

# Mitigation through pedagogy: strategies for effective climate change educational interventions

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## Abstract

Climate change is continually growing as a pressing issue with natural, economic, and health repercussions. Concurrently, education has become a notable tool to induce pro-environmental behavioral change in students, considerably assisting in global mitigation efforts. This opportunity prompted a systematic literature review to determine what impact recent findings can have in understanding and implementing effective climate change educational approaches in secondary schools. *Google Scholar*, an academic database, was used to identify 469 relevant sources. Twenty-two of these were used in the final analysis, which assessed practical strategies to communicate climate change to students. Three main themes were identified in successful interventions: (1) Employing personal relevance and empowerment as tools for engaging students, (2) Adopting a multidisciplinary and system-based approach in the classroom, and (3) Embracing effective communicators as sources of information, namely teachers and peers. The results of constructive pedagogy translate to action beyond educational institutions and generate positive changes in students that aid in the fight against the climate crisis. Future research ought to focus on

longitudinal studies and interventions in developing nations that disproportionately suffer from the impacts of climate change.

*Keywords:* Environment, education, curriculum, climate change

## Introduction

Climate change poses a persistent and ever-growing threat to all human beings and ecosystems; the economic, health, and environmental repercussions of this crisis make it a top concern to scientists, policy-makers, and the general public. Researchers point out that the economic effects of growing carbon emissions build “a strong case for near-term action” (Tol, 2009). Additionally, climate change will have a profound impact on public health matters (Levy & Patz, 2015) and biodiversity (Bellard et al., 2012). Concurrently, environmental knowledge and literacy are lacking in the general public, and more specifically, in students (Roychoudhury et al., 2017). Thus, there is a pressing need to take considerable measures and educate those who will be most affected by Global Climate Change (GCC): the young generation.

Students must be prepared to respond to the challenges climate change precipitates— both adaptation and mitigation strategies are essential

in this effort (Anderson, 2012). Firstly, students should learn to react appropriately to changing conditions caused by GCC, such as increased flooding and the consequences of erratic weather patterns. Furthermore, students must be taught to make substantial lifestyle changes to decrease their carbon footprint with actionable steps to aid in the global effort to combat this crisis. These actions require effective teaching strategies so that students can model what they have learned throughout their lives and be a part of greater social change (Sharma & Monteiro, 2016).

#### *The Technical Implications of Climate Change Education*

Although covering this topic in the classroom decreases students' exposure to other subjects in an already-packed curriculum, studying climate change offers an opportunity to develop various skills crucial to overall student success. Critical thinking, problem-solving, interdisciplinary connections, and collaboration are all stimulated when learning about climate change, allowing students to think creatively and change behavior (Anderson, 2012). Reading comprehension (Siegener & Stapert, 2020) and data interpretation (Holthuis et al., 2019) are among the many abilities encouraged in a successful climate change curriculum. Therefore, there is a strong case to integrate GCC learning into the classrooms: it instructs relevant content-knowledge and skills applicable to young people's lives.

The burgeoning need for this type of curriculum is furthered by the implementation of the Next Generation Science Standards (NGSS) in multiple schools across the United States, which correspond with the abilities gained when learning about climate change (Roychoudhury et al., 2017). When studying GCC, students connect scientific knowledge and practices, developing an understanding of where scientific data comes from and how to interpret it (Holthuis et al., 2020). These skills, such as data interpretation and designing solutions, are a crucial part of the NGSS, and GCC curricula offer an opportunity to acquire them.

#### *The Environmental Implications of Climate Change Education*

Lastly, the positive environmental changes in student behavior when learning about climate change are a significant factor in this curriculum's importance. Students will turn knowledge into action if taught efficiently. For example, a climate change course introduced in San Jose State University motivated students to make several changes to lifestyle choices, reducing the average carbon footprint by 3.54 tons, showing that changes in their daily behavior significantly influenced their impact (Cordero et al., 2020). If implemented on a wide scale, this type of educational approach could be as effective as solar energy in reducing CO<sub>2</sub> emissions (Cordero et al., 2020). Additionally, in another GCC course taught in New Zealand, researchers found that students developed a more complex and complete understanding of sustainability and climate change, taking into account environmental, social, and economic factors— all of this driving long-term change (Sharma & Monteiro, 2016).

There is a substantial lack of research into approaches to successful climate change educational interventions; moreover, these span across age levels and are not directed to preparatory school levels in particular (Monroe et al., 2019). Research often lacks a synthesis of educational approaches and focuses on particular and isolated strategies. Therefore, it is crucial to compile all information on current pedagogical strategies to provide a myriad of recommendations for implementing GCC in a secondary school setting— this is the primary purpose of this review.

The prolonged impacts of the climate crisis demand action, and education serves as a powerful pathway to establish these changes via knowledge and inspiration (Bofferding & Kloser, 2015). Therefore, it is imperative to implement climate change into the classroom through effective approaches. Three main educational strategies were identified via a comprehensive literature review: engagement through personal relevance and empowerment, a multidisciplinary

and system-based approach, and powerful communicators proved to be influential in students' perspectives on climate change.

## Methodology

A systematic literature review was performed, allowing for a comprehensive analysis of data and evidence from multiple perspectives (Cooper, 2010). The qualitative study follows specific and replicable steps; keywords were used to narrow the search, and all of the documents taken into account were in English. Entering the search terms (such as "climate change" AND "education," "climate education," OR "environmental education") in the *Google Scholar* academic database yielded (n = 469) results and (n = 82) relevant papers were screened. Various iterations of "climate" such as "environment" and "global warming" were included to broaden sensitivity while maintaining specificity.

From the papers screened, (n = 56) papers were excluded due to irrelevance to the review (most touched on broader environmental and sustainability education or did not focus on school curricula), publish date (older than 12 years), and language (any other than English); (n = 26) full-text articles were assessed for eligibility. These papers were reviewed and tracked in a spreadsheet. Each of them was evaluated thoroughly on whether they should be included in the final set (relevancy, quality, and credibility were assessed). A PRISMA 2009 checklist was used to guide this process and keep track of source information (Moher et al., 2009). Some of the papers excluded explored the importance of climate change education only, rather than reporting on educational interventions or recommending effective strategies. Moreover, all information sources used were from peer-reviewed journals, works from accredited academic institutions, and sites from national agencies and trusted organizations; therefore, the data used in this synthesis is reliable and credible. Twenty-two relevant sources were chosen and included in this review. A limitation of this method was the exclusion of many relevant papers from

authors whose first language was not English, which might have offered worldly perspectives and valuable insights into educational strategies. Figure 1 portrays this method for further clarification.

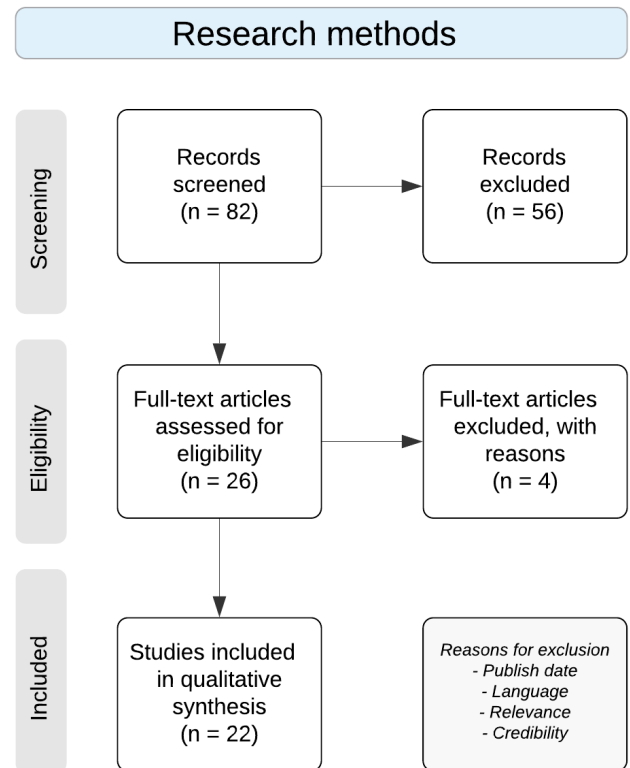


FIGURE 1: Vetting process for systematic literature review

## Personal Relevance, Empowerment, and Engagement

Global Climate Change (GCC) should be introduced through engaging and empowering means; making the topic relevant to students is the first step towards an effective intervention. Empowering, action-based learning is strongly encouraged by educators and researchers, and there is a need to introduce pedagogical strategies that engage and encourage students to take action (Boakye, 2015). If behavioral changes are expected, students must be informed that their actions have consequences and that GCC is not far-astray or irrelevant to their present and future.

### *The Importance of Personal Relevance*

Students will feel especially connected to the climate crisis if they perceive substantial repercussions in their local communities and are then inspired to change their behavior and take action-oriented approaches. If possible, making education personally relevant to learners through community projects is a highly effective means to achieve this; students may then take meaningful steps after learning about the impacts of GCC locally (Monroe et al., 2019). For example, a class introduced in a Bachelor's program in Unitec, New Zealand, incorporated community-based projects, which resulted in significant social and environmental interconnectedness and sparked social responsibility (Sharma & Monteiro, 2016). Students examined the complexities of their community, which allowed them to adapt to future contexts and connect scientific findings on climate change to tangible impacts locally. Therefore, it is imperative to establish a connection between the causes and consequences of climate change so that students feel an urgency to act and set the issue into perspective.

#### *Empowerment in Climate Change Education*

Constructive hope is another powerful method to inspire action in scholars (Ojala, 2012). Hope does not deter young people nor induces helplessness; instead, it presents a pathway to real change with small steps that aggregate when many of them are incorporated into their personal lives. There is notable pessimism surrounding climate change, but constructive hope may counter that cynicism with possible solutions and actions to reverse and mitigate impacts (Meehan et al., 2018). Historical perspectives, trust in collective action, and technological solutions can offer optimism about the crisis. Researchers in Uppsala University, Sweden, have found that hope in these various actors and influences was a good predictor of pro-environmental behavior in teenagers (Ojala, 2012). Accordingly, hope is a valuable tool to engage students and lead them to solutions.

Furthermore, solution-based learning in experiments, trials, and community projects offers critical insight into transforming knowledge into

progress. Empowerment through this approach allows students to understand complex topics. Thinking about creative solutions makes learners citizens of the world, allowing them to better assess and manage the effects of changing conditions in natural and human affected regions (Fahey, 2012). Thinking about solutions turns pessimistic thinking into a mindset of progress and action, changing attitudes and behaviors.

Since pedagogy is a primary driver of long-term change, classroom activities must allow students to reflect and react (Anderson, 2012). Case studies, calculations of individual carbon footprints, and community action projects have proven to offer both of these opportunities (Cordero et al., 2020). In short, empowering, engaging, and making climate change personally relevant to students through stimulating activities is essential to substantial behavioral changes and effective interventions.

#### *Engagement and the Importance of Individual Choices*

For students that are not in areas directly affected by the climate crisis, it may be a challenge to make them aware of their contribution to the issue. Industrialized nations are the largest contributors to carbon emissions, yet the least affected by the consequences of the crisis (McMichael et al., 2006); informing students in areas that are not impacted by the crisis of the results of their actions is critical in inducing responsibility. To overcome this barrier, professor Sarah Riggs Stapleton of the University of Oregon had high school students meet local people affected by climate change in Bangladesh (Stapleton, 2019). Students visualized the impacts of the crisis in other communities and felt connections far more powerful than information, contextualizing concepts and establishing solutions to the problems they encountered. This connection method can be encouraged widely through video chat technologies, with students learning about personal stories from the people most affected by this issue globally. Directly connecting carbon emissions to tangible negative impacts may increase awareness and a sense of responsibility.

Rhetorical strategies are essential in persuasively conveying the importance of climate change. Films, movies, books, and other forms of imagery tend to be impactful in students' perceptions about GCC. For instance, a 2020 case study in a Washington middle school curriculum pilot used a collection of climate-centered fiction and nonfiction books, resulting in significant engagement on the part of the student body (Siegner & Stapert, 2020). Students were able to establish connections to solutions and even reported higher levels of literacy. Learners will relate to the topic via stories since vivid portrayals allow them to visualize real-world experiences and invigorate action.

### **Multidisciplinary and System-Based Learning**

Young people lack fundamental scientific knowledge relating to global climate change, although it is widely agreed that it is anthropogenic (Corner et al., 2015). Additionally, many find other issues such as economic development a bigger priority (Dawson, 2012). Scientific evidence may not be enough to convince students of the importance of GCC; hence, it should be presented from a public health or "win" perspective. Co-benefits, such as improvements to public health and addressing energy security, may help communicate the issue more effectively and as a "gain frame," producing positive attitudes in taking action (Corner et al., 2015; Stevenson et al., 2017). Therefore, educators should emphasize the multifaceted nature of the climate crisis, as it relates to economics, social justice, and multiple other fields.

Exploring the humanities when learning about climate change is a pathway towards local and global connection in students, allowing them to explore the implications of GCC from multiple perspectives (Boakye, 2015). A Master's program at the University of the Sunshine Coast in Australia took this multidisciplinary approach and found that when the program embedded topics like economics into the curriculum, problem-solving and other skills like research abilities were developed (Fahey, 2012). As a result, heightened awareness and a better

understanding of methods to approach challenges were both observed.

The climate crisis also strongly relates to inequity due to its heightened negative impacts in low-income communities and developing countries. Framing GCC as a social justice issue, given it disproportionately affects marginalized communities, will result in feelings of responsibility and willingness to act upon these disparities (Stapleton, 2019). Understanding data and the consequences of increasing temperatures is the first step towards successful teaching, but communicating the implications and solutions to the issue will push initiative towards change: the ultimate goal of effective climate change education.

Furthermore, climate change is not based on linear relationships but on a system of complex interactions. A United States study composed of student assessments on content knowledge found that traditional environmental literacy education showed a significant increase in understanding of the topic; still, students developed linear relationships instead of connections among various systems (Roychoudhury et al., 2017). Educators must emphasize the dynamic relationships between systems in nature that are affected by climate change and develop a complex understanding of the connections between different causes and consequences.

Schools should acknowledge the multifaceted nature of the crisis and approach the topic in an interdisciplinary manner. Trusted role models are essential in effectively getting this message across. Therefore, it is imperative to understand who these communicators are and how they can convey this information.

### **The Importance of Effective Communicators**

Teachers have a tremendous impact on students' perspectives of climate change and on inspiring future action; they ought to serve as a source for hope, constructively teaching facts and taking a clear stance on climate change (Ojala, 2012). Educators have been consistently identified as one of the primary sources of

information that students rely on for climate change information (Zsóka et al., 2013), playing an essential role in GCC education and as critical communicators.

However, some teachers face some barriers in effectively conveying this critical information due to pressure to address the “controversial” nature of GCC (Wise, 2010). They also note insufficient knowledge on the topic as an obstacle to teaching climate change (Dawson, 2012). A survey of Colorado public school science teachers (n=628) on the topic of climate change instruction found that the unsubstantiated controversy around GCC makes it hard for teachers to address the topic with true value: they may feel obligated to show “both sides of the argument” (Wise, 2010). Professor Wise, who conducted the survey, also found that many educators did not have a sufficient understanding of climate science. This lack of content knowledge and environmental literacy serves as another impediment for teachers (Zsóka et al., 2013).

Professional development may serve as a useful way to educate teachers on effective strategies and the necessary information for teaching climate change (Siegener & Stapert, 2020). Teachers may also talk about different approaches to solutions to the climate crisis with students, but be clear in the scientific consensus and data on changing temperatures (Holthuis et al., 2019; NASA).

#### *Student Communication and Discussion*

Peer-to-peer interaction and communication with other youth serve as sources of relevant information for students; young people serve as influential communicators on climate change and may impact students’ perceptions about the topic (Corner et al., 2015). Discussion among peers with activities like Model United Nations (MUN) simulations, where students represent a delegation and discuss policy matters to develop solutions, may influence their comprehension of solutions to GCC (Cordero et al., 2020). Additionally, listening to perspectives regarding the impacts of climate change in global communities from other people who are the same

age may influence action and deepen student understanding (Stapleton, 2019).

#### *Addressing Misconceptions*

Lastly, misconceptions surrounding climate change are ubiquitous among students worldwide; teachers serve an important role in addressing these in the classroom (Monroe et al., 2019). Some of the most common misunderstandings are not finding a relationship between household energy consumption and emissions, confusing air pollution with greenhouse gases (Dawson, 2012), and confusing GCC with ozone depletion (Bofferding & Kloser, 2015). These misconceptions must be addressed by communicators directly so that students may form relevant connections and an accurate understanding of the topic.

#### **Discussion and Conclusion**

Climate change education is essential towards developing conscious and innovative minds, and practical pedagogical approaches are fundamental to effective interventions. Scientific information must be reinforced with activities that engage students to connect topics to solutions and systems. Additionally, community-based learning is a major component in empathizing with others and driving change. Empowerment is also crucial and must show the impact of individual behavioral changes.

This pedagogical model ought to be multidisciplinary and solution-based, encouraging students to generate solutions to environmental issues. Climate change affects mostly the population that is not responsible for emissions, meaning global climate change (GCC) is a foreign and abstract concept for the people that most need to engage in mitigation efforts. Films, movies, studies, and forms of imagery tend to be impactful in students’ perceptions and to communicate this concept to those not directly affected by the crisis.

Lastly, teachers must have the experience required to teach the topic, not only as a set of facts but also as a problem requiring solutions; training through professional development may serve as a source of this knowledge. Educators must also address common student

misconceptions to ensure a better understanding of the topic. Communication among peers and teachers leads to the constant exchange of ideas and promotes change culture: a primary goal in education.

Effective climate change education has a critical role in mitigating GCC. Successful interventions may significantly reduce students' emissions and encourage pro-environmental behavior; if instituted widely, climate change education may have effects comparable to solar rooftops and afforestation in decreasing atmospheric CO<sub>2</sub> levels (Cordero et al., 2020). Consequently, the results of effective interventions are remarkable, and the implications of this educational model are notable. Figure 2 below summarizes the educational strategies discussed and their impacts.

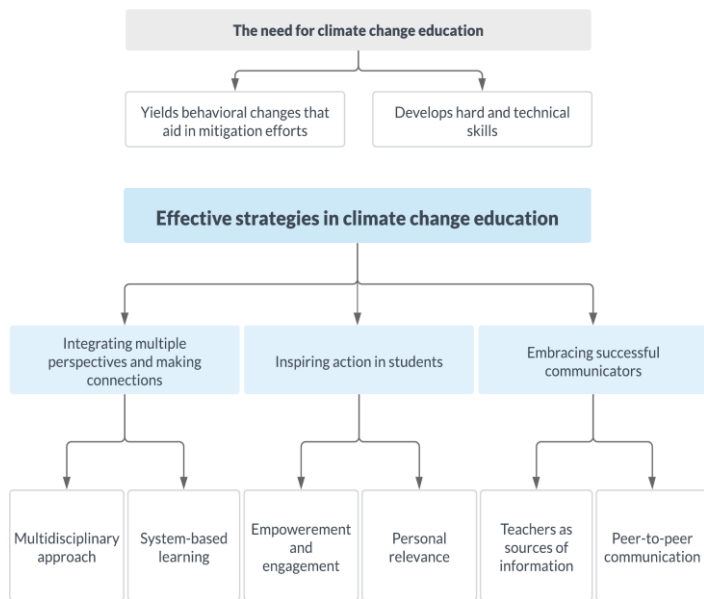


FIGURE 2: Summary of effective strategies for climate change education

### Limitations

Some limitations of the strategies explored previously lie in communicating an abstract concept to students who are not noticeably affected by climate change (Stapleton, 2019). Communicating GCC's effects in global communities through video chat technologies, for example, may be successful but costly. There is also a growing culture of climate deniers, and the

controversial nature of the issue has impacted perceptions and actions in both students and teachers (Wise, 2010). Acknowledging these perspectives and facing them is difficult but required in effective interventions.

Additionally, examining these skills may require a different format than regular testing, as there are multiple connections and systems that are tough to assess in a multiple-choice test (Roychoudhury et al., 2017). Free response and project-based assessments may be an adequate solution to this obstacle. Lastly, many teachers cite the lack of time in their year as an impediment to teaching climate change (Dawson, 2012). Encouraging administrators to embrace climate education and persuading schools and states to adopt the Next Generation Science Standards (NGSS) are significant steps to promote the adoption of this curriculum.

### Recommendations for Further Research

Climate change education requires more research in developing countries, as the leading studies come from nations like the United States, Australia, Canada, and the United Kingdom (Anderson, 2012). Different approaches and responses to educational models may arise in other countries. Hence, it is critical to collect information from a wider range of locations. Longitudinal studies into the long-term impacts of GCC education are also lacking. These studies are important in getting insight into the effects of curricula, showing if there are sustained behavioral changes in students or other quantifiable intervention success measures (Cordero et al., 2020).

Although research into educational interventions primarily focuses on secondary school settings, there are multiple studies used in this review that were implemented in academic institutions across various school levels, from elementary to graduate education. These case studies and research papers may provide some insight into future action in secondary schools but may not translate universally to a full extent. Further investigation on the secondary setting will be of benefit in analyzing strategies specific to that level.



## The Necessity of Future Interventions

In hindsight, the urgency and effectiveness of climate change education are evident. Adopting some of these measures across educational systems may significantly shift student behavior and inspire responsibility and initiative. Institutions ought to utilize these strategies in order to hold successful interventions that result in meaningful change at the micro and macro levels.

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