

Education for climate justice: Teaching practices in formal education

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Abstract: The climate crisis, increasingly addressed by bodies such as the IPCC and UN through their reports, demands urgent adaptation and mitigation actions, in addition to integrating climate justice into decisions. Climate justice addresses social inequalities related to climate impacts, highlighting the importance of inclusive policies. In this context, education emerges as a key element for awareness and action, promoting creative and inclusive pedagogies that engage students. Investigating teaching methodologies for climate justice is crucial, given the limited academic focus on this field and the urgency for effective curricula. In this paper, we analyze what is being taught about climate justice in other countries and cultural contexts in both primary/secondary and higher education, identifying the teaching methodologies and approaches employed, as well as the main findings regarding climate justice education. To achieve this, a narrative literature review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines used to support the transparent reporting of the study identification and selection process. The results indicate that students seek climate change education that integrates social justice and interdisciplinary practices, while teachers face structural, emotional, and pedagogical challenges in addressing the topic in the classroom.

Keywords: climate crisis, environmental justice, narrative literature review.

Introduction

Debates about the climate crisis are increasingly recurrent and complex, mainly due to the increase in the incidence of extreme meteorological phenomena and the way in which this not only directly affects different populations but also alters the collective perception of the climate issue. The Intergovernmental Panel on Climate Change (IPCC) and the United Nations (UN) are also calling attention to this subject through reports, conferences, and working groups.

Through the Sixth Assessment Report (AR6), the IPCC issued an alert about the global climate crisis, highlighting the urgency of adopting adaptation policies that strengthen the resilience of cities, protecting both the population and the environment (Jacobi et al., 2022). The author further states that it is "essential to define adaptation priorities, decarbonize public management sectors, and include climate justice in decision-making, as a sustainable future demands integrated policies that consider social and economic aspects" (Jacobi et al., 2022, p. 44).

The climate crisis is complex and reaches many levels of discussion, and it should be so, because its impacts “are unevenly distributed, and the fair sharing of responsibilities requires adequate representation and protection of those vulnerable to climate change, that is, to climate justice issues” (Rolleston et al., 2023, p. 2).

Climate justice is a concept that goes beyond global warming, integrating environmental issues with social inequality. It’s an offshoot of climate justice and refers to the fair treatment of all communities when dealing with climate change, recognizing that some groups suffer the impacts in a disproportionate way, despite contributing less to the problem (Levy et al., 2023).

In this sense, education has an important role in mitigating the climate emergency and addressing climate justice, as well as being a foundation for promoting transformation towards a sustainable future. While education is proposed as the most efficient mechanism to change behaviour and improve climate literacy, it’s unclear the best way to deliver it (Mochizuki; Bryan, 2015). According to Stapleton (2018), rethinking the educational and communicative approach to climate change is essential, considering the warnings in literature about the dangers of oversimplifying or resorting to stereotypes. For Vaughter (2016), climate change education needs to go beyond the transmission of knowledge and begin to develop “action competence” so that students stay active in promoting social and environmental transformation.

Teachers play an essential role in this transformation, encouraging students to think critically about mitigation and adaptation approaches to climate change (Stevenson; Nicholls; Whitehouse, 2017). However, curricular policies can’t be considered sufficient if they just aim at developing “critical thinking” without any link to solutions that can be put into practice about the subject; students must be encouraged to create their own solutions to the problem and acquire the skills to implement them effectively (Vaughter, 2016; Mochizuki; Bryan, 2015).

According to IPCC’s synthesis report, “increasing education including capacity building, climate literacy, and information provided through climate services and community approaches can facilitate heightened risk perception and accelerate behavioural changes and planning.” (IPCC, 2023, p. 30). It’s undeniable that in tackling the climate crisis, education must be one of the responses, forming more critical and aware citizens.

However, although topics such as climate and sustainability are frequently highlighted in curricular documents, teaching and learning them present challenges, especially because climate education objectives vary in each education level (Vilhunen et al., 2024). This complexity arises from the need to consider political, economic, and sociocultural factors.

Despite the vast literature about environmental education and/or education for sustainability, very little directly addresses climate justice education (McGregor; Christie, 2021). This can occur in part due to the complex interaction between social injustice and climate change, and in part due to the concept of justice, which isn’t universally accepted or understood in the same manner by all people.

Climate justice education demands inclusive space for all ages, promoting comprehension and fair action, inspiring a transformative educational culture in the face of climate change and its unequal social consequences (Trott et al., 2023). It's necessary to bring students into reality, showing that the actions and consequences of the climate emergency are before our eyes, in the daily lives of many people, not only in the melting of glaciers and the extinction of polar bears. Therefore, for such an urgent and complex topic, there emerges the need for a broad framework of pedagogical practices that defies us to leave our usual cognitive safety and encourages the necessary flexibility for the transformation of perspective (Robinson; Walker; Walter, 2023).

This allows us to examine our problems, offer new and viable solutions, and put creative power in the hands of students. "Educational responses to climate change best take the form of active social learning that develops the capacity for personal and societal transformative practice" (Stevenson; Nicholls; Whitehouse, 2017, p. 70).

Thus, our objective is to analyze what is being taught, both in basic education and higher education, about climate justice, which methodologies and approaches are used, and the main conclusions about this topic. Because, although we find a diversity of articles in the literature about climate justice, research on climate justice education is still underexplored. The need for curricula that articulate the social justice aspects of climate change is clear and urgent (Stapleton, 2018).

In this context, the growing interest in climate change education and the recognition of the challenges associated with addressing this issue highlight the importance of reviewing the existing literature to identify effective educational strategies (Monroe et al., 2019). Therefore, examining the initiatives and approaches already described in previous studies can contribute to understanding how the topic has been addressed and identifying gaps that may inform the development of future curricula and further research.

Methodology

For this research, a narrative literature review was conducted to identify, describe, and critically discuss the existing literature studies on educational practices related to climate justice in formal education. The review process comprised the following stages: defining the research question, conducting the literature search, selecting the studies, extracting the data, and analyzing and synthesizing the results.

Narrative review is a flexible methodological approach that supports the synthesis and critical interpretation of knowledge in the field of education (Sukhera, 2022). Although it offers flexibility in the selection and interpretation of the literature, it should be conducted with transparency and methodological coherence throughout the research process (Ogassavara et al., 2025; Sukhera, 2022). This approach enables researchers to identify, describe, and critically discuss existing literature, contributing to an in-depth understanding of complex topics, the identification of research gaps, and the development of contextualized perspectives (Rother, 2007; Sukhera, 2022).

To ensure transparency in the reporting of the review process, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were used as a supporting framework, particularly for reporting the identification and selection of studies (Page et al., 2021). Thus, PRISMA was not adopted as the methodological framework of the review, but rather as a guideline to support the transparent presentation of the review procedures.

This review was carried with the support of the Parsif.al platform, an online tool used to organize and document the procedures for searching and selecting articles, register the inclusion and exclusion criteria, and identify and remove duplicate records. The first stage consisted of defining the research question, which guided the selection of descriptors and the formulation of the search strategy.

The research was structured to explore teacher's practice, both in higher education and basic education, in teaching and engaging students about climate justice and also students' views on this approach. The formulation of the main question was oriented by the PICO strategy (Population, Intervention, Context), where the target population is composed of teachers and/or students involved in undergraduate courses and basic education; intervention refers to the applied teaching methods, and the context was formal education.

The application of the PICO framework at the beginning of the review ensures that the research addresses a well-defined and focused question, thereby reducing the inclusion of irrelevant evidence. Based on this information, we formulate the main question:

- What teaching methodologies are being used to teach and engage students about climate justice?

In addition to the main question, secondary questions complement the investigation:

- How is climate justice being integrated into curricula?
- What pedagogical approaches are most effective in teaching this topic?
- What is the impact of educational initiatives on climate justice on students' environmental awareness?
- What challenges and barriers do educational institutions face in integrating climate justice into their practices?

The databases used for this research were Scopus and ERIC (Educational Resources Information Center), renowned and relevant sources for this subject. We chose Scopus because it contains selected and multidisciplinary articles (Gusenbauer; Haddaway, 2020), in addition to covering a larger number of journals in comparison to other databases (Mongeon; Paul-Hus, 2016), and ERIC because it's a database specific to the educational field (Gusenbauer; Haddaway, 2020). The search was carried out using strings created with Boolean operators, adapted according to the specificities of each database. The search strategy for the literature review was carried out based on descriptors such as "climate justice", including related terms such as environmental justice and climate inequality, both in Portuguese and

English, and for the educational element, descriptors such as education, formation, curriculum, and pedagogy (Table 1).

Table 1. Search strings used in databases

Databases	Search Strings
ERIC	"climate justice" AND education
Scopus	"climate justice education"
Scopus	"climate justice" AND education
Scopus	"climate justice" AND curriculum

Inclusion and exclusion criteria were also established to ensure the relevance and quality of the selected studies. The inclusion criteria covered studies related to teaching practices in formal education, including primary, secondary, and higher education, as well as articles, theses, and dissertations linked to science teaching. Exclusion criteria included reports, literature reviews, grey literature, and documents not related to science teaching. The research was carried out with a time limit until 2024 and without a geographical limit, using variations of descriptors according to the recommendations of the databases.

The selected articles were imported into the Parsif.al online platform, where duplicates were removed. Following that, the initial screening by title and abstract was then performed, and studies that didn't meet the previously established inclusion criteria were eliminated. After this stage, the remaining articles were read in full for a more detailed evaluation.

In the process of reading the articles in full, the data from the studies were extracted and organized in an Excel spreadsheet. In the data extraction stage, information such as study titles, objectives, main results, and responses to research questions was collected. For the analysis, filing techniques and qualitative analysis were used, allowing the organization of data to answer the research questions. This detailed planning seeks to ensure that the literature review is comprehensive, and aligned with the investigation objectives.

Data extraction was performed by the primary researcher. Following data extraction, the extracted data were reviewed and verified by a second researcher to ensure the consistency and accuracy of the information. The extracted information was checked against the original publications, particularly with regard to the study objectives, main findings, and responses to the research questions. Any inconsistencies or uncertainties identified during the verification process were discussed between the two researchers and resolved by consulting the original publication.

The search conducted in the databases resulted in 282 articles in total (Table 2), with the majority found in the Scopus database (76.6%). These results highlight a significant gap in the literature regarding the teaching of climate justice.

Results and Discussion

1. Characterization of selected studies

Of the total of 282 articles and theses initially identified, 94 documents were excluded because they were duplicates (Figure 1). After a preliminary analysis of the titles, 61 papers remained in the selection. Subsequently, with the analysis of the keywords and abstracts, 16 documents were selected for full reading and data extraction for the final analysis. Most of the excluded studies were literature reviews or weren't related to science teaching, a condition aligned with this article's objectives and research questions.

Table 2. Number of publications found in the databases

Databases	Number of articles found
ERIC	66
Scopus	216
Total	282

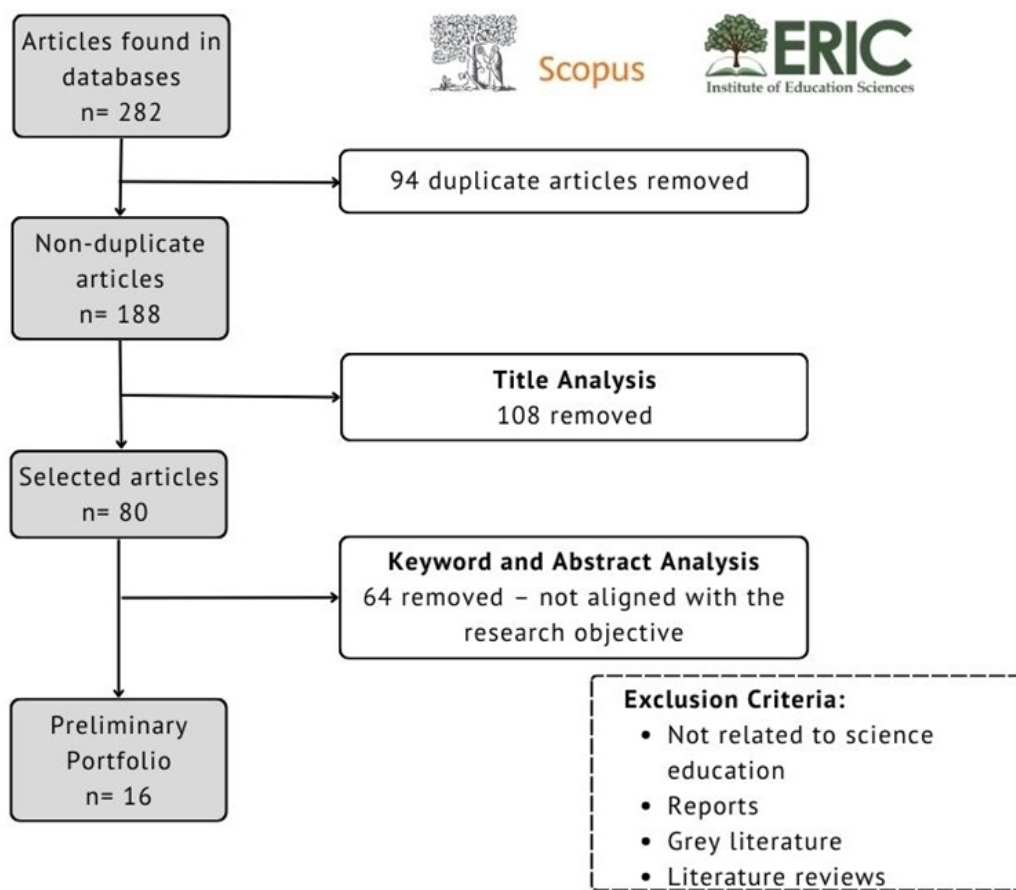


Figure 1. Flowchart of the article search and selection process in the narrative Literature Review

Despite the small number of articles identified, those found highlight the topic's complexity and its multiple biases. On the one hand, this gap points

to the urgent need for further investigations; on the other hand, the existing studies, indicated in Appendix 1, have the potential to offer valuable contributions to the educational context, allowing teachers to identify and apply more appropriate and coherent methodologies based on the experiences of other researchers.

From the results found, according to Figure 2, it can be seen that the subject is recent, since most of the selected publications are from 2024 (38%). This shows that it's a current, relevant subject that requires further study and academic production in the education field.

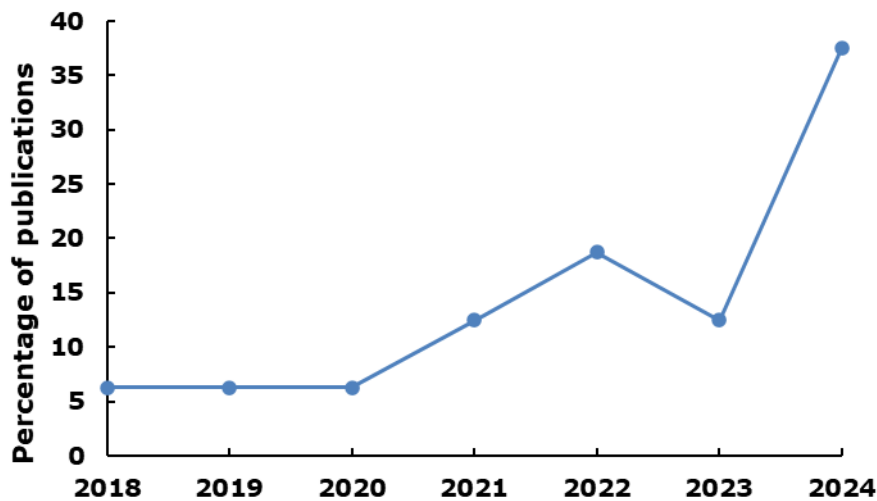


Figure 2. Percentage of publications per year

Regarding the countries that have published the most on this subject, the United States of America stands out as the country that has conducted the most research on climate justice education, reflecting its academic leadership and the volume of scientific production in the field. Of the eight publications that involved North America, seven were initiated by researchers from the United States, as shown in Figure 3, which shows the continents involved in the publications, both as the target of investigation and as the origin of the researchers.

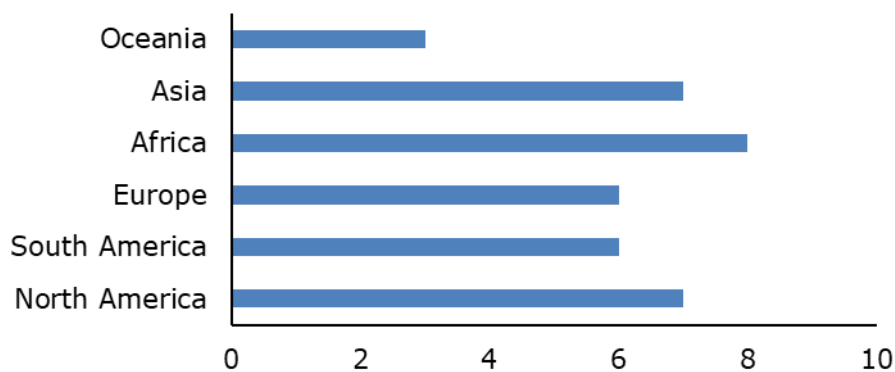


Figure 3. Continents with the highest involvement in publications

Countries in Africa and Asia were the most investigated in partnerships between schools and researchers, highlighting the interest in understanding the unequal impacts of climate change in these regions and promoting actions aimed at climate justice.

2. Integrating climate justice into curricula and pedagogical approaches

2.1 Basic Education

Based on the full reading of the selected articles, it became clear how important it is to discuss this topic, both from the perspective of teachers and students. The articles analyzed suggest that the integration of climate justice into curricula is still incipient, both in basic and in higher education.

The article written by Stapleton (2018) reports on the experiences of US secondary education students on an exchange in Bangladesh, whose objective was to learn about and experience the climate change faced by Bangladeshi residents. The students met people that lived in rural areas, climate refugees and people living in slums because their farms can no longer be cultivated due to flooding caused by the increase of storms. Something very different from their realities.

According to the author, young people not only noticed the difference but also requested that this approach be adopted to teach and inform about climate change. By exploring different places in Bangladesh and interacting with the locals, the participants could assess the complexity of the impacts in a single country. According to the students, the experience was very enriching and surprisingly enlightening regarding climate change and social impacts, which they had no idea were happening. The students were able to narrate the entire experience and how they felt about the situation.

Similarly, Gladwin, Karsgaard, and Shultz (2022) integrated high school students from different countries. Through knowledge interchange, the students understood energy transition as a complex change that goes beyond individual actions, requiring structural and sociocultural transformations. Students were broadly vocal about how their education typically focused on isolated core subjects, such as math and sciences, understood as the drivers of individual success and, thus, prioritized in a Western-oriented educational curriculum.

Following the same multidisciplinary perspective, Clark (2024) argues for the importance of teaching climate change in schools as a sociopolitical and scientific process, promoting "critical climate awareness" among students. This approach seeks to enable students to understand the structures that underpin climate inequalities and connect them to scientific and social dimensions.

Project-based learning (PBL) is one established strategy to involve students in highly technical and complex topics (Burns; Molina-Castrillón, 2023). The students analyzed in the research were part of an educational program that promotes student engagement on climate issues through innovative tools, such as portable air quality monitors. The students used these devices in their daily routines to collect data and analyze the impacts of pollution. In weekly meetings with educators, the students discussed how socioeconomic and climate factors affect access to clean air. The use of

pedagogical strategies, such as PBL, is pointed out as essential to connect technical learning to real social contexts (Burns; Molina-Castrillón, 2023).

There are still many places that don't have pedagogical practices on sustainability. In participatory research with secondary education students in Peru and Uganda, based on qualitative interviews, artistic expression, and visual stimuli, the researchers identified that students lack critical thinking about the structural causes of environmental crises and global inequalities (Wilder et al., 2024). Results like these raise an alert about educational practices in countries in both the Global North and the Global South.

The National Curriculum for England, for example, currently doesn't consider social justice issues in relation to climate change (Walker, 2024; Heinemeyer et al., 2024). In that way, organizations such as Teach the Future push for a more inclusive curriculum that addresses the climate emergency comprehensively.

Innovative projects, such as Suitcase Stories, use storytelling methodologies to empower young people and promote dialog on climate justice, seeking to overcome the traditional limitations of the current curriculum (Heinemeyer et al., 2024). Heinemeyer et al. (2024) used participatory narratives with young people to explore climate adaptation, emphasizing engagement in lived experiences of climate change through mutual learning and story exchanges between the Global South and the Global North. According to the same article, the most effective pedagogical approaches in teaching climate justice include participatory storytelling, experiential and relational learning, arts, and emotional education.

In Ireland, there's a study that investigates how educators, future educators, and environmental specialists understand climate change. Although climate change education isn't explicitly referenced, the curriculum shares many of the key concepts and underlying values of education for sustainable development and environmental education in a broad way (Waldron et al., 2019). In addition to that, there are Green Schools, an awarded NGO-led initiative that has become deeply embedded in the Irish primary education landscape, offering the potential for an integrated, holistic approach (Waldron et al., 2019).

Another study, carried out in basic education in the United States, found that climate injustices aren't widely addressed, despite their potential to engage students' interest and raise concern (Borgerding et al., 2024). According to the authors, teaching for action was ranked as a relatively low priority, consistent with previous research in which climate science content is taught more frequently than mitigation actions and sociopolitical aspects of climate. They also stated that pedagogical strategies, such as experiential learning and civic engagement, proved themselves effective in promoting awareness, empathy, and critical thinking, but more support is needed to integrate climate justice into formal education.

In a study conducted to understand how sustainability is approached in classrooms in Austrian basic education, Heigl et al. (2022) found that climate justice is being integrated into curricula mainly through sustainability topics in mandatory classes, especially in subjects such as

ethics, social sciences and natural sciences. The paper suggests that sustainability shouldn't be treated as an "extra" or optional topic, but rather incorporated into current mandatory subjects. Another approach highlighted in the paper is the encouragement of critical reflection and debate, where different opinions on sustainability can be discussed in a democratic environment. That not only highlights the diversity of perspectives but also develops students' critical thinking.

2.2 Higher Education

According to results found by Alkon (2024), the best strategy for teaching is community-based pedagogical practices. Reflecting deeply on the ways in which health and environmental justice connect to one's own lived experiences changes what is at stake in a socio-environmental-themed class. The teacher used active methodologies and community-centered pedagogical practices, introducing readings, videos, and discussions on environmental justice. Issues such as the impacts of capitalism, neoliberalism, and colonialism on the environmental crisis were explored, in addition to historical and contemporary movements for climate justice.

Another author who advocates the use of active methodologies to promote learning on topics such as community resilience, climate justice, and social vulnerability is Duram (2021). The author states that "one-way communication of climate science, exemplified in lectures to passive listeners, does not elicit thorough understanding or changes in behavior. On the other hand, active learning closes the perception-action-learning loop" (Duram, 2021, p. 1495).

Rolleston *et al.* (2023), through research involving London, Brazil, Fiji, and Kenya, believe that an essential measure to fight the climate crisis is integrating diverse and enriching learning opportunities in higher education institutions, allied with combined actions that involve research, community engagement, and campus operations. The author also states that a relevant issue is how the lessons learned from contexts where students and communities experience climate change more directly can be transferred to other scenarios. In this way, they'll learn how to deal with the situation.

Another study involving Brazil, Fiji, Kenya, and Mozambique warns about the integration of climate justice into university curricula, as it's a multifaceted process that involves several strategies and considerations (Nussey *et al.*, 2022). The authors advocate the methodology of Participatory Action Research (PAR), collaborative learning, interdisciplinary approaches, critical reflection, and an emphasis on epistemic justice, recognizing diverse forms of knowledge and experience.

In Alvey's (2020) research involving teachers in the United States, climate justice is being integrated into social sciences curricula in several ways, establishing connections between the climate crisis and core disciplines such as economics, politics, and civics. According to the author, the most effective pedagogical approaches to teaching climate justice include interdisciplinary integration of social and natural sciences, problem-based learning that engages real-world issues, deliberative discussions that encourage exploration of different perspectives, and experiential education that connects students with the community. Furthermore, the use of

narratives that highlight the experiences of affected communities fosters emotional connection to the topic, while critical reflection on individual responsibilities empowers students to become informed and engaged citizens (Alvey, 2020).

3. Impact of climate justice educational initiatives on students' environmental awareness

The experiences reported in the studies had a profound impact on the students involved in the research, especially those who had different experiences, such as exchange programs. In the research conducted by Stapleton (2018), the fact that the students left the US and visited places that had witnessed the impact of climate change was already enlightening in itself. "I didn't know that one country was being more affected by climate change [than others]," that was the reaction of a student after visiting Bangladesh. The author further states that, through their experiences, the participants established connections between several issues, such as increasing severity of cyclones, rising sea levels, salinization of groundwater, and climate refugees moving into increasingly dense urban slums.

This approach to countries that are most affected by climate change allows students to see things in a more humane way, knowing people affected by climate crises and showing how it affects them on a daily basis. According to Gladwin, Karsgaard, and Shultz (2022), by examining energy transition possibilities, the students brought to consideration not only technical applications but also structural and sociocultural components of a more "cautious" use of resources.

In another knowledge exchange experience between students from different countries, they understood the connection between environmental, social, and political contexts with environmental problems, in addition to positioning themselves as part of the climate systems (Clark, 2024; Burns and Molina-Castrillón, 2023).

Educational initiatives focused on climate justice can significantly impact students' environmental awareness, fostering engagement, empowering marginalized voices, providing transformative learning experiences, promoting interdisciplinary knowledge, encouraging collaborative relationships, and enabling critical reflection on systemic issues (Nussey et al., 2022; Borgerding et al., 2024; Heinemeyer et al., 2024).

The study on climate justice revealed how students, even the most privileged, often saw environmental issues as distant and abstract (Alkon, 2024). According to the author, some of them acknowledged the limitation of call-to-action campaigns that focus solely on individual change, deflecting responsibility from corporations. Other students, however, continued to see changes in their own habits as a more practical way to take action.

As the students talked about climate change during the activities, they described the burden of climate disruptions on their community and/or family members and the lack of resources to be resilient during extreme weather events such as heat waves (Clark, 2024; Walker, 2024). In some studies, where climate justice approaches are not as effective, young people, driven by climate change, are demanding climate justice and

criticizing their own educational experience (McGregor; Christie, 2021; Duram, 2021).

In studies by Waldron et al., both teachers and future teachers weren't familiar with the concept of climate justice and showed limited awareness of the disproportionate impact that climate change has on the poorest communities that have least contributed to its cause. This clearly shows that the countries least impacted by climate change are the ones that discuss the issue the least. Students develop empathy by hearing climate injustice experiences from different contexts, which helps them recognize the complexity and urgency of climate change (Heinemeyer et al., 2024). Furthermore, this approach broadens their global awareness, empowering them to become active agents of change in their communities and in a broader context.

In this context, to Heigl et al. (2022) and Alvey (2020), educational initiatives on climate justice significantly affect students' environmental awareness by integrating sustainability topics into core disciplines and promoting relevant and critical discussions about the climate crisis. Collaboration between educators from different fields improves learning, and the active community and student involvement bring meaning to education.

4. Challenges and barriers found by educational institutions in integrating climate justice into their educational practices

Analyzing the challenges and barriers pointed out by researchers is strategic for defining objectives and goals for projects and research planning, as it makes it possible to understand the main gaps in teaching. Gladwin, Karsgaard, and Shultz (2022) highlight their schools' lack of curricular engagement with energy-related topics, especially in ways that encourage interdisciplinary learning, collaboration across contexts, and the construction of alternative energy futures associated with climate justice.

In the same way, Nussey et al. (2022) point out the lack of institutional support, with few initiatives and insufficient curricular integration, lack of community involvement, and exclusion of student voices. Those issues are also raised by the work of Wilder et al. (2024), in addition to resource limitations, fragmented understanding of justice, and focus on anthropocentric perspectives. For Heigl et al. (2022), educational institutions face several challenges in integrating climate justice into their educational practices, including the lack of inclusion of sustainability topics in official curricula, which leads to a dependence on committed teachers who promote these topics outside of regular class hours or, in some cases, end up not addressing the subject at all.

Clark (2024) argues that while educational standards are necessary, they are insufficient to promote transformative education, focusing solely on scientific knowledge, ignoring equity issues and the sociopolitical dimensions of climate change, and failing to encourage effective collaborative action. The author further states that there are other significant challenges, including teacher resistance and lack of adequate resources.

This resistance often occurs due to teachers' lack of confidence in teaching social and political aspects, as climate change topics are multidimensional. Teachers need to feel comfortable addressing controversial issues in the classroom; however, teaching about climate change is often perceived as a daunting task, particularly when introducing a critical approach to ecological sustainability as a global concern (Waldron et al., 2019; Alvey, 2020). A key component for upgrading climate change action competency into curricula is improving teacher qualification through training programs (Vaughter, 2016, p. 2).

Furthermore, fear of controversy and limited knowledge on the topic make it difficult to address issues such as race and power (Waldron et al., 2019; Duram, 2021; McGregor; Christie, 2021; Borgerding et al., 2024; Heinemeyer et al., 2024). Climate justice discourse offers an essential analysis to address climate action as a sociopolitical problem, taking power and social inequalities into account (McGregor; Christie, 2021).

Another factor that hinders the inclusion of climate justice teaching into curricula is that some educators assume that the students' emotional resilience is insufficient to deal with climate justice challenges (McGregor; Christie, 2021; Borgerding et al., 2024; Heinemeyer et al., 2024). These emotional issues were extensively addressed in the articles analyzed, presented through the terms climate anxiety and ecophobia.

Furthermore, the pressure to follow strict curricula and the lack of adequate teaching resources limit the ability to explore these issues effectively. Another significant challenge is cultural and institutional resistance, with environmental issues still seen as primarily belonging to natural sciences, leaving climate justice aside as an undervalued topic. This segmentation hinders holistic connection needed to address social, economic, and environmental interactions, thus limiting the students' critical thinking on these essential topics.

Thus, improving teaching and learning may require updating and developing curricula and pedagogies, which, in turn, depend on the training of academic staff in this area (Rolleston et al., 2023). In addition to stimulating student participation and involvement in the proposed discussions and activities (Alkon, 2024), linking knowledge to action on climate change in curricula will be more successful if educational institutions have operational policies that allow students to put this knowledge into practice (Vaughter, 2016).

Conclusions

The research found that students, especially those in basic education, demonstrate a clear demand for climate change education, with an emphasis on social justice and inequality. The most effective methodologies are those that combine practical experiences with an approach to different realities, combined with theoretical classes that explain fundamental concepts. However, teachers face significant challenges, such as the lack of adequate training on the topic and difficulties in adopting an interdisciplinary approach.

Additionally, the concern with climate anxiety in students is a barrier,

with many educators fearing that it will have a negative emotional impact. There's a lack of teaching materials and support resources that can help teachers address the topic efficiently. In this context, it's urgent that institutions and governments promote curricular and structural changes, preparing professionals to deal with these issues, so that the responsibility for teaching climate change doesn't fall exclusively on science teachers but involves all fields of knowledge.

As with any research, this study has some limitations. The approach to Climate Justice in formal education is still an emerging and relatively recent field in the literature. In addition, a more specific distinction could have been made between the countries of origin of the researchers and those in which the studies were conducted, allowing for a better understanding of which countries produce knowledge on the topic and which are the subjects of investigation. This is an important issue to be addressed in future research, particularly by deepening the geographical analysis and investigating how different social, territorial, and educational contexts have incorporated Climate Justice into their practices and curricula, thereby contributing to the consolidation of this field of research.

In this context, in light of recent climate-related developments, the integration of education for sustainable development and climate change education into school curricula is still in its infancy. Few countries have dedicated themselves to addressing this topic in their research.

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Appendix 1. Articles selected for final analysis

Article	Author	Journal	Year
A Case for Climate Justice Education: American Youth Connecting to Intragenerational Climate Injustice in Bangladesh	Stapleton, S.	Environmental Education Research	2018
Geographical Process or Global Injustice? Contrasting Educational Perspectives on Climate Change	Waldron <i>et al.</i>	Environmental Education Research	2019
Deferral, Agency, and Hope Pre-Service Social Studies Teachers Making Sense of the Pedagogical Demands of Engaging Climate Crisis.	Alvey, E.	Journal of Social Studies Education Research	2020
Teaching a social science course on climate change : Suggestions for active learning	Duram, L.A	Bulletin of the American Meteorological Society	2021
Towards Climate Justice Education: Views from Activists and Educators in Scotland	McGregor e Christie	Environmental Education Research	2021
Building University Capabilities to Respond to Climate Change Through Participatory Action Research: Towards a Comparative Analytical Framework	Nussey <i>et al.</i>	Journal of Human Development and Capabilities	2022
Collaborative Learning on Energy Justice: International Youth Perspectives on Energy Literacy and Climate Justice	Gladwin <i>et al.</i>	Journal of Environmental Education	2022
Justice, What a Dream!—Mapping Intersections of Sustainability and Inclusion	Heigl <i>et al.</i>	Sustainability (Switzerland)	2022
Aiming Higher? Implications for Higher Education of Students' Views on Education for Climate Justice	Rolleston <i>et al.</i>	Sustainability (Switzerland)	2023
The Air We Breathe: Integrating Citizen Science with Social Justice to Drive Climate Literacy	Burns e Molina-Castrillón	Science Teacher	2023
A pedagogy for the end of the world: teaching environmental health and justice in a sacrifice zone	Alkon, A.H.	Journal of Environmental Studies and Sciences	2024
Critical climate awareness as a science education outcome	Clark, H.F.	Science Education	2024
Environmental justice in education for climate action: Case studies from Perú and Uganda	Wilder <i>et al.</i>	Children and Society	2024
Mutual Learning through Participatory Storytelling: Creative Approaches to Climate Adaptation Education in Secondary Schools	Heinemeyer <i>et al.</i>	Research in Education	2024
Secondary Science Teachers' Views and Approaches for Teaching for Climate Justice and Action	Borgerding <i>et al.</i>	Journal of Science Teacher Education	2024

What role for geography in justice-focused climate change education?	Walker, C.	Geography	2024
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