant(s) - extent/level	Going on environmental field trips increases support for conservation
Intervention	Nature based experience held outdoors presented by trained education staff
Mediator (Med), Moderator (Mod)	Mod

Information	Whitburn et al., 2023
Mediator/moderator descriptor	Participant's baseline (pre-existing) connection to nature
Mediator/moderator more detailed descriptor	Moderation effect: participant's initial (baseline) connection to nature significantly moderated the effect of the fieldtrip on post-intervention connection to nature
Mediator/moderator - measured by self-report (SR) or observation (O)	SR
Mediator/moderator extent/level	Higher levels of connection to nature
Behaviour - name(s) or descriptor	Support for conservation
Behaviour - technical name(s) or descriptor	Donating money as a way to support conservation through 3 different options: conservation of native species, domestic animal cares and child own school.
Behaviour - measured by self-report (SR) or observation (O)	O
Behaviour - extent/level	Donating to conservation over other options
Duration of time - time between the measures of different parts of the study (data collection)	31 October 2017 and 15 August 2018
Duration of time - length of time exposure to determinant	Half day
In the case of pre-post intervention design studies what was measured pre-intervention?	NA
Impact of local context - description	Participants gave their ethnicity as New Zealand European (61.9 %), Māori (24.9 %), Pacific Peoples (25.3 %), Asian (11.7 %) and Middle Eastern, Latin American or African (5.4 %). Field trip takes place in local natural locations, i.e., zoos.
Impact of local context	No explicit local context measured but can be inferred from location of Wellington Region of Aotearoa New Zealand
Facilitator	Trained education staff, in line with Ministry of Education (2015) guidelines at zoos and wildlife sanctuaries.

Table 7 Data extraction for Betzler and Kempen, 2023

Information	Betzler and Kempen, 2023
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Strengthening sustainable consumption behaviour in high school students: Evaluation of an experiential training intervention targeting psychological determinants.
Hypothesis/research question/research aim	To evaluate a psychological and experientially based training programme aimed at strengthening sustainable consumption. It was hypothesised that the participants would show higher levels of the following outcomes: 1. Knowledge-based problem awareness and knowledge of consumption alternatives 2. Emotional feelings (pride and guilt) 3. Values (personal norms) 4. Rational factors (attitude, perceived behavioural control, intention) 5. Behaviour (sustainable consumption)
Study design	Interactive training session evaluated by a pretest, post-test and follow up (Longitudinal)
Single or multicentre study; if multicentre, number of recruiting centres.	1 high school - 6 classes
Setting - countries	Lower Saxony, Germany
Setting - school subject(s) or topics	NA
Participants - level of education	High school (grade 11) (17.1 avg. age)
Participants - number at the end of the study	56
Determinant(s) - name(s) or descriptor	Participation in environmentally sustainable consumption training intervention

Information	Betzler and Kempen, 2023
Determinant(s) - technical name(s) or descriptor	Designed as a psychology based educational programme focusing on the following factors: • Cognition (knowledge) • Anticipated emotions (pride and guilt) • Values (personal norms) • Rationalisations (attitude, perceived behavioural control, intention) • Behaviour (sustainable consumption)
Determinant(s) - measured by self-report (SR) or observation (O)	SR
Determinant(s) - extent/level	Intervention results in higher self-reported PEB
Intervention	Psychology based educational programme focusing on cognitive factors, emotional and value-based factors, and social and infrastructure factors.
Mediator (Med), Moderator (Mod)	NA
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Sustainable consumption behaviour
Behaviour - technical name(s) or descriptor	Composite scale on plastic, fashion, and food consumption (e.g., using cloth bags, sustainable eating, buying second-hand clothing).
Behaviour - measured by self-report (SR) or observation (O)	SR
Behaviour - extent/level	More likely to avoid plastic and buy organic food (and other similar PEB)
Duration of time - time between the measures of different parts of the study (data collection)	Avg. 63.2 days between T2-T3 (1 day extra including pre-test)

Information	Betzler and Kempen, 2023
Duration of time - length of time exposure to determinant	5 consecutive school hours for 45 mins each
In the case of pre-post intervention design studies what was measured pre-intervention?	Assessment of learners' problem awareness, anticipated emotions, attitude, subjective norm, perceived behaviour control, intention, knowledge about sustainable consumption, environmentally sustainable consumption behaviour (ESCB).
Impact of local context - description	Larger temporal events that may occur outside the study (i.e., media coverage or a local environmental catastrophe which could impact research) remain unaccounted for.
Impact of local context	Does include gender and class which could impact results. No explicit ones measured: however, the article mentions intergenerational influence over learners' actions - i.e., perhaps Germany has particular societal norms that could impact PEB. Includes gender and class in results.
Facilitator	"Trainers" is the only description offered in the article

Table 8 Data extraction for Balundė and Poškus, 2025

Information	Balundė and Poškus, 2025
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Fostering interest in and support for climate change activism among adolescents.
Hypothesis/research question/research aim	Why do young people engage in environmental conservation actions and whether the extent of the engagement can change over time?
Study design	Pre-test intervention post-test and follow up through surveys (longitudinal study)
Single or multicentre study; if multicentre, number of recruiting centres.	4 schools in 3 administrative regions
Setting - countries	Lithuania
Setting - school subject(s) or topics	NA
Participants - level of education	High school (12-16 years)
Participants - number at the end of the study	245
Determinant(s) - name(s) or descriptor	Participation in environmental education intervention
Determinant(s) - technical name(s) or descriptor	Aiming to increase understanding, concern and engagement with climate activism
Determinant(s) - measured by self-report (SR) or observation (O)	SR
Determinant(s) - extent/level	Significant increases in following news about activists contemplating, and actual protest participation. Significant increase in interest in the activities of climate change activists, willingness to participate in protests against climate change, and self-reported participation by adolescents in protests against climate change.
Intervention	4-session classroom-based educational intervention focused on broad environmental topics (nature, waste, energy, pollution), including presentations and learner-facilitated discussion.
Mediator (Med), Moderator (Mod)	Mod

Information	Balundė and Poškus, 2025
Mediator/moderator descriptor	Gender and School Differences
Mediator/moderator more detailed descriptor	Gender and school were between-subjects grouping factors. Modest effects were observed on outcomes, with girls showing higher engagement than boys.
Mediator/moderator - measured by self-report (SR) or observation (O)	O
Mediator/moderator extent/level	Statistically modest effects of gender and school on outcome variables. Interest in and support for climate change activism.
Behaviour - name(s) or descriptor	Adolescents' interest in and support for climate activism
Behaviour - technical name(s) or descriptor	5-item self-report scale on activism-related engagement (e.g., news following, support for protests, actual participation).
Behaviour - measured by self-report (SR) or observation (O)	SR
Behaviour - extent/level	More likely to participate in climate activism
Duration of time - time between the measures of different parts of the study (data collection)	October - December 2022
Duration of time - length of time exposure to determinant	1 educational activity a week (45 mins) over 4 weeks
In the case of pre-post intervention design studies what was measured pre-intervention?	Interest in and support for climate activism (5 items)
Impact of local context - description.	In Lithuania, environmental education is only just starting to be noticed by policy makers and is mostly focused on providing general knowledge on environmental issues. Moreover, environmental education is rather fragmented and is not universally included in a national curriculum across all levels of education, from pre-school to tertiary education institutions. The educational system in Lithuania faces other pressing issues, such as teachers' dissatisfaction with work conditions, resulting in a shortage of teachers and industrial action.

Information	Balundė and Poškus, 2025
Impact of local context	Environmental activism in Lithuania is low—likely the result of CCE only starting to be included in curricula. Difference in results from different schools could be impacted by differences in local context, however it appears this is not explored. It is not an empirical finding from this study.
Facilitator	A trained facilitator, experienced in working with learners and holding a pedagogical background. Different facilitator from each school.

Table 9 Data extraction for Trott, 2019

Information	Trott, 2019
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Children's constructive climate change engagement: Empowering awareness, agency, and action
Hypothesis/research question/research aim	To explore how ten- to twelve-year-olds experienced and made sense of their climate change awareness through an after-school programme (that facilitated both individual and collaborative climate change action)
Study design	Mixed methods using survey and focus groups, together with a pre and post survey
Single or multicentre study; if multicentre, number of recruiting centres.	18 schools - 3 boys and girls clubs
Setting - countries	United States
Setting - school subject(s) or topics	NA
Participants - level of education	Primary and Middle school (ages 10-12) (4th - 7th grade)
Participants - number at the end of the study	55
Determinant(s) - name(s) or descriptor	Science, camera, action (education intervention)
Determinant(s) - technical name(s) or descriptor	15-week after-school programme combining climate education, photovoice (digital storytelling), and youth-led community action. The programme facilitated individual and collaborative climate change action with the intention of improving knowledge of climate change. To statistically significantly improve learners' knowledge and certainty of climate change.
Determinant(s) - measured by self-report (SR) or observation (O)	SR (for knowledge) and SR (growing climate change awareness)
Determinant(s) - extent/level	Significant increase in knowledge; improved certainty and attention to climate change present after participating in the programme.
Intervention.	"Science, Camera, Action!" – six hands-on climate lessons, three photovoice cycles, and child-designed action projects over 15 weeks.
Mediator (Med), Moderator (Mod)	NA

Information	Trott, 2019
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Climate-related personal and community action
Behaviour - technical name(s) or descriptor	Development of family action plans; youth-led sustainability projects (e.g., local garden, city council campaign).
Behaviour - measured by self-report (SR) or observation (O)	SR
Behaviour - extent/level	Action documented and evaluated qualitatively; meaningful engagement and impact observed
Duration of time - time between the measures of different parts of the study (data collection)	15 weeks between January and May 2016
Duration of time - length of time exposure to determinant	1 hour weekly for 15 weeks (avg. attendance 11/12 weeks)
In the case of pre-post intervention design studies what was measured pre-intervention?	Knowledge and awareness. Two items to gauge participants' general perceptions about climate change and 11 items to assess their specific climate change knowledge, including participants' understanding of Earth's climate system, the causes and consequences of climate change, and actions to address climate change.
Impact of local context - description	US schools, low-income areas. Rural, urban and suburban areas. Most US adults support climate change education, but it's rarely taught well in schools. Teachers often feel unprepared, and young learners are especially overlooked. Learners learn about climate change from media, which can cause anxiety. Without proper guidance, they may avoid the topic. There's a need for education that informs and empowers learners.
Impact of local context	BSG is a low cost, not-for-profit organisation that runs mostly through volunteers. Not an empirical finding from this study.

Information	Trott, 2019
Facilitator	Researcher-led. Not mentioned but can infer it was run by facilitators at BSG clubs.

Table 10 Data extraction for Sharma, 2022

Information	Sharma, 2022
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Understanding the impact of social learning forms on environmentally sustainable consumption behaviour among school children
Hypothesis/research question/research aim	To investigate the effects of social learning forms given as interventions on ESCB amongst primary school learners
Study design	Experimental pre and post-test, intervention
Single or multicentre study; if multicentre, number of recruiting centres.	7 schools - 6 interventions, 1 control
Setting - countries	Rajasthan/India
Setting - school subject(s) or topics	NA
Participants - level of education	Primary school (3rd, 4th and 5th classes)
Participants - number at the end of the study	760
Determinant(s) - name(s) or descriptor	Social learning (SL) Participation in an intervention that targets social learning theory
Determinant(s) - technical name(s) or descriptor	Intervention based on SL. Critical, participatory learning approaches that challenge unsustainable mental models and promote exploration of sustainability (which was run on computers).
Determinant(s) - measured by self-report (SR) or observation (O)	O
Determinant(s) - extent/level	Improved sustainable choices. There is significant difference (F<0.5) in ESCB when a social learning theory is used in an intervention vs in a control.
Intervention	Different schools got different interventions, as the key aim was to check how learners understand instruction. One intervention was the use of videos displaying sustainable consumption behaviour.
Mediator (Med), Moderator (Mod)	NA

Information	Sharma, 2022
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Environmentally sustainable consumption behaviour (ESCB)
Behaviour - technical name(s) or descriptor	The three steps of environmentally sustainable consumption behaviour, namely: purchase, use and dispose of. Found significant effects on waste management behaviour. Additionally participants who completed SL interventions were keen to participate in various activities resulting in better learning and longer retention. It was found that they were very eager to know the impact of their daily consumption activities.
Behaviour - measured by self-report (SR) or observation (O)	O
Behaviour - extent/level	Participant who completed interventions including SL has significantly higher waste management behaviour, energy consumption, etc.
Duration of time - time between the measures of different parts of the study (data collection)	5 weeks (pre and post occurred right before and immediately after)
Duration of time - length of time exposure to determinant	5 weeks
In the case of pre-post intervention design studies what was measured pre-intervention?	Pre-test to measure the effectiveness of the ECSB scales; however, not so much a pre-test to identify learners' thoughts or actions.
Impact of local context - description	Urban Indian schools (schools in the urban area of Rajasthan under Municipal Council) are mentioned. Otherwise, local context is not considered so much here. They do mention, however, that education could be reformed, but not so much any local context.

Information	Sharma, 2022
Impact of local context	If policymakers support and encourage schools to adopt SL tools for ESCB, schools must also ensure the necessary infrastructure and resources are in place, particularly in countries like India (where schools often face challenges such as limited funding, uneven access to technology, and varying teacher training levels).
Facilitator	Researcher and field investigator

Table 11 Data extraction for Kumar et al., 2023

Information	Kumar et al., 2023
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Using empirical science education in schools to improve climate change literacy
Hypothesis/research question/research aim	This study was aimed at improving the awareness of learners and knowledge related to climate change, heating, and cooling of planet Earth, and at infusing their curiosity in STEM.
Study design	Quasi-experimental pre–post intervention design with both qualitative and quantitative data analyses
Single or multicentre study; if multicentre, number of recruiting centres.	4 schools
Setting - countries	United Kingdom
Setting - school subject(s) or topics	STEM (Science, Technology, Engineering and Mathematics)
Participants - level of education	Primary and secondary school (9-14 years)
Participants - number at the end of the study	103 (71 learners did both quizzes)
Determinant(s) - name(s) or descriptor	School types (primary and secondary) and in individual classes (class levels)
Determinant(s) - technical name(s) or descriptor	This educational initiative is likely to increase learners' motivation and engagement in STEM subjects. Initiative to increase understanding of climate systems as a result of an increased interest in STEM, by merging school education with climate change science using a co-creation method between different stakeholders, in the formulation of an engaging climate education programme utilising thermal imaging.
Determinant(s) - measured by self-report (SR) or observation (O)	SR

Information	Kumar et al., 2023
Determinant(s) - extent/level	The majority of learners demonstrated an improvement in knowledge related to heat and climate change, as a result of participating in the Heat-Cool programme. This educational initiative is likely to increase learners' motivation and engagement in STEM subjects. Significant increase in climate literacy after participating in the heat cool initiative.
Intervention	School programme that uses thermal imaging cameras and interactive activities to teach primary and secondary learners about climate change, thermodynamics, and global warming. Co-created with parents, teachers, and researchers.
Mediator (Med), Moderator (Mod)	NA
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Increases learner motivation/engagement in STEM and greater climate literacy
Behaviour - technical name(s) or descriptor	STEM subjects promote climate literacy; interest in STEM and climate-related learning increase after intervention. Starting climate education in the early years can increase the number of learners wishing to work in climate related fields.
Behaviour - measured by self-report (SR) or observation (O)	O
Behaviour - extent/level	Climate education initiatives are effective to help improve climate literacy and motivation
Duration of time - time between the measures of different parts of the study (data collection)	October 21–March 22
Duration of time - length of time exposure to determinant	5 activities for 30 mins over 5–6-week interval

Information	Kumar et al., 2023
In the case of pre-post intervention design studies what was measured pre-intervention?	Climate quiz. The pre-session quiz assessed the knowledge of learners on the subject before the practical sessions, and the post-session quiz was designed to evaluate and analyse the effect of these sessions' activities on learners' learning and understanding.
Impact of local context - description	Declining interest in STEM (science, technology, engineering and mathematics) education in schools in the UK and other countries. There is information referencing all the different countries and their approach to STEM/climate education, which is a consideration of local context.
Impact of local context	Somewhat related to local context is that learners in the UK have a declining interest in STEM. Arguably, this is the result of the traditional science curriculum and its inability to keep learners interested. This is not an empirical finding from this study.
Facilitator	Involving parents, teachers, researchers, and learners in the formulation of an engaging climate-education programme. Mainly collaborative with schoolteachers and researchers.

Table 12 Data extraction for Pongsophon, 2024

Information	Pongsophon, 2024
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Cultivating environmental consciousness
Hypothesis/research question/research aim	To investigate the long-term impact of the School Botany Programme on learners' environmental consciousness. To evaluate learners' values, beliefs, knowledge, and environmental consciousness related to plant genetics conservation in the School Botany Programme, and to develop and validate a structural equation model (SEM) predicting environmental consciousness in this context.
Study design	Mixed methods (qualitative case study and multilevel structural equation modelling or MSEM) Phase 1: Qualitative case studies to build a hypothetical model Phase 2: Quantitative validation of the model using MSEM Qualitative case studies were carried out to identify factors influencing environmental consciousness at both the learner and within-school levels during Phase 1. Construction and critical evaluation of a hypothetical model and questionnaires completed during phase 2.
Single or multicentre study; if multicentre, number of recruiting centres.	52 schools
Setting - countries	Thailand
Setting - school subject(s) or topics	NA (Royal patronage level school programme/green classroom programme)
Participants - level of education	Secondary school
Participants - number at the end of the study	2299
Determinant(s) - name(s) or descriptor	Learner-level and school-level determinants 1. Environmental values, belief and knowledge (learner level determinants) 2. Participation in garden-based education programmes (school botany programme) (school-level determinants)

Information	Pongsophon, 2024
Determinant(s) - technical name(s) or descriptor	The School Botany Programme, an initiative within the RSPG, aims to engender conservation awareness among the youth and wider public. Participating schools are required to cultivate living botanical gardens, establish herbariums, create botanical learning spaces, engage in continuous botanical research, and safeguard local endangered flora, all integrated within their offer. Learning in these garden spaces is experiential and hands on.
Determinant(s) - measured by self-report (SR) or observation (O)	O (case studies) SR (knowledge test) SR (questionnaire, comprising 46 indicators across three sections, assessed environmental consciousness, beliefs, and values on a 5-point Likert scale)
Determinant(s) - extent/level	Programme participation leads to significant outcomes in ecological behaviour, in addition to significant increases in moral and ethical reasoning, emotional growth and cognitive development.
Intervention	The RSPG's mission is to foster sustainable conservation, development, and utilisation of plant genetics for the Thai populace, inculcating a conservationist mindset. The work is underpinned by learning resources, utility, and raising environmental consciousness.
Mediator (Med), Moderator (Mod)	Med
Mediator/moderator descriptor	Environmental Belief
Mediator/moderator more detailed descriptor	Environmental values affected environmental consciousness via environmental beliefs. (Phase 1: Qualitative case studies to build a hypothetical model) Validates through SEM, showing environmental belief as an intervening construct. MSEM
Mediator/moderator - measured by self-report (SR) or observation (O)	SR
Mediator/moderator extent/level	Significant
Behaviour - name(s) or descriptor	Environmental consciousness for environmental conservation. (Actions and practices demonstrated by learners in the School Botany Programme).
Behaviour - technical name(s) or descriptor	Environmental consciousness: Caring for school trees, initiating environmental activities at school and local resource conservation, creating tools and inventions to strengthen the community, and expressing interest in further studies in green predict development. There were 46 indicators across three sections in the questionnaire, assessed environmental consciousness, beliefs, and values on a 5-point Likert scale.

Information	Pongsophon, 2024
Behaviour - measured by self-report (SR) or observation (O)	O (interview) and SR (questionnaire)
Behaviour - extent/level	Intervention enhances learning outcomes across various domains including PEB (significantly)
Duration of time - time between the measures of different parts of the study (data collection)	Data collection occurred in the second term of 2016
Duration of time - length of time exposure to determinant	Academic years 2014-2016
In the case of pre-post intervention design studies what was measured pre-intervention?	NA
Impact of local context - description	Situated in a humid tropical region, Thailand boasts a remarkable array of biodiversity. Thailand is experiencing a sharp decline in biodiversity, with over 21,000 tropical species facing extinction. This precipitous loss is largely attributed to inadequate awareness, appreciation, scientific understanding, and sustainable management of natural resources.
Impact of local context	Thailand is experiencing a sharp decline in biodiversity. This loss is attributed to a lack of awareness, appreciation, scientific understanding, and sustainable management of natural resources.
Facilitator	Botanical garden committee chairpersons or coordinators from each of the 52 schools. Content was validated by three experts, including professors of conservation science and environmental education, and an RSPG scholar.

Table 13 Data extraction for Murphy et al., 2024

Information	Murphy et al., 2024
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	The influence of a teacher's professional development programme on primary school pupils' understanding of and attitudes towards sustainability
Hypothesis/research question/research aim	To explore whether a model of teachers' Continuing Professional Development (CPD), implemented with teachers, could positively affect teachers' classroom practice and, in turn, learners' (ages 8–11 years) understandings of sustainability issues and sustainability competencies.
Study design	Mixed methods design with pre and post interviews from both learners and teachers
Single or multicentre study; if multicentre, number of recruiting centres.	5 schools (7 classes)
Setting - countries	Ireland (Dublin)
Setting - school subject(s) or topics	Science Education
Participants - level of education	Primary school (8-11 yrs) (2nd-5th class)
Participants - number at the end of the study	145
Determinant(s) - name(s) or descriptor	CPD programme (continuing professional development)
Determinant(s) - technical name(s) or descriptor	Consists of four key elements: use of SDGs, inquiry-based science education, school sustainability projects and sustainable education.
Determinant(s) - measured by self-report (SR) or observation (O)	O (experiencing the teaching) SR (questionnaire)
Determinant(s) - extent/level	The CPD programme has had a positive influence on their pupils' learning about and attitudes towards sustainability; results showed significance, with marked changes in plastic use after intervention.
Intervention	This programme was based on a framework of sustainability competencies. It aimed to promote transformative teaching methods. It aimed to provide learners with the knowledge, skills and values needed to support sustainable ways of living. The goal was to help future generations meet their own needs. It also encouraged participation, creativity, innovation, and the ability to imagine new ways of life.

Information	Murphy et al., 2024
Mediator (Med), Moderator (Mod)	NA
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Strategic action through improved attitudes of sustainability
Behaviour - technical name(s) or descriptor	Engaged with their Home School Community Liaison Officer: • To influence meaningful changes in their school lunches • To significantly reduce the consumption of single-use plastic at school. This was done via campaigns to raise awareness amongst learners. Learners also undertook school strikes to engage politicians.
Behaviour - measured by self-report (SR) or observation (O)	O (interviews) SR (questionnaire)
Behaviour - extent/level	Intervention had a significant effect on the use of single plastics (and other similar anti-behaviours) evaluated through a qualitative analysis
Duration of time - time between the measures of different parts of the study (data collection)	6 months
Duration of time - length of time exposure to determinant	6 months
In the case of pre-post intervention design studies what was measured pre-intervention?	The same questionnaire was given to participants pre and post. The questionnaire, containing 21 questions across three sections, gathered information regarding the pupils' understanding and experiences of and attitudes towards learning about sustainability in school, prior to and after their teacher's engagement with the CPD.
Impact of local context - description	Urban Dublin schools - limited research on sustainable education in Ireland

Information	Murphy et al., 2024
Impact of local context	In Ireland, the primary curriculum supports active learning aligned with ESD, but teachers' broad subject responsibilities limit their depth of knowledge. This makes it challenging to integrate ESD effectively without targeted, high-quality professional development suited to the Irish context - not an empirical finding from this study.
Facilitator	Teachers aligning with CPD

Table 14 Data extraction for Christodoulou and Grace, 2025

Information	Christodoulou and Grace, 2025
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Becoming 'Wild Citizens': Children's articulation of environmental citizenship in the context of biodiversity loss
Hypothesis/research question/research aim	The aim was to develop and implement a practical and realistic approach to environmental citizenship in primary education focusing on biodiversity loss, and to investigate what learners see as environmental citizenship.
Study design	Qualitative exploratory methodology with semi-structured group interviews in groups (near the beginning of the programme and the end)
Single or multicentre study; if multicentre, number of recruiting centres.	5 primary schools
Setting - countries	South East England
Setting - school subject(s) or topics	After school club/science class
Participants - level of education	Primary school (7-10 years old)
Participants - number at the end of the study	130
Determinant(s) - name(s) or descriptor	Wild citizens programme, i.e., environmental education intervention.
Determinant(s) - technical name(s) or descriptor	Voluntary programme run in schools which is a biodiversity enhancement educational programme. Learners explored biodiversity in their school grounds, designed and implemented enhancements (like planting wildflowers and building animal shelters).
Determinant(s) - measured by self-report (SR) or observation (O)	SR (Determinants were inferred through the participants' own words and participants' reflections were analysed qualitatively)
Determinant(s) - extent/level	Participants experienced greater confidence in influencing their own actions over wildlife conservation after the programme; however, significance of the programme was not measured.

Information	Christodoulou and Grace, 2025
Intervention	During the Wild Citizens programme, primary school learners follow the steps of the underpinning socioscientific inquiry-based learning (SSIBL) pedagogical framework. The approach also models the process of creating and implementing a basic Biodiversity Action Plan (BAP), which includes recording what species/groups of living things are present in the school grounds at the start, deciding how to enhance biodiversity and what to prioritise, and creating a timeline for implementing the BAP.
Mediator (Med), Moderator (Mod)	NA
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Enacting agency through small, manageable actions
Behaviour - technical name(s) or descriptor	Engagement in pro-environmental behaviours Learners' articulation of their confidence in creating change at three levels of influence: 1. Making a difference to wildlife 2. Making a difference by influencing others to take pro-environmental action 3. Making a difference at a global level of influence Learners' articulation of environmental citizenship dimensions, which are: 1. Environmental awareness (environmental knowledge, seeing the bigger picture, environmental experiences) 2. Values (environmental responsibility, social responsibility, valuing nature, valuing being outdoors) 3. Action competence: • knowledge of action possibilities, e.g., performed actions • willingness and commitment to action • making a difference, e.g., confidence in own capacity for change These were measured across two points of the projects (early in the intervention and after intervention) and showed change.
Behaviour - measured by self-report (SR) or observation (O)	SR (in interviews expressed they understood what actions needed to be changed to prevent biodiversity loss)

Information	Christodoulou and Grace, 2025
Behaviour - extent/level	More biodiversity awareness and actions
Duration of time - time between the measures of different parts of the study (data collection)	April–July 2021 (Data collection differed between each school)
Duration of time - length of time exposure to determinant	Once weekly for 3–7 months (again differs between each school)
In the case of pre-post intervention design studies what was measured pre-intervention?	Pre-programme understanding. Semi-structured group interviews were conducted with a sub-sample (60%), exploring how learners articulate environmental citizenship within this context. Implies that the same semi-structured interview was used between the two test points.
Impact of local context - description	Inner-city primary schools in the south-east of England; socioeconomically deprived areas of the city.
Impact of local context	An inner-city school, so the low results from before intervention could be a result of low connection to nature as a result of living in a city. Use of local species and wildlife for study rather than exotic species to make biodiversity more 'local'.
Facilitator	Teachers, researchers, and a university learner intern supporting Wild Citizens in that school. School teachers ran the programme, but it was co-designed by and implemented with primary school teachers, local government ecologists and educators, and university learner interns with specialisms in ecology.

Table 15 Data extraction for Oturai et al., 2022

Information	Oturai et al., 2022
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	How can we test plastic pollution perceptions and behaviour? A feasibility study with Danish children participating in the Mass Experiment.
Hypothesis/research question/research aim	The aim was to test the feasibility of evaluating a large-scale Citizen Science (CS) initiative and gain first findings into the impacts of this type of programme. The hypothesis was that the intervention would increase risk perception, self-efficacy, empowerment, and self-reported pro-environmental behaviour.
Study design	Voluntary, anonymous pre, post and follow-up questionnaires (no individual tracking data was matched at the team level). Observational study with no blinding.
Single or multicentre study; if multicentre, number of recruiting centres.	48 matches teams from schools or groups (no obvious school centres mentioned)
Setting - countries	Denmark
Setting - school subject(s) or topics	Citizen science
Participants - level of education	Primary and High schools (ages 7-16)
Participants - number at the end of the study	930 pre and 830 post (for matching teams) but 2355 overall including non-matched teams)
Determinant(s) - name(s) or descriptor	Mass experiment based on plastic pollution, used as an educational intervention
Determinant(s) - technical name(s) or descriptor	Including the clean-up activity, educational materials, and optional laboratory tests. Large-scale, two-day experiment with learners called the Mass Experiment (ME). Overall theme of the ME 2019 was plastic pollution in nature and consisted of a comprehensive CS activity. 5th grade learners and upwards had access to doing voluntary predefined tests for polymer identification in their school laboratories.
Determinant(s) - measured by self-report (SR) or observation (O)	SR

Information	Oturai et al., 2022
Determinant(s) - extent/level	Participating reduces anti-environmental behaviour, but results appear to be NS. There are, however, differences in age for all the different factors.
Intervention	The intervention focused on plastic pollution, with learner teams carrying out a 100-meter clean-up in local natural areas using a standardised protocol adapted from the EU's Joint Research Centre (JRC) marine litter method. Each team collected and sorted plastic into 22 categories using materials provided by ASTRA, including gloves, bags, and sorting mats. Older learners could also conduct voluntary polymer identification tests in school laboratories. Educational materials supported learning before, during, and after the clean-up.
Mediator (Med), Moderator (Mod)	Mod
Mediator/moderator descriptor	Age and participation level
Mediator/moderator more detailed descriptor	(ages 7-12 and ages 13-16) (high or low)
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	Younger participants (7–12) decreased their litter-picking and encouragement behaviours after the intervention, possibly due to unmet expectations or limited environmental understanding. In contrast, older learners (13–16) maintained stable PEB levels, suggesting their broader environmental comprehension and biocentric reasoning helped sustain their actions.
Behaviour - name(s) or descriptor	Self-reported pro-environmental behaviour/action and psychological outcomes as risk perception, self-efficacy, empowerment. Waste management.
Behaviour - technical name(s) or descriptor	Sorting waste at home. Picking up litter from the ground study measured different factors: risk perception, reported behaviour, self-efficacy and empowerment as means to improve PEB. Risk perception.
Behaviour - measured by self-report (SR) or observation (O)	SR
Behaviour - extent/level	Baseline engagement was already high (ceiling effect). There were few or no main effects of the intervention on the four measured items (given in the hypothesis). Nevertheless, scores were considerably high for both time points, which indicates high PEB and risk perceptions for all participants, and that is regardless of the intervention they experienced.

Information	Oturai et al., 2022
Duration of time - time between the measures of different parts of the study (data collection)	Pre occurred before the ME, and one week after the intervention for post survey.
Duration of time - length of time exposure to determinant	Week 39 of the year
In the case of pre-post intervention design studies what was measured pre-intervention?	Direct replica of the post
Impact of local context - description	The intervention engaged learners directly with their local environment, raising awareness of plastic pollution in their own communities.
Impact of local context	Mention of family and societal norms which could impact learners' PEB. High initial risk perception which corresponds with the general population of Denmark.
Facilitator	Teachers provided with educational materials for use before, during and after the clean-up. Teacher responsible for a team; clean-up, however, was conducted by ASTRA and their collaborators.

Table 16 Data extraction for Trott, 2021

Information	Trott, 2021
Identifier of the study. If there is more than one study in an article they are sequentially numbered.	1
Article title	Youth-led climate change action: multi-level effects on children, families, and communities.
Hypothesis/research question/research aim	Examine multi-level impact of youth climate action. To investigate the multi-level impacts of youth climate action following an after-school programme that used participatory methods to encourage learners' action at household and community levels.
Study design	Mixed methods using survey and focus groups. Pre and post survey.
Single or multicentre study; if multicentre, number of recruiting centres.	3 Boys and Girls Clubs (BGC)
Setting - countries	USA
Setting - school subject(s) or topics	NA
Participants - level of education	Primary/Middle school (ages 10-12) (4th - 7th grade)
Participants - number at the end of the study	55
Determinant(s) - name(s) or descriptor	Environmental education intervention
Determinant(s) - technical name(s) or descriptor	Programme for learners aimed to help grow understanding about the earth's changing climate, ecosystems, and human actions. Another aim was to help identify opportunities for action.
Determinant(s) - measured by self-report (SR) or observation (O)	SR (growing climate change awareness, environmental values, action competence) (Participants described their own thoughts, feelings and actions)
Determinant(s) - extent/level	Significant increase in knowledge; improved certainty and attention to climate change.
Intervention	After-school participatory action. "Science, Camera, Action!" – six hands-on climate lessons, three photovoice cycles, and child-designed action projects over 15 weeks.
Mediator (Med), Moderator (Mod)	NA

Information	Trott, 2021
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Climate-related personal and community action
Behaviour - technical name(s) or descriptor	Recycling, energy use, public influence. E.g., made learners care what they do, engendered enthusiastic engagement in PEB, helped the environment and showed learners they can lower their carbon footprint.
Behaviour - measured by self-report (SR) or observation (O)	SR
Behaviour - extent/level	Ripple effects to family/community. Pre-/post-programme survey: Statistically significant increase in participants' pro-environmental behaviours and environmental stewardship. Carbon footprint survey: Statistically significant mean decrease. Focus Group: Action documented and evaluated qualitatively; meaningful engagement and impact observed.
Duration of time - time between the measures of different parts of the study (data collection)	15 weeks in 2016
Duration of time - length of time exposure to determinant	1 hour weekly 15 weeks
In the case of pre-post intervention design studies what was measured pre-intervention?	Measured attitudes toward environmental conservation, as well as participants' behavioural intentions and specific actions regarding the environment.
Impact of local context - description	Urban, family-based context; a safe, affordable place to go during key out-of-school time. Affordable.

Information	Trott, 2021
Impact of local context	BSG is a low-cost, not-for-profit organisation that runs mostly through volunteers. Not an empirical finding from this study.
Facilitator	Not mentioned but can infer it was run by facilitators at BSG clubs

Table 17 Data extraction for Gabrielsen et al., 2025

Information	Gabrielsen et al., 2025
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	“It was a real wake-up call for the pupils.” How can collaboration with external actors outside school influence education for sustainable development?
Hypothesis/research question/research aim	To investigate how an educational programme in collaboration with an external actor can influence ESD in primary school education. Both teachers’ and learners’ experiences were explored.
Study design	Case study. During and after first implementation and 2 years after (Longitudinal).
Single or multicentre study; if multicentre, number of recruiting centres.	3 primary schools; one teacher provided 2 classes each.
Setting - countries	Norway
Setting - school subject(s) or topics	NA Out of school educational programme (although the teachers are science teachers)
Participants - level of education	Primary school (6th grade)
Participants - number at the end of the study	120
Determinant(s) - name(s) or descriptor	Action competence, awareness (feelings and thoughts about reducing food waste). Waste sorting facility (associated with TMF which is a whole education institution).
Determinant(s) - technical name(s) or descriptor	Emotional and cognitive engagement. Learners were exposed to a large amount of food waste, visited a soap-bubble insulated greenhouse where sustainable tomatoes are grown, made their own sustainable smoothie, and tasted insects. The learners gained practical experience in reducing food waste from the intervention. With the experiences of all the food waste, this was a practice of problem-solving, a critical sustainability competence identified via qualitative data analysis.
Determinant(s) - measured by self-report (SR) or observation (O)	SR (the worksheets)

Information	Gabrielsen et al., 2025
Determinant(s) - extent/level	No quantitative analysis used. However qualitative analysis highlights that learners showed increased action competence and improved sustainable behaviour two years post intervention.
Intervention	Exposed to a large amount of food waste, visited a soap-bubble insulated greenhouse where sustainable tomatoes are grown, made their own sustainable smoothie, and tasted insects.
Mediator (Med), Moderator (Mod)	NA
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Waste sorting behaviour. Improved waste management through action competence.
Behaviour - technical name(s) or descriptor	Recycling and litter avoidance through the lens of the learners, and a follow up two years later, identify the participants' littering and other waste habits. Focus on action competence and affective influence.
Behaviour - measured by self-report (SR) or observation (O)	O
Behaviour - extent/level	Qualitative findings highlight that the programme has a great impact on providing learners with the action competence to help tackle real world tangible problems.
Duration of time - time between the measures of different parts of the study (data collection)	2 and a half years
Duration of time - length of time exposure to determinant	90 mins
In the case of pre-post intervention design studies what was measured pre-intervention?	No pre; only during, after, two years after (teachers POV).

Information	Gabrielsen et al., 2025
Impact of local context - description	TMF receives food waste from 1.2 million inhabitants, in addition to livestock manure from local farms, and transforms this into climate-friendly biogas, used as vehicle fuel, as well as green CO_2 and bio-fertiliser for local food production in Norway.
Impact of local context	Norwegian local community. No clear local context in the view of the link, but study uses a local plant.
Facilitator	The educational programme was developed by the authors of this study, in collaboration with the three teachers and educators from TMF, in a process led by the authors.

Table 18 Data extraction for Stafford and Brain, 2022

Information	Stafford and Brain, 2022
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Building teen empowerment through a clean air contest: implications for designing education outreach
Hypothesis/research question/research aim	1. Explore how teens' experience with the contest affects their understanding of local air pollution and motivation to adopt clean air behaviours 2. Investigate how the contest prompts teen engagement with their parents/guardians (or other family members) about air pollution and parent/guardian response
Study design	Past evaluations and semi structured interviews
Single or multicentre study; if multicentre, number of recruiting centres.	Not mentioned however implies participants are all from different high schools
Setting - countries	Utah, USA
Setting - school subject(s) or topics	NA Public service announcement (PSA) design competition
Participants - level of education	High school
Participants - number at the end of the study	9 teens 10 parents/guardians
Determinant(s) - name(s) or descriptor	Clean air contest
Determinant(s) - technical name(s) or descriptor	The contest teaches learners the air pollution implications of their new driving privilege, as well as responsible driving, and transportation ways to help preserve air quality. It draws across EE and art education. For instance, learners are asked to rate their level of confidence before and as a result of this poster competition on 11 specific skills related to art, science, marketing, and personal behaviours.
Determinant(s) - measured by self-report (SR) or observation (O)	SR (interviews)
Determinant(s) - extent/level	Learners and parents had positive attitudes about their experience with the contest and appreciated how it opened opportunities beyond learning about local air pollution.

Information	Stafford and Brain, 2022
Intervention	Topics include the science behind Utah's winter inversions and associated pollution, driving/transportation strategies that can help preserve air quality, e.g., refrain from idling, carpooling, etc., and persuasive marketing and advertising appeals. Constructing the PSA entries becomes a class assignment or club activity.
Mediator (Med), Moderator (Mod)	NA
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Clean air issues focusing on car pollution
Behaviour - technical name(s) or descriptor	Results are self-reported however PEB is highlighted to have increased. Examples include stopping a car from idling whilst waiting at school pickup.
Behaviour - measured by self-report (SR) or observation (O)	SR
Behaviour - extent/level	Contest's impact on contestants' personal behaviour, paired t tests on two scale questions indicated that, collectively, learners reported they were more likely to engage in air pollution-reduction behaviours promoted in their posters than before the contest.
Duration of time - time between the measures of different parts of the study (data collection)	30-60 min interviews (assume interviews were conducted during the pandemic. Learners who had won throughout different years.
Duration of time - length of time exposure to determinant	50 minutes in fall and winter chosen in December
In the case of pre-post intervention design studies what was measured pre-intervention?	NA

Information	Stafford and Brain, 2022
Impact of local context - description	Various valley regions along Utah's densely populated Wasatch Front occasionally experience some of the most polluted air in the country, especially during the winter inversions. The inversions happen when cold, snow-covered valley floors reflect rather than absorb heat, preventing the normal vertical mixing of warm and cold air. Thus, warm air above becomes a lid and traps cold air, along with unhealthy emissions from vehicles, buildings, and agriculture, onto valley floors. Conservative state. Red air day means children cannot play outside; however, the children had not been told.
Impact of local context	As above
Facilitator	The authors engage learners in dozens of high school art, business, and environmental science classes, and club meetings. Contestants create their PSAs publicly alongside their teachers (as homework), families, and peers.

Table 19 Data extraction for Franceschini and Rocha, 2025

Information	Franceschini and Rocha, 2025
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Design for sustainable behaviour: an exploratory study in schools' washrooms
Hypothesis/research question/research aim	Explore the application of Design for Sustainable Behaviour (DfSB) within built environments, specifically by developing and implementing a toolkit designed to encourage more sustainable behaviours among children in school washrooms. Measure changes in resource consumption before and after the toolkit is installed.
Study design	Case study supported by field research. First, an intervention plan was defined (Phase 1), followed by gaining an understanding of users and context (Phase 2). Design opportunities, target actions, and design strategies were identified (Phase 3). An intervention design was then developed with real users (Phase 4). Finally the design, and intervention were evaluated with real users (Phase 5).
Single or multicentre study; if multicentre, number of recruiting centres.	2
Setting - countries	Southern region of Brazil
Setting - school subject(s) or topics	NA
Participants - level of education	Primary and high school (2-17 yrs)
Participants - number at the end of the study	36 interviews were conducted, but more learners use the washrooms
Determinant(s) - name(s) or descriptor	Design for Sustainable Behaviour (DfSB) toolkit in school washrooms
Determinant(s) - technical name(s) or descriptor	Set of stickers placed on elements like light switches, soap dispensers, toilet paper, and paper towel dispensers. These stickers featured playful and natural visual motifs designed to prompt children to use fewer resources and adopt more sustainable habits.
Determinant(s) - measured by self-report (SR) or observation (O)	O

Information	Franceschini and Rocha, 2025
Determinant(s) - extent/level	Sticker seeks to reduce consumption by eliciting the link between resources (paper) and the environment. No statistical test was used to ascertain whether the intervention resulted in an increase of PEB. Interviews and resource use were used. Only effective reduction was found in energy conservation, not paper towels or soap.
Intervention	Installing a Design for Sustainable Behaviour (DfSB) toolkit in school washrooms, consisting of playful, illustrated stickers placed on items like taps, soap dispensers, and light switches. These stickers served as visual prompts to encourage participants to use water, energy, and materials (like paper towels) more responsibly. The goal was to influence behaviour at the point of use in a subtle, engaging way. The intervention was supported by workshops to raise awareness and involved learners in co-creating new sticker ideas.
Mediator (Med), Moderator (Mod)	Mod
Mediator/moderator descriptor	School type
Mediator/moderator more detailed descriptor	Private OR public school
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	Private school seems to have some greater results from the intervention in most aspects. Toilet paper consumption however was higher after intervention in private school.
Behaviour - name(s) or descriptor	Resource consumption of water, paper and resources
Behaviour - technical name(s) or descriptor	Relationship between resources and devices which aim to increase PEB through nudges. Focuses in particular on resource consumption within bathrooms, i.e., soap, paper towels, energy, and toilet paper.
Behaviour - measured by self-report (SR) or observation (O)	O/SR
Behaviour - extent/level	Interview responses suggest that the toolkit can be used to increase sustainable behaviour in terms of resources in participants; however, overall effectiveness was not as great as expected. Effectiveness was most major in regard to energy consumption.
Duration of time - time between the measures of different parts of the study (data collection)	17 weeks

Information	Franceschini and Rocha, 2025
Duration of time - length of time exposure to determinant	Toolkit implemented for one month. No length mentioned for workshop(s)
In the case of pre-post intervention design studies what was measured pre-intervention?	NA
Impact of local context - description	Private/public school
Impact of local context	Difference in results could be the result of a private vs public school, i.e., learners tend to perceive the nudges more than at the public school.
Facilitator	All staff from both schools observed the changes, and three teachers also commented that their learners talked about the changes in the first week of the intervention. External researchers (toolkit development, and co-creation workshop). Not mentioned but infers that school teachers/staff may have conducted the intervention.

Table 20 Data extraction for Kanada, Norman, Kaida & Carver (2022)

Information	Kanada, Norman, Kaida & Carver (2022)
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Linking environmental knowledge, attitude, and behaviour with place: a case study for strategic environmental education planning in Saint Lucia
Hypothesis/research question/research aim	Explore how urban and rural settings affect learners' environmental knowledge, attitudes, and behaviours. This serves as a first step in understanding how place of residence influences environmental actions.
Study design	A quantitative case study. Structured surveys were used to collect numerical data from a large sample (1,285 learners). Statistical analyses (e.g., ANOVA, path analysis) was applied to test hypotheses and model relationships.
Single or multicentre study; if multicentre, number of recruiting centres.	Single centre (Saint Lucia)
Setting - countries	Saint Lucia
Setting - school subject(s) or topics	NA
Participants - level of education	Secondary school learners (ages 11-19, younger group: ages 11–14 and older group: ages 15–19)
Participants - number at the end of the study	1285
Determinant(s) - name(s) or descriptor	Environmental knowledge, environmental attitudes, the sense of place
Determinant(s) - technical name(s) or descriptor	Knowledge of environment, pro-environmental attitudes, place attachment and place meaning
Determinant(s) - measured by self-report (SR) or observation (O)	SR
Determinant(s) - extent/level	Quantitative survey scores
Intervention	The effect of the place (urban-rural differences)
Mediator (Med), Moderator (Mod)	NA

Information	Kanada, Norman, Kaida & Carver (2022)
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Environmental behaviour (action)
Behaviour - technical name(s) or descriptor	Reported pro-environmental behaviour (action)
Behaviour - measured by self-report (SR) or observation (O)	SR
Behaviour - extent/level	Frequency of behaviours.
Duration of time - time between the measures of different parts of the study (data collection)	The survey was conducted between April 2013 and January 2014. Data was collected at a single point in time for each participant, not repeatedly.
Duration of time - length of time exposure to determinant	One-time survey (The survey was conducted between April 2013 and January 2014)
In the case of pre-post intervention design studies what was measured pre-intervention?	NA
Impact of local context - description	Local culture, urban-rural differences and identity in Saint Lucia shaped participants' sense of place, which influenced learners' environmental knowledge environmental attitudes and behaviours.
Impact of local context	High. Cultural and geographical characteristics strongly linked to environmental outcomes.
Facilitator	NA

Table 21 Data extraction for Sharma and Gupta (2025)

Information	Sharma and Gupta (2025)
Identifier of the study. If there is more than one study in an article, they are sequentially numbered.	1
Article title	Analysing the impact of educational tools on fostering sustainable consumption in children
Hypothesis/research question/research aim	To ascertain the impact of active and passive learning tools on environmentally sustainable consumption behaviour (ESCB) in learners. Do active learning (AL) methods impact learners ESCB? Do passive learning (PL) methods impact learners ESCB?
Study design	Experimental design: Pre-test–post-test control- group design
Single or multicentre study; if multicentre, number of recruiting centres.	7 independent and state schools
Setting - countries	India (Bhiwadi)
Setting - school subject(s) or topics	Environmental studies (or its equivalent)
Participants - level of education	Primary school children (Grades 3, 4, and 5)
Participants - number at the end of the study	641 children (269 active group, 275 passive learning group, 97 control group) 50 teachers teaching environmental studies (or its equivalent)
Determinant(s) - name(s) or descriptor	Type of educational tool (active or passive learning tools)
Determinant(s) - technical name(s) or descriptor	Effectiveness of the educational tool type used: -Active learning tools e.g., demonstration, video, question and discussion, pausing lecture -Passive learning tools e.g., lecture, visual instruction (TV, posters), textbook reading -Control group (there is no information about control group leaning approach)
Determinant(s) - measured by self-report (SR) or observation (O)	O The effectiveness of the learning tools was measured by observation
Determinant(s) - extent/level	The extent of exposure to active learning tools over four weeks had a statistically significant and meaningful impact on children's sustainable consumption behaviour. Passive learning tools, despite being used similarly, did not produce significant behavioural change.

Information	Sharma and Gupta (2025)
Intervention	5-week intervention using AL or PL tools or control group in classroom settings
Mediator (Med), Moderator (Mod)	NA
Mediator/moderator descriptor	NA
Mediator/moderator more detailed descriptor	NA
Mediator/moderator - measured by self-report (SR) or observation (O)	NA
Mediator/moderator extent/level	NA
Behaviour - name(s) or descriptor	Environmentally Sustainable Consumption Behaviour (ESCB)
Behaviour - technical name(s) or descriptor	ESCB (purchase, use, dispose-off behaviours) Purchase: buying a cloth shopping bag instead of a plastic one Use: drawing on the opposite side of the paper as opposed to requesting another piece of paper to make the second drawing Dispose-off: using recycling bins instead of trash cans for used paper.
Behaviour - measured by self-report (SR) or observation (O)	O (Learners' sustainable consumption behaviours) SR (interviews with teachers)
Behaviour - extent/level	Learners made choices in simulated scenarios. And their choices were scored 0 or 1 per behaviour (max score = 3 per child per phase)
Duration of time - time between the measures of different parts of the study (data collection)	5 weeks (Pre-test in Week 1, Post-test in Week 5)
Duration of time - length of time exposure to determinant	4 weeks (Week 2-5 interventions)
In the case of pre-post intervention design studies what was measured pre-intervention?	ESCB behaviour (purchase, use, dispose-off choices) (before the intervention began, during the Week 1 pre-test phase.)
Impact of local context - description	This study was conducted in Bhiwadi, India. There were some local educational limitations such as reading ability which affected the passive learning tool effectiveness.
Impact of local context	Significant. Literacy levels influenced effectiveness of passive learning tools like posters and books

Information	Sharma and Gupta (2025)
Facilitator	Teachers and researchers conducted interventions in classrooms