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REVIEW

Justice in climate change education: a systematic review

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ABSTRACT

Growing recognition of the multi-faceted injustices of climate change has resulted in shifting public and policy discourse around how to understand and address climate change, yet justice considerations are rarely present in climate change education (CCE). With aims of bringing visibility to existing efforts and building a foundation for more widespread justice-driven CCE, this systematic review examined how justice frameworks are being employed in a range of CCE contexts, within and beyond the classroom. Analyses of 55 peer-reviewed articles with data from 57 countries published between 2007 and 2020 demonstrate that the empirical literature on justice in CCE has grown significantly in recent years. Notably, justice-driven CCE in this review took place within and beyond STEM education settings, was fueled more by people-focused aims (e.g. advancing equity) compared to planet-focused aims (e.g. protecting the environment), and encompassed a remarkable diversity of educational processes, goals, and outcomes—with learners of all ages—across formal, community-based, and activist learning contexts. Findings have implications for scholars, educators, and practitioners across disciplines committed to educating for justice in the face of climate change.

Introduction

Climate change is increasingly understood as an issue of multi-faceted injustices—intergenerational, racial, and economic, to name only a few (Scandrett 2016; Sultana 2022a; Tutu 2010). This is apparent when considering that, globally and within countries, those who have historically contributed the least to climate change in the form of greenhouse gas emissions are already facing disproportionate burdens in the form of rising sea-levels, drought, and climate-fueled extreme weather events (Hickel 2020). Groups experiencing elevated climate-driven risks and harms include the youngest and oldest populations of the world, as well as low-income, Black, Brown, Indigenous, and Communities of Color, as climate change exacerbates age-based physiological vulnerabilities and intensifies existing social, economic, and health inequities (Benevolenza and DeRigne 2019; Helldén et al. 2021). An additional layer of injustice is that these groups are often excluded from spaces of decision-making and action to address the climate crisis (Archer et al. 2014; Fitzgerald 2022). Growing awareness and documentation of these realities has

resulted in public and policy discourse increasingly aimed at addressing climate change through the lens of climate justice.

Climate justice is a concept and framework that aims to bring visibility to and work against climate-fueled inequities, socially and geographically, by centering the perspectives and needs of marginalized and disproportionately-affected groups (Schlosberg and Collins 2014; Sultana 2022a). Climate justice is rooted in concepts of environmental justice in terms of its ecological analysis and practice as well as broader efforts to adopt and honor concepts of universal human rights. Though activists and advocates have been speaking the language of climate justice for decades (McGregor et al. 2018), its relatively recent mainstreaming in academic and policy documents is a notable development. Attributable to relentless efforts by members and allies of the global climate justice movement, the 2015 Paris Climate Agreement laid out numerous justice-related challenges in need of redress, including gender and generational inequities as well as human rights concerns—especially to Indigenous communities (United Nations Framework Convention on Climate Change 2015). More recently, the latest report from the United Nations Intergovernmental Panel on Climate Change (IPCC 2022) was the first in six assessment reports dating back to 1990 to center justice considerations in our understanding of climate change causes, consequences, and solutions. Alongside their increasing justice focus, these guiding documents emphasize education as a key mechanism to facilitate the transition towards more just, equitable, and sustainable societies around the globe. This is because education can be a key driver of public awareness and engagement with complex climate change realities and their possible solutions (Reid 2019). This raises the question: How and to what extent are justice considerations appearing in climate change educational contexts?

Now more than ever, there is a demand to consider climate change not only as a scientific and technical issue, but one with social, economic, historical, and ethical dimensions (Kissling and Bell 2020). Arguments for a more holistic approach to climate change education (CCE) rest on the notion that a more thorough understanding of the complexities of climate change—including its inherently political ones—is a necessary precondition for cultivating an informed and engaged public capable of tackling one of the greatest challenges humanity has ever faced (Kagawa and Selby 2015; Tutu 2010). Unfortunately, several systematic reviews of the CCE literature in recent years have concluded that the political dimensions of climate change are often missing (Bhattacharya et al., 2020; Jorgenson, Stephens, and White 2019; Monroe et al. 2019), and when they are considered in classroom contexts, they rarely engage substantively with issues of justice (Kranz et el., 2022). What this means is that, with key exceptions, most approaches to CCE are out of alignment with guiding frameworks applied in policy and interdisciplinary scholarly contexts whose core mission is to address the climate crisis. If CCE is to make good on its oft-touted promise of being a force for societal transformation, considerations of justice are critical. With aims of offering inspiration and guidance that may spur more widespread adoption of justice frameworks in CCE, the present study is a systematic review exploring the experimental and forward-thinking ways justice frameworks in general, and concepts of climate justice in particular, are being employed and enacted across a diverse range of climate change educational settings, within and beyond the classroom.

Climate justice: framing the problem

How climate change issues are framed, within and beyond educational contexts, has important implications for how we understand its causes and consequences, as well as the solutions we imagine. According to Nisbet (2009), 'frames are interpretive storylines that set a specific train of thought in motion, communicating why an issue might be a problem, who or what might be responsible for it, and what should be done about it' (p. 15). Framing climate change as an issue of (in)justice necessarily goes beyond traditional scientific and technical problem definitions

to incorporate sociocultural, historical, and moral dimensions of the problem—particularly along the lines of rights, risks, and responsibilities (Shaw 2016). Moreover, conceptualizing climate change problems through the lens of justice can expand the significance of solutions beyond 'environmental protection' (e.g. flourishing ecosystems) and into the overlapping spheres of personal and societal well-being (e.g. thriving communities). Recent studies exploring the perspectives and motivations of climate change educators, youth activists, and students suggest that justice concerns can be a key driver for meaningful engagement by learners and educators alike (Dittmer et al. 2018; Fisher 2016; Grosse 2019; Howell and Allen 2019; Stapleton 2019; White et al. 2022).

Climate justice is a heterogenous and ideologically contested concept for which there is no universally agreed-upon definition (Schlosberg and Collins 2014; Scandrett 2016; Trott et al. 2022). Still, efforts to advance climate justice—like the environmental justice movement before and alongside it—are united by a shared focus on 'local impacts and experience, inequitable vulnerabilities, the importance of community voice, and demands for community sovereignty and functioning' (Schlosberg and Collins 2014, p. 359). Moreover, the aims of climate justice transcend those originally held by environmental justice advocates in that they encompass 'rectify[ing] environmental burdens posed by discriminatory policies and systems, *and by climate change itself* [emphasis added]' (Grady-Benson and Sarathy 2016, p. 18). Of the multi-faceted injustices of climate change, a core reality is:

> …the disproportionate contribution of greenhouse gases by nations and humans with more economic resources and disproportionate harm done to nations and humans with fewer economic resources, non-human living beings, and ecosystems. (Tayne et al., 2020, p. 707).

Such disproportionate climate-driven harms are attributable to greater overall risk exposure, lower adaptive capacity, heightened sensitivity to stressors, and limited access to quality support services, such as healthcare (Wuebbles, Fahey, and Hibbard 2017).

Conceptualizations of climate justice also draw upon broader ethical and legal dimensions of justice, such as procedural justice, which refers to people's involvement in decision-making, and distributive justice, which refers to the distribution climate change harms and responses through planning and policies (Harvey 2011; Ogunbode 2022). Specifically, a climate justice perspective recognizes that disproportionately-affected groups often see fewer direct benefits from local climate actions (i.e. distributive injustice), which—as a result of being left out of planning and decision-making (i.e. procedural injustice)—can further entrench existing inequities (Schrock, Bassett, and Green 2015; Thomas and Warner 2019). Viewing climate change through a justice lens magnifies and makes clear that the benefits and burdens of climate action, as well as climate-fueled hazards and harms, affect people 'differently, unevenly, and disproportionately', and thus bring into sharp relief the necessity of 'redressing the resultant injustices in fair and equitable ways' (Sultana 2022a, p. 118). Often, this means working in solidarity with marginalized and frontline communities who are facing climate impacts first and worst. Finally, climate justice calls for dismantling systems of oppression and exploitation that fuel the climate crisis and perpetuate asymmetrical harms. In order to address multi-faceted climate injustices at their systemic roots, advancing climate justice requires understanding climate change as embedded in human-created systems and structures of violence and exploitation (e.g. neoliberal capitalism, racism, settler-colonialism) that must be unmade, abolished, or reimagined in ways that center human well-being (Trott et al. 2022). Such notions of climate justice are aligned with the concept of 'just sustainabilities', defined as 'the need to ensure a better quality of life for all, now, and into the future, in a just and equitable manner, whilst living within the limits of supporting ecosystems' (Aygeman et al., 2003, p. 5).

Especially relevant in the context of education are considerations of intergenerational justice. Specifically, another key facet of climate injustice is that young people alive today and future generations will bear the brunt of climate disruption due to the simple fact that they will live

further, compared to older generations, into an increasingly socio-ecologically unstable future characterized by more frequent and extreme climate-driven hazards, climate-fueled migration, and profound social unrest (e.g. food shortages, water scarcity, infrastructure failure, political instability). As a result, recent years have witnessed the rise of the youth climate justice movement (e.g. Sunrise; Fridays for Future), which consists of decentralized global networks of young people whose awareness of climate injustices—intergenerational, social, and environmental—are core to their demands for policy and systems change to avert the worst consequences of climate change (Grosse 2019; O'Brien et al., 2018). Studies with youth climate justice activists note that some of the chief reasons for their activism are the failure of formal educational systems to substantively engage learners on issues of climate injustice as well as the failure of both educators and policymakers to more actively work on behalf of young peoples' best interests (White et al. 2022). Because critical, justice-infused topics are often left out of classroom discussions, youth activists are most often getting their information from peer networks and social media rather than formal classroom instruction (Wallis and Loy 2021). On the one hand, the rise of the youth climate justice movement is encouraging—as it demonstrates that young people are motivated and capable of engaging with critical societal issues that will increasingly shape their lived realities. On the other, studies with youth activists highlight a missed opportunity in formal educational contexts to facilitate young people's critical, collective, and constructive engagement with climate change—an issue that is increasingly and understandably associated with mental health consequences, such as climate anxiety, grief, and despair (Hickman et al. 2021; Sciberras and Fernando 2022). Indeed, a recent study found that most students reported feeling disempowered by their education related to climate change (Jones and Davison 2021). Educating for climate justice in formal settings may thus offer young people a space to reflect on and process their thoughts and emotions about climate change as well as a platform for justice-informed action. As noted by McGregor and Christie (2021), 'justice is the bridge between knowledge and action that is so often elusive in climate change education' (p. 16).

Educating for climate justice

In academic and policy realms, climate justice has emerged as a key framework in developing approaches to climate change mitigation and adaptation, yet it has been slow to take hold in educational settings. For example, in an interview study with students, teachers, and climate specialists in Ireland, Waldron and colleagues (2016) found notable differences in how students and teachers conceptualized climate change—as a geographical issue requiring individual action—versus climate specialists, who conceptualized climate change as a social justice issue requiring collective political action. An influential systematic review of climate change educational approaches found that very few educational programs 'intentionally approached climate change from both social and science disciplines' or engaged with climate change as an opportunity for students to envision alternative futures based on what matters most to them (Monroe et al. 2019, p. 807). Of the 49 climate education interventions reviewed by Monroe and colleagues, none focused on justice-related outcomes. Other more recent reviews of CCE have identified similar trends misaligned with climate justice principles. For example, Bhattacharya and colleagues (2020) conducted a systematic review of 178 peer-reviewed studies of CCE in K-16 settings and found that much of the content focused on climate science and the mechanisms of climate change (e.g. carbon cycle, greenhouse effect), with little to no attention given to political or justice dimensions. Additionally, in a systematic review of energy and environmental education by Jorgenson, Stephens, and White (2019), a key finding was that, across the 70 studies reviewed, there was a general lack of attention to envisioning alternative (i.e. renewable energy-based) futures and most studies promoted private- rather than public-sphere actions in response to climate change. Finally, in a recently-published systematic review exploring the

political dimension in CCE, Kranz et al. (2022) found that 'central aspects of climate policy such as the 1.5-degree limit, the IPCC reports, or climate justice are rarely addressed' (p. 1). Of the 75 empirical studies identified in their review, just six addressed climate justice issues, and only half of these employed climate justice as a theoretical framework or central learning goal (i.e. Öhman and Öhman 2013; Siegner and Stapert 2020; Stapleton 2019). A concluding recommendation by study authors was that:

> …the topic of climate justice could act as a kind of door-opener for addressing the political perspective of climate change in education contexts, since both the causes and consequences of climate change lie in a historically constituted global economic system, and can thus be understood as an intersecting set of social inequalities. (p. 25)

It is worth noting that calls for justice-informed CCE are not new. In a 2010 book chapter, Lotz-Sisitka engaged with the title question, 'Climate injustice: How should education respond?', and in the same book, editors Kagawa and Selby (2010) called for a paradigm shift in CCE towards addressing the root causes and justice dimensions of the climate crisis. As they put it, 'there can be no ethical and adequately responsive climate change education without global climate justice education' (p. 242).

Despite the fact that little research in the CCE domain has considered climate justice as a framework for formal education, there is evidence that educators are heeding this call. In the spring of 2019, teachers began organizing themselves to share curricular materials related to climate justice (Zinn Education Project 2022). Specifically, the 'Teach Climate Justice' campaign addresses the 'gulf' between the problem of climate change and schools' insufficient response by engaging with questions such as, 'How do we teach the climate crisis in a way that also confronts racism, economic inequality, misogyny, militarism, xenophobia, and that imagines the kind of world that we would like to live in?' And in July of 2022, the National Oceanic and Atmospheric Administration (NOAA) in partnership with the Detroit Zoological Society announced a three-day workshop for educators focused on climate justice, specifically 'how global climate change is affecting the metro Detroit region, and how [educators] can engage their students in taking action to address this global phenomenon' (NOAA, personal communication, July 12, 2022). Other such efforts—including a climate justice-oriented National Wildlife Federation program called 'Earth Tomorrow' (Osborne Jelks & Jennings, 2022)—are documented in a recently-published edited volume (Walsh 2022) entitled, *Justice and Equity in Climate Change Education: Exploring Social and Ethical Dimensions of Environmental Education*. Additional evidence for the increasing momentum around teaching climate justice in the classroom is a recent special issue of *Connected Science Learning*—a journal published by the National Science Teachers Association—focused on, 'Exploring Climate Justice Learning: Visions, Challenges, and Opportunities'. Morrison and Bell (2021) introduced the special issue by highlighting the reality that 'instruction and learning focused on climate justice has been mostly absent from school-based contexts', and went on to describe the collection of articles as addressing critical questions such as: 'What is the role of science education in dismantling, desettling, and reforming educational systems to focus on climate justice?' and 'How can we disrupt white environmental imaginaries within curricula and instruction about how we collectively respond to climate change and instead focus on just and thriving futures for Communities of Color?' Questions such as these are core to advancing a climate justice agenda, which according to Scandrett (2016), 'must be rooted in the material interests of those social groups negatively affected by and engaged in struggles against the hydrocarbon economy' (p. 477).

What these recent examples signify is that while justice-infused CCE is in fact taking place across a variety of school and community settings, only an infinitesimal portion is captured in the peer-reviewed academic literature. Moreover, education for climate justice is occurring within and outside of formal educational spaces, including within and through community-based and activist contexts (e.g. the youth climate justice movement) where self-directed and social learning

is taking place, and from which public awareness of, and political pressure for climate justice often emanates (McGregor and Christie 2021). As such, a key limitation in recent reviews of the CCE literature is their exclusive focus on formal educational settings, and further restrictions placed on educational level (e.g. K-16; Bhattacharya et al., 2020) and age (e.g. up to 20; Kranz et al. 2022). As noted by Kagawa and Selby (2010):

> Climate change is too urgent and important to suffer 'death by formal curriculum' … [and] to be left to cloistered school-age education, so 'all age learning' linked to local arenas and channels of participatory democracy and directed towards effecting responsive change locally is necessary. (p. 242)

Given the relative absence of justice considerations in published research on formal CCE, there is a need to understand how (climate) justice frameworks are being employed and enacted across a diverse range of climate change educational settings, within and beyond the classroom.

The present study

To date, no studies have attempted to summarize and synthesize the literature on justice in climate change educational contexts. With aims of bringing visibility to existing efforts as well as laying the groundwork for more widespread justice-driven approaches in CCE, this systematic review examined the small but growing literature at the intersections of education, climate change, and justice. Systematic reviews use 'explicit, systematic methods to collate and synthesise findings of studies that address a clearly formulated question' (Page et al. 2021, p. 3). Specifically, this review aimed to classify and describe how peer-reviewed studies incorporate (climate) justice frameworks, what methodological, pedagogical, and action-oriented characteristics are apparent in this literature, and what are the actual and aspirational processes and outcomes of justice-informed educational approaches, in terms of their micro-level (i.e. cognitive, affective and behavioral) to macro-level (i.e. policy) effects. The present review was guided by the following key research questions:

1. What are the publication trends (e.g. number of articles; disciplines; author location) at the intersections of CCE and justice?
2. What kinds of justice are referenced in CCE, and more specifically:
    a. How central are justice frameworks in CCE?
    b. How and to what extent is climate justice showing up as a central framework in CCE?
3. What are the methodological properties (e.g. research designs) and who are the participants (e.g. age groups) in this literature?
4. What kinds of education are described, and more specifically:
    a. What are the educational processes and outcomes described in this literature?
    b. How and to what extent does action appear across studies?
5. What are the micro- to macro-level factors explored in research on justice in CCE?

Method

This review began by considering questions that would be of interest to scholars and practitioners of CCE, as well as reviewing previous relevant literature reviews, including scoping reviews and systematic reviews (Bhattacharya et al., 2020; Derr and Simons 2020; Jorgenson, Stephens, and White 2019; Monroe et al. 2019). This literature informed the specific focus and steps taken in the present research (see Figure 1). Early considerations also involved testing keyword searches in major databases to calibrate the scope of the review, evaluating and testing various systematic review software tools, and carefully documenting the search strategy as it
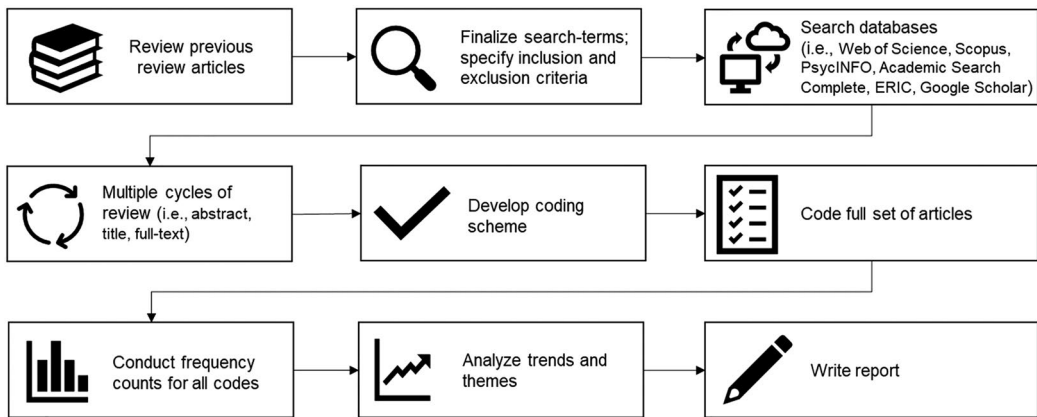
Figure 1. Stages of the systematic review process.

evolved. The reporting process in the present review is guided by the 2020 PRISMA (i.e. 'preferred reporting items for systematic reviews and meta-analyses') statement, which offers reporting guidance on the identification, selection, appraisal, and synthesis of studies (Page et al. 2021).

Search strategy

The present research began as a systematic review of the academic literature on climate justice education, then widened in scope to consider the justice dimension in CCE more broadly. To generate a search string used across databases, search terms related to climate change, education, and justice were combined in a variety of arrangements and searched using Boolean operators (i.e. 'AND', 'OR') to identify records of interest. The Boolean/Phrase used for the present research was: 'climate justice education' OR 'climate justice' AND education OR 'climate education' AND justice OR 'climate change education' AND justice OR 'climate change' AND education AND justice. This search string was used across five databases: Web of Science, Academic Search Complete, Scopus, ERIC (EBSCOhost) and PsycINFO. These databases were chosen for their broad scope (e.g. Web of Science, Academic Search Complete, Scopus) and specific relevance to the current review (e.g. ERIC, PsycINFO). Indexed within these databases are more than 10,000 journals covering a wide range of disciplines. To be considered for inclusion, search terms could appear in the article's title, abstract, keywords, main text, or references, as well as in the title of the journal. This review was restricted to peer-reviewed journal articles, without date restrictions. A couple of databases used in this review index articles as early as the nineteenth century (e.g. 1865 in Academic Search Complete; 1872 in PsycINFO), but all databases include articles published from 1966 to the present. This review includes all articles, including advanced online publications, published through the end of 2020. The final search was conducted on January 12, 2021. Across databases, the initial search produced a sample of 365 records to be included in the initial review (see Figure 2).

In order to identify additional records of interest, a manual search was conducted before proceeding to the screening phase. This involved: (1) reviewing the reference lists of excluded theoretical and review articles, which were relevant to the present review; (2) scanning the reference lists of included articles that were determined to be most relevant to the focus of this review; (3) searching Google Scholar for the term 'climate justice education'; and (4) manually searching keywords in a small subset of top journals identified in this review as publishing relevant articles, based on initial search results. The journals identified for more rigorous searching included: *Environmental Education Research, Local Environment: The*
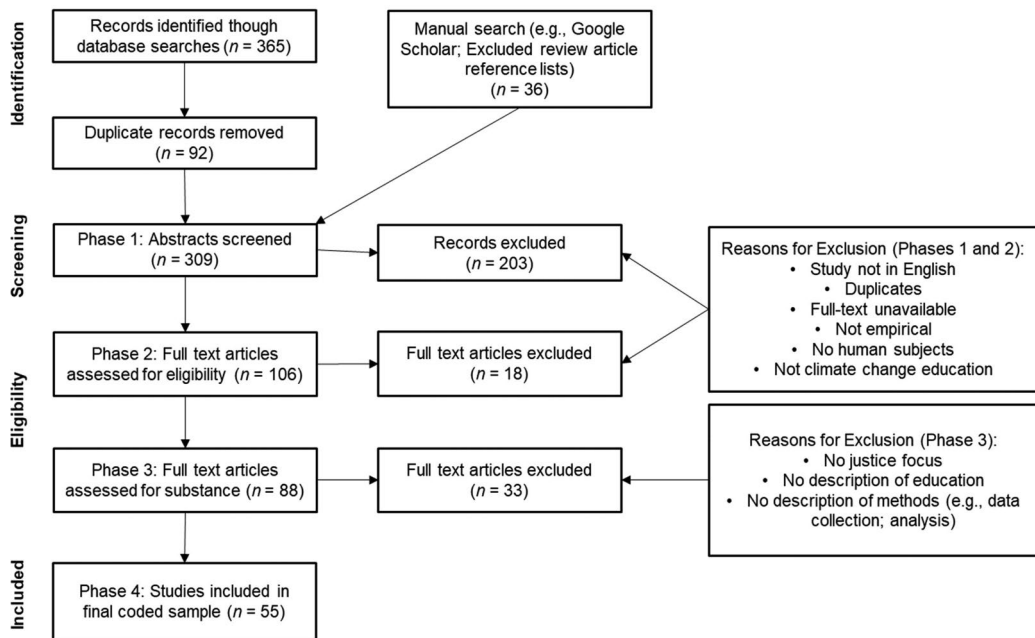
Figure 2. Systematic review process: identification, screening, and eligibility assessment.

International Journal of Justice and Sustainability, Ecopsychology, International Research in Geographical and Environmental Education, Journal of Cleaner Production, and *Sustainability.* Manual search strategies play an integral role in identifying articles not indexed in major databases (DeLuca et al. 2008). Together, these searches yielded a total of 36 non-duplicate articles to be added to our review sample.

Eligibility criteria

To survey the landscape of published research on how justice frameworks are being employed within CCE contexts, eligibility criteria for this systematic review emphasized empirical articles with human participants (e.g. educators, students). This systematic review thus did not include theoretical articles, curricular materials, non-empirical case studies, or review articles (e.g. literature, systematic, or scoping reviews). Key to determining eligibility was the reporting of data collection methods, ensuring that only empirical articles were included in the present review. Eligibility criteria further stipulated that articles must focus on the intersection of climate change and education in some way. This could include a range of topics, including evaluations of climate change educational programs or interventions as well as research on the cognitive, affective, or behavioral dimensions of CCE. Flexibility on this criteria—for example, not restricting the present analyses to formal education or programs—allowed for a greater breadth of articles to be considered in this review, including those relevant to, but perhaps not examining CCE interventions. Finally, articles were retained in the analysis as long as they made mention of 'justice' in the title, abstract, keywords, or body of the article. Whether to screen for a more substantive focus on justice was deliberated upon by the research team. Ultimately, it was decided that using this simple approach to screening would allow us to categorize articles ranging from those applying a justice framing in their work (e.g. in Introduction or Discussion sections) to those with a more explicit focus on justice (e.g. throughout article; in Results section). Additionally, this approach allowed for the examination of the range of justice lenses, within and beyond

climate justice, associated with CCE in published research. Due to the language capabilities of the research team, only articles published in English were included in this review.

The way CCE was conceptualized shifted during the course of this review. At the project's outset, based on previous reviews (e.g. Monroe et al. 2019), CCE was imagined as a process taking place primarily in the formal classroom or in the form of extracurricular activities (e.g. after-school or community-based programs). Moreover, it was assumed that climate change would be the explicit focus of the educational process. However, as the review progressed, it became clear that the intersection of climate change and education encompassed a wider variety of settings and primary educational foci. Further, despite database searches yielding hundreds of unique articles, climate justice was less represented in the CCE literature than anticipated. Though we originally set out to look at 'climate justice education' specifically, early in the screening process and given that our search strategy permitted doing so (i.e. via the search string 'climate education' AND justice OR 'climate change education' AND justice OR 'climate change' AND education AND justice'), we broadened the focus of the review to consider the justice dimension of CCE more generally. To adhere to this review's original intentions, in the analyses that follow, we consider certain aspects of climate justice-focused articles as a smaller subset. Finally, this review was inclusive of diverse research designs and methodologies, not limited to outcomes-focused evaluations of CCE programs or interventions. By including psychosocial investigations (i.e. those exploring the thinking and feeling aspects surrounding CCE), this review was able to summarize the kinds of activities (e.g. curricula; programs) taking place at the intersections of climate change, education, and justice, as well as the ways they are viewed and experienced by students, educators, and other participants.

Study selection and article screening

The present study took place over a period of 18 months from January 2021 to June 2022 and consisted of a team of four graduate students and one faculty member in the Department of Psychology at the University of Cincinnati and a research scientist in the College of Natural Resources at Colorado State University. The systematic review process was carried out in five phases. Phases 1 and 2 (i.e. article screening) were carried out by four members of the research team, Phases 3 and 4 (i.e. coding system development and article coding) were conducted by five members of the research team, and the full research team conducted Phase 5 data analysis and visualization. To set up the initial database, search results were first exported into the reference management software tool RefWorks before screening for duplicates using automated and manual processes. All articles were then imported into the open-access systematic review software tool CADIMA before being subjected to an additional layer of duplicate screening using CADIMA's auto-detection tool. Across all three phases of duplicate screening, 92 articles were removed from the database (see Figure 2).

In Phase 1, all article titles and abstracts were screened according to three criteria: (1) Article Type (i.e. must be empirical); (2) Data Source (i.e. human subjects); and (3) Study Focus (i.e. climate change and education). Screening for the final criterion (i.e. Justice) occurred in Phase 2. In the CADIMA tool, response options for determining eligibility for each criterion were 'No' (i.e. does not meet requirement), 'Unclear', and 'Yes'. Each article's title and abstract were independently screened for eligibility by two research team members. When both eligibility decisions matched on all three criteria, the article was either removed from the database (i.e. contained 'No' for one or more criteria) or retained for Phase 2 review (i.e. contained some combination of 'Yes' and 'Unclear' for all criteria). When eligibility decisions diverged one on or more criteria, each inconsistency — flagged in the CADIMA system — was resolved through a consensus process whereby research team members met and discussed each inconsistency, reviewed each article title and abstract together, and reached agreement on a final screening decision. When

consensus meetings led to a clearer articulation of the eligibility criteria, this information was documented in a shared file for use by the full research team throughout the screening process. When uncertainty was present during title and abstract review, Phase 1 screening intentionally leaned toward inclusion and articles were retained for further analysis. As summarized in Figure 2, the team reviewed 309 article titles and abstracts. Of these, 203 were screened out due to not being empirical articles, not involving human participants, or not being focused on climate change and education. A few additional articles were removed from the database due to not being in English. This left 106 articles to be reviewed in Phase 2.

Phase 2 consisted of reviewing full-text articles. First, all 106 articles were located and uploaded into the CADIMA system. Next, two members of the research team screened each article according to the same eligibility criteria as Phase 1 (i.e. Article Type, Data Source, and Study Focus), plus the final criterion (i.e. Justice). Articles not mentioning 'justice' in the article's title, abstract, keywords, or main text were screened out. Response options for the four Phase 2 eligibility criteria were 'Yes' (i.e. fits eligibility criteria) or "No." As in Phase 1, all full-text articles were subjected to screening by two independent research team members who later resolved discrepant responses in meetings using a consensus process. Articles required "Yes" responses on all four eligibility criteria to be retained for further analysis. As depicted in Figure 2, of the 106 full-text articles reviewed, 18 were screened out due to not meeting one or more eligibility criteria. This left 88 articles to be included in further phases of review.

Coding system development and application

In Phase 3, the research team developed and piloted a coding system to capture article properties. Initial coding categories were drafted based on previous reviews as well as study characteristics of particular interest in the present review. All articles included in the present review were coded for a range of characteristics across five main categories aligning with this study's research questions: (1) Publication Trends and Article Properties (e.g. year of publication, author institutional affiliation, journal discipline); (2) Justice Dimensions (e.g. types of justice, centrality of justice); (3) Methodological Approaches and Participants (e.g. research design, age groups); (4) Education and Action Dimensions (e.g. educational setting, program type, action orientation); and (5) Factors Investigated (e.g. micro-level behavior change, macro-level policy change).

Five members of the research team collaborated on developing the initial coding system as well as fine-tuning questions and categories as the coding system evolved. Prior to piloting, the full coding system was programmed into REDCap, a secure web-based tool for managing surveys and databases (Harris et al. 2009). Unique records were created for each article, and the coding system — a mix of open-ended and multiple-choice items — was entered into a form to be completed by research team members. To pilot the coding system, two members of the research team (i.e. pairs of coders) were assigned to independently code 15% of articles ($n = 9$), then the full team convened to discuss coding decisions, raise questions, and make further revisions to improve the coding system. Once a complete coding system was established, in Phase 4, each article was independently coded by a member of the research team via REDCap. A second member of the research team reviewed coding decisions, questions, and comments entered for each article using the REDCap comment system. In addition to addressing coding uncertainties via REDCap software, the full research team met regularly over a 9-month period to review and refine the coding structure and process. Revisions to the coding system took place before and during Phase 4 coding, for example by integrating open-ended notes items throughout the coding system to provide context and clarification for coding decisions. During Phase 4 coding, additional articles were determined to not meet all inclusion criteria and were dropped from further analysis. These articles were independently reviewed by two members of the research team before making a final exclusion decision. In the present review, 33 articles were excluded during coding, leaving 55 articles as the final sample for this review.

Data analysis and visualization

After coding all 55 articles, Phase 5 consisted of analyzing the full sample to address research questions using both quantitative and qualitative analyses. During the project's final phase, the team met regularly to plan and coordinate analyses as well as to discuss data organization and visualization tools. To analyze close-ended items, the research team employed descriptive statistics (e.g. frequency counts; percentages) and a range of visualization techniques (e.g. tables, figures, maps). To analyze open-ended items, thematic analysis was employed and results are presented narratively below (Braun and Clarke 2006). To facilitate analysis, the comprehensive codebook and database were exported from REDCap. Quantitative analyses were conducted in Microsoft Excel, qualitative analyses were conducted using MAXQDA 2020 (VERBI Software 2021), and maps were generated using QGIS.

Because it was not possible to code every article for all coding categories, totals reported below do not always sum to the full sample. Further, because most multiple-choice items were 'select all' (not single answer), totals across response options often exceed 100%.

Results

Publication trends and article properties

In order to explore publication trends at the intersections of CCE and justice, each article was coded for year of publication, 2020 impact factor (i.e. CiteScore), and major and sub-disciplines associated with each journal. The number of journal articles reporting on CCE with a justice dimension has grown markedly in recent years (see Figure 3). Most articles in this review (87.3%) were published between 2015 and 2020, with nearly half (47.3%) published in 2019 and 2020. In addition to the increasing number of total publications per year, the average journal impact factor (i.e. CiteScore) has risen over time as well (see Figure 4). Based on the present review criteria, 2007 marks the beginning of considering "justice" in CCE (i.e. Bardsley and Bardsley 2007). In their 2007 article, Bardsley and Bardsley introduced a constructivist pedagogical approach, implemented in a post-secondary geography classroom, designed to guide students to think critically about the local ecosystem impacts of climate change on their coastal community in South Australia and discuss possible micro- (i.e. behavioral) to macro-level (i.e. societal) responses. In this paper, the authors recognized climate change as a topic that can be learned about in relation to "issues of social and ecological justice" (p. 332) by asking questions such as "Who or what will be affected and be the most vulnerable?" and "Who or what will not be able to manage?" (p. 338).
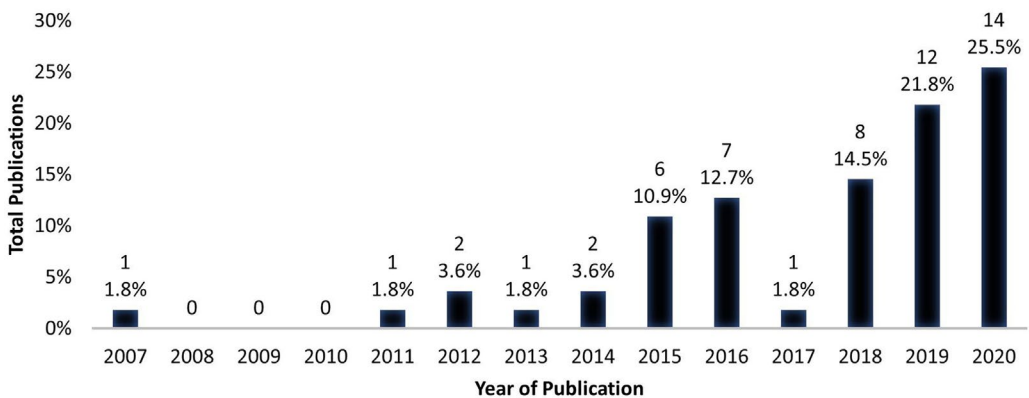

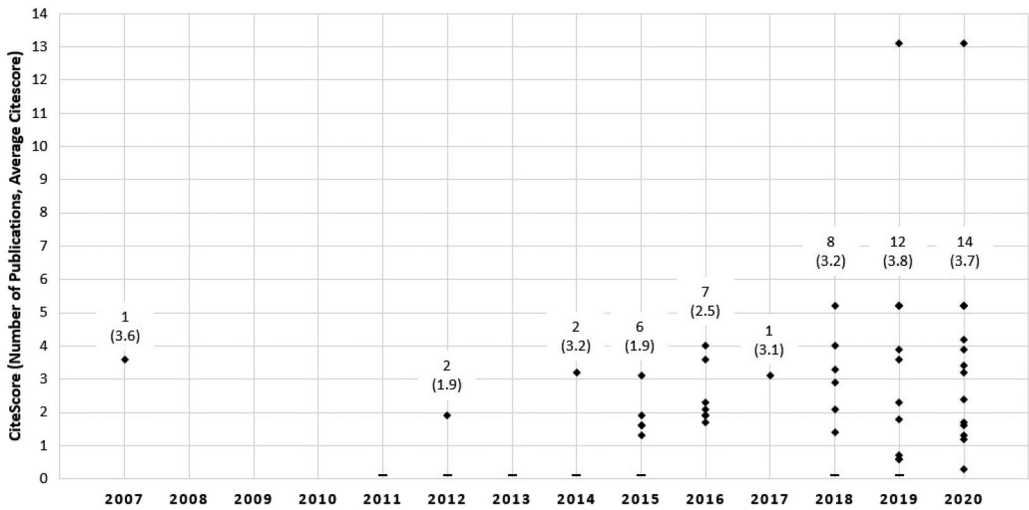**Figure 3.** Number of publications over time.

Figure 4. CiteScore over time.
Note. Diamonds represent articles published in journals with a CiteScore. Dashes indicate articles published in journals with no CiteScore.
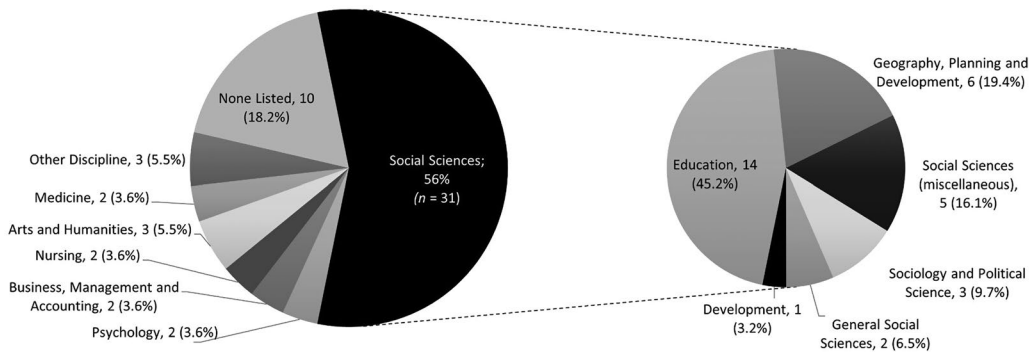

Figure 5. Publications by journal discipline category.

Articles published at the intersections of CCE and justice appeared in journals classified across a range of disciplines, the majority in the social sciences, with the most common sub-discipline being education (see Figure 5). Beyond those listed, other major disciplines included mathematics, engineering, and pedagogy in health promotion.

To capture the geographic context of publishing authors, each author's institutional affiliation was recorded (see Figure 6). By continent, the greatest proportions of author institutional affiliations were from North America, followed by Europe (see Table 1). It is worth noting that because this review is based on English language publications only, these findings do not represent all published, peer-reviewed studies of justice in CCE.

Finally, keywords listed for each article were documented in order to explore the possibility of common intersecting focus areas in research referencing justice in CCE contexts. Across articles, there were 180 total keywords, the top 30 of which appear in Figure 7. Figure 7 depicts all keywords listed for more than one article ($n = 30$). Climate change was listed across 15 articles (27.3%), climate justice was listed across 7 (12.7%), climate change education and education were each listed across 6 articles (10.9%), and environment, environmental justice, and youth were listed across 4 articles (7.3%). Keywords listed across 3 articles (5.5%) included: education for sustainable development, environmental education, risk, sustainability,
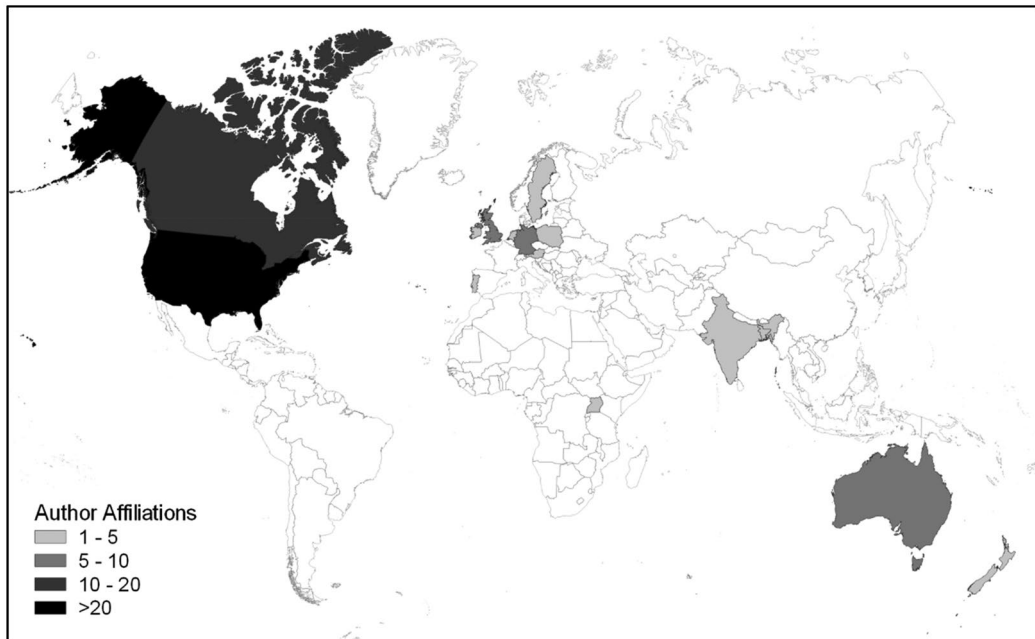
Figure 6. Map of author institutional affiliations.

Table 1. Geographic location of author institutional affiliations.

Continent/Country	Author Institution
Asia	**6 (6.0%)**
Bangladesh	2
India	3
South Korea	1
Africa	**5 (5.0%)**
South Africa	2
Uganda	3
Australia and Oceania	**7 (7.0%)**
Australia	6
New Zealand	1
Europe	**26 (26.0%)**
Austria	1
Germany	8
Ireland	3
Netherlands	1
Poland	2
Portugal	1
Sweden	3
United Kingdom	7
North America	**56 (56.0%)**
Canada	17
United States of America	39

transformative learning and youth engagement. The remaining keywords listed in Figure 7 appeared across two articles.

Justice dimensions

To classify and describe the range of justice framings applied across articles, each article was coded for the types of justice (e.g. social, environmental, racial) mentioned anywhere in the article's title, abstract, keywords, or main text. Coding captured whether or not common justice
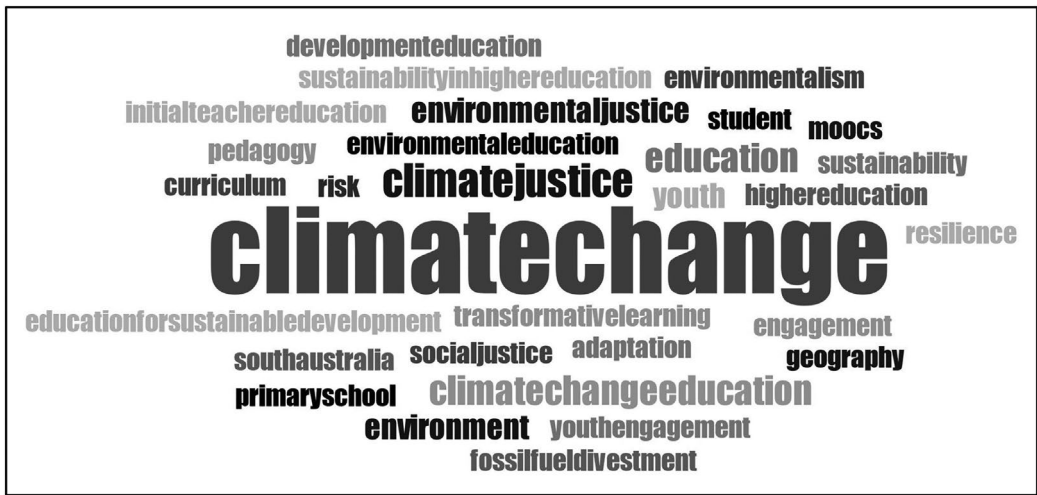
Figure 7. Word cloud of journal article keywords.
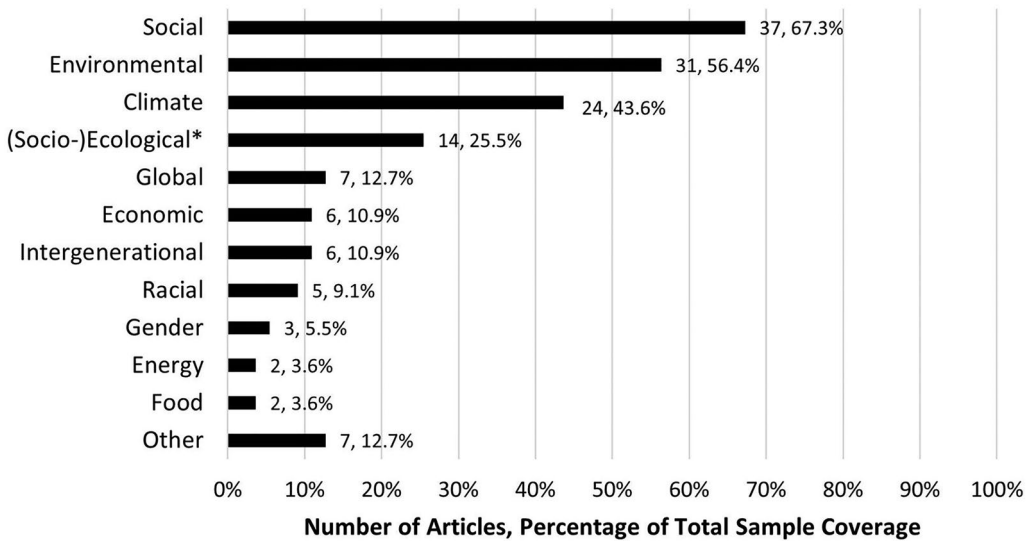
Figure 8. Prevalence of justice framings across articles.
Note. The (Socio-)Ecological category included eco-justice, eco-social, socio-ecological, socio-environmental, and earth justice framings.

framings were present in each article (see Figure 8). Beyond those listed, articles referenced 8 additional forms of justice, including epistemic, procedural, spatial, water, human, (climate-) health, and intragenerational justice. Most articles (81.5%) mentioned more than one type of justice ($M = 2.95$), with a few referencing six or seven (Chonody and Olds Sultzman 2022; Jimenez et al., 2020; Kissling and Bell 2020; Tayne et al. 2021).

Additionally, each article was coded according to whether and how many times justice was mentioned across 7 key article components: title, abstract, keywords, introduction, method, results, and discussion. Articles with alternative section headings were coded according to the overall purpose of each section as they correspond to traditional empirical section headers. Across articles, justice appeared in 21 article titles (38.2%), 42 abstracts (76.4%), and 16 keyword lists

Figure 9. Centrality of justice frameworks.

(34.0% of 47 articles listing keywords). Of 1405 total justice mentions, the greatest proportion ($n=456$; 32.5%) was located in articles' introduction sections—appearing across 49 articles (89.1%)—often as a statement of the problem, theoretical framework, or rationale for the study. Mentions of justice occurred with equal prevalence in articles' Results and Discussion sections ($n=41$ articles; 74.6%, respectively), though the raw number of justice mentions was far higher in Results sections ($n=450$; 32.0%) 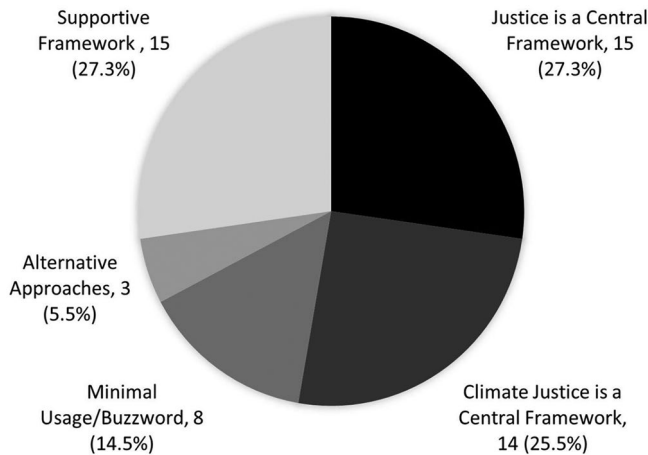compared to Discussion sections ($n=258$; 18.4%). Justice was mentioned least often in articles' Method sections ($n=25$ articles; 45.5%) and had the fewest mentions overall when comparing across main-text sections ($n=128$; 9.1%). Within articles, across 6 key article components (excluding keyword lists, which did not appear in all articles), the greatest proportion of articles mentioned justice across 4 ($n=13$ articles; 23.6%) or all 6 sections ($n=12$ articles; 21.8%), followed by similar proportions of articles mentioning justice across 5 sections ($n=10$ articles; 18.2%), 2 sections ($n=9$ articles; 16.4%), or 3 sections ($n=8$ articles; 14.5%). The smallest proportion of articles mentioned justice in only 1 section ($n=3$ articles; 5.5%).

Of course, mentioning justice is not a straightforward indicator of how substantively each article engaged with justice frameworks. In order to capture the centrality of justice across articles, each article was categorized into one of four categories, drawing on the framework developed by Aboytes and Barth (2020) in their systematic review examining how transformative learning frameworks were employed across a range of sustainability education contexts. In the present review, articles were placed into categories ranging from low to high centrality, indicating the extent to which justice frameworks were integrated within the study's purpose, processes, outcomes, or implications (see Figure 9). Most articles in this review ($n=29$; 52.7%) treated justice as a Central Framework, meaning that justice was a leading focus or rationale in the article. In these articles, advancing social, environmental, and other forms of justice were not passively mentioned; they were a main driver of the research or education, sometimes with an action component embedded to advance justice. More than a quarter of articles ($n=15$; 27.3%) employed justice as a Supportive Framework, meaning that they explicitly referenced justice frameworks in their research, but fell short of centering justice in their article's main arguments or processes. These articles often referred to some key elements of justice in relation to their research, but more actively engaged with other central theories and frameworks. The smallest proportion of articles ($n=3$; 5.5%) applied justice as an Alternative Approach, meaning that embedding justice was seen as a way to move beyond science-centric approaches to CCE. In this subset of articles, traditional approaches to CCE were framed as less transformative, which served to emphasize the more radical and critical features of justice-driven CCE. Finally,

approximately one in seven articles (*n* = 8; 14.5%) were categorized into the Minimal Usage/Buzzword category, indicating the lowest level of centrality. These articles used justice terminology sparsely and imprecisely, usually by applying it superficially without engaging with the meaning of terms used. Further, these articles did not directly reference justice-focused theory or research. It is worth noting that, although all articles spoke to the justice dimensions of their focus area to some extent, it was most commonly employed as a framing device (e.g. problem-framing; theoretical framework) and less clearly as an explicit content focus of the educational activities. As mentioned, only some studies included in this review examined educational interventions, and of those that did, it was sometimes difficult to extract details of the interventions. Key exceptions are highlighted across the below sections.

Nearly half (48.3%) of the articles with justice as a Central Framework employed climate justice as a central framework. Of the 24 articles mentioning climate justice, most (62.5%) did not provide a definition of the term and more than a third (37.5%) provided no theoretical background on climate justice. The small subset of articles (*n* = 9) providing a definition were most likely to mention that climate justice is a matter of recognizing and addressing the disproportionality between climate change responsibility and harm, whereby those most responsible for climate change are also most insulated from its consequences (i.e. the world's wealthiest people and countries), and those least responsible for climate change are facing its consequences first and worst (i.e. the world's poorest people and countries) (e.g. Stapleton 2019; Waldron et al. 2019). Moreover, some articles recognized climate justice as rooted in social and environmental justice frameworks (e.g. Grady-Benson and Sarathy 2016), with aims of advancing equity, equal rights, and human rights (e.g. Montoute, Mohammed, and Francis 2019; Shaw 2016). Fewer articles referenced ethical and legal frameworks highlighting the procedural (i.e. decision-making) and distributive (i.e. resource allocation) dimensions of climate justice, which emphasize the importance of amplifying the voices of disproportionately-affected groups and redressing discriminatory policies and systems in order to direct resources where they are most needed (e.g. Harvey 2011; Sandhaus et al. 2018). Finally, in defining climate justice, several articles noted that its ultimate aims are to address the root causes of climate change and its multi-faceted injustices (Tagg and Jafry 2018), which are embedded within global systems and structures, including capitalism, racism, globalization, settler-colonialism, and other systems of exploitation and extraction (Montoute, Mohammed, and Francis 2019; Tayne et al., 2020).

Articles in this review embodied climate justice values and principles, for example by partnering with marginalized groups and frontline communities who are bearing brunt of climate disruption (e.g. Meyer et al. 2018; Sandhaus et al. 2018), building mutual understanding and international solidarities between global North and South (e.g. Stapleton 2019; Tagg and Jafry 2018), and facilitating collective action focused on the systemic causes of climate disruption (e.g. Reimer et al., 2016). An important example of justice-infused education is Dittmer and Riemer's (2013) evaluation of a youth-focused workshop series that took place in Canada's Waterloo region. Because youth participants (ages 17–19) were members of privileged groups, the workshop explored examples of environmental injustice intended to prompt critical reflection and discussion "to help the youth understand the different actors and forces that sustain environmental injustice, and to begin to explore the role they could play in building a more just system" (p. 5). Workshops involved a combination of reflection, discussion, video stories, slideshows, interactive activities, and action planning. Evaluation findings indicated that, following the workshops, youth were thinking more critically and empathically about environmental injustice(s), while expressing attitudes, motivations, and action plans rooted in their newly-gained environmental justice concerns.

Methodological approaches and participants

To document methodological trends in this literature, each article was coded for its main overarching methodological approach (i.e. quantitative, qualitative, or mixed methods), as well as
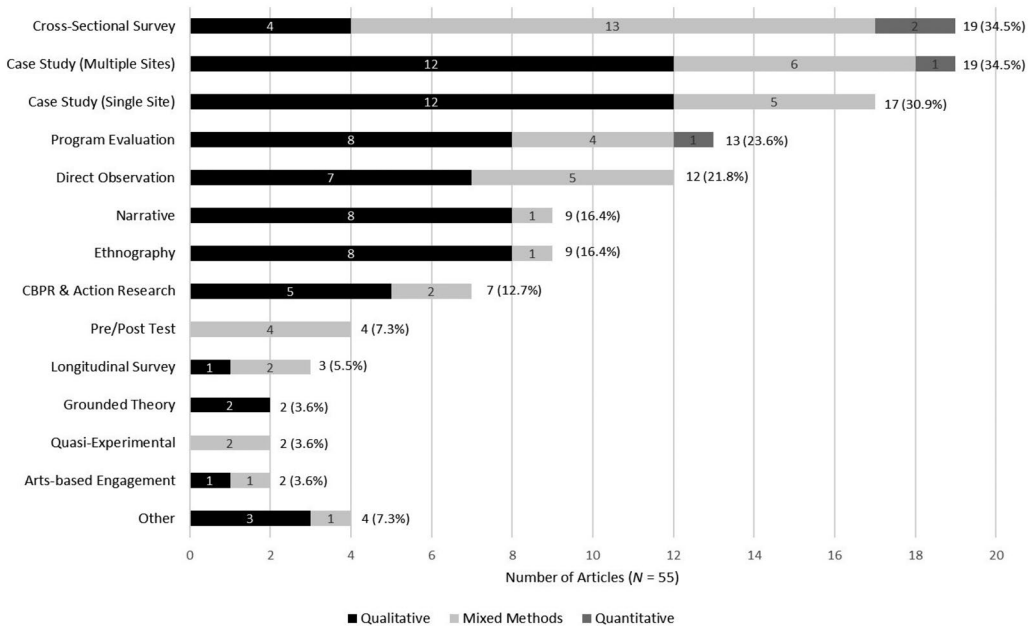
Figure 10. Research design by major methodology.

for the specific types of data collected (e.g. questionnaires; focus groups) and research designs used (e.g. case study; cross-sectional survey; ethnography). In terms of major methodology, most articles in this review were qualitative (65.5%), followed by mixed methods (30.9%), and a small portion of purely quantitative studies (3.6%). As summarized in Figure 10, studies employed a range of research designs and most (65.5%) combined more than one approach. Nearly two-thirds of articles (65.5%) used either a single- or multiple-site case study design, and more than one-third of articles (34.5%) employed cross-sectional surveys. Beyond survey data collection, the most common form of data collection, employed in 40% of articles, was interviews — most often conducted with students and educators (see Figure 11). Archival data and artifacts were also a prevalent data source, appearing in 30.9% of articles, and these often included student work samples, assignments, teacher lesson plans, and web content (e.g. Leonard et al. 2016). While nearly half of articles (43.6%) collected only one type of data, most articles described two (23.6%), three (21.8%), or four or more (10.8%) data sources. A prevalent combination was administering surveys along with interviews, observed in 14.5% of articles (e.g. Otto et al. 2018), or combining surveys with archival data sources (e.g. Krasna et al. 2020), observed in 9.1% of articles. Several articles combined a range of qualitative data sources, such as James (2019) who centered concepts of social, environmental, and water justice in conducting 12 arts-based inquiry workshops with youth in Cape Town, South Africa to explore their local community's climate-driven water crisis and whose empirical data sources included video footage, transcripts, and researcher reflections.

Each article was also coded for the nature of data collected, specifically whether studies represented basic research (i.e. advancing knowledge by addressing key questions) or applied research (i.e. addressing problems by testing solutions). Most studies in this review (72.7%) were applied research, often examining educational programming or interventions (e.g. curricula; community outreach) (e.g. Djonko-Moore et al. 2018; Dür and Keller 2018). These studies were sometimes characterized by scholars' closer proximity to the data, for example drawing on personal experience and reflections (e.g. Gaylie 2014; Mallon, 2015), auto-ethnography (e.g. Bratman et al. 2016), participant observation (e.g. Grady-Benson and Sarathy 2016), and participatory methods (e.g. Meyer et al. 2018). The remaining studies (27.3%) used a variety of methods
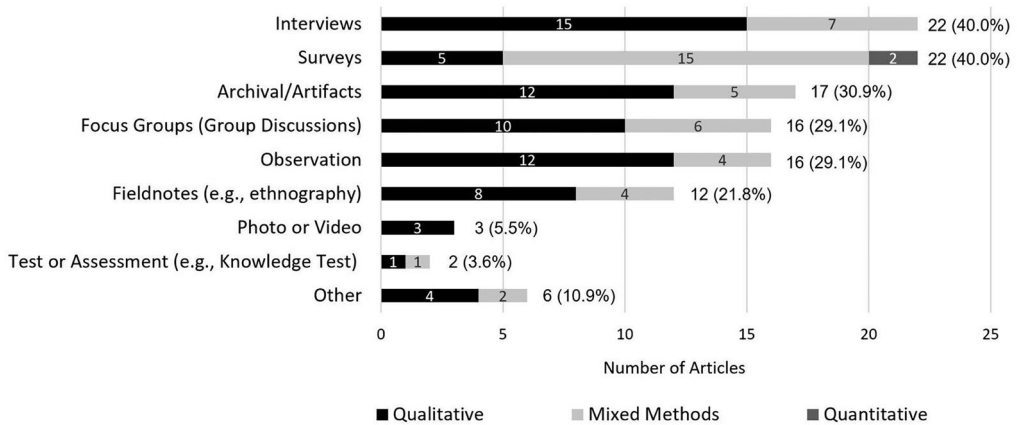
Figure 11. Data type by major methodology.

to examine questions of interest at the intersections of justice and CCE, for example through surveying job market trends regarding climate-related careers (Krasna et al. 2020), examining public awareness campaigns (e.g. Maina, Murray, and McKenzie 2020; Montoute, Mohammed, and Francis 2019), and more generally, investigating research questions from specific populations and stakeholder groups about their experiences and insights (e.g. Bardsley 2017; Byrne et al. 2014; Chonody and Olds Sultzman 2022; Chonody, Sultzman, and Hippie 2020; Hanley and Jakubec 2019; Grosse 2019). Several of these studies were characterized by less direct interaction between researchers and participants and often included data collection with general populations (i.e. unknown others) as well as over greater distances (e.g. multi-country studies) (e.g. Otto et al. 2019).

Due to clear differences between author location (see Table 1) and participants' location, each article was coded for where research activities and data collection took place (see Figure 12). Whereas authors' institutional affiliations were concentrated in 17 countries, mostly in the global North, research participants were in 57 countries, representing all major populated regions of the world (see Table 2). Similar to author location however, the majority of data collection took place in Europe and North America, which together accounted for 51.3% of data collection countries across articles. Given that this review was limited to articles published in English, the geographic spread of participants is notable.

To explore who the participants were in each study, articles were reviewed for sample characteristics and coded for participants' age groups as well as the various roles of participants, as described within articles (e.g. students, educators, community members). Across studies, most participants were adults (ages 18 and older), appearing in 61.8% of articles, and college students (41.8%), followed by adolescents, high school, and upper secondary students (ages 13 to 17; 21.8%), youth under 18 (age unspecified; 18.2%), and children (ages 12 and under; 12.7%). Age groups were unclear in 10.9% of articles. It is worth noting that these age groupings were variously overlapping and, due to age cut-offs aligning with the U.S.-based educational system, studies often spanned multiple categories—such as Timon, Kaunda, and Hewitt (2019) who conducted interviews and focus groups with students, educators, pastors, community leaders and congregation members. As in the work of Timon and colleagues, studies in the present review engaged a range of participant groups, the most prevalent being students—appearing in nearly three-quarters of articles (74.5%)—followed by educators (58.2%), professionals (e.g. nurses, social workers; 21.8%), community residents (12.7%), activists (10.9%), and other groups (12.7%), such as non-governmental and civil society organizations (e.g. Pavel 2015) as well as youth engaged in a community-based environmental organization (Dittmer and Riemer 2012).
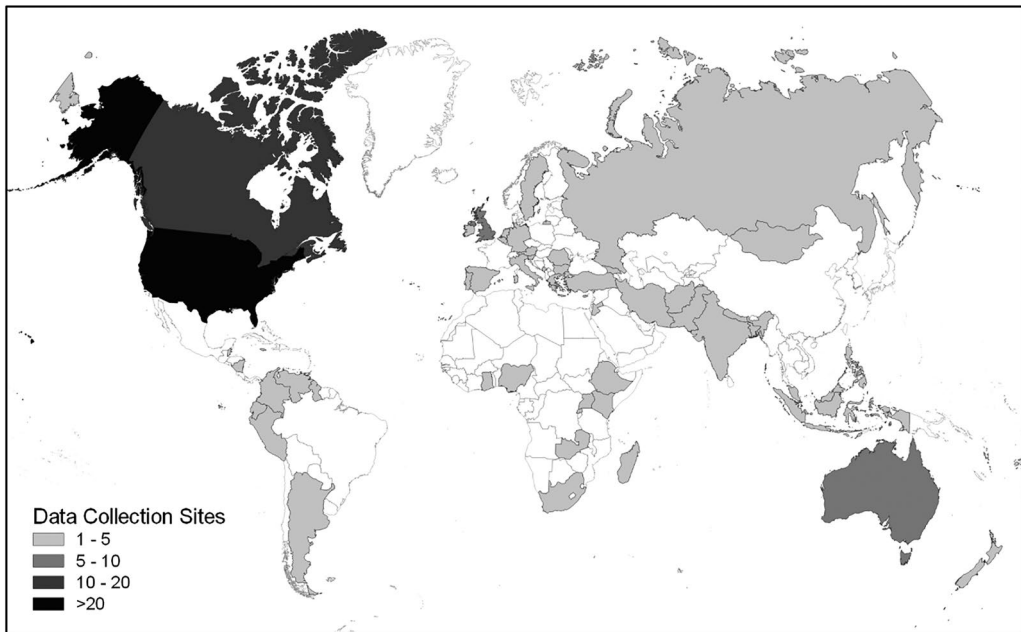
Figure 12. Geographic location of educational programming and data collection across studies.

Table 2. Data collection countries across articles.

Continent/Country	Total Articles
Asia	**7 (7.8%)**
Bangladesh	3
India	3
Singapore	1
Africa	**5 (5.6%)**
Ghana	2
South Africa	1
Uganda	2
Australia and Oceania	**9 (10.0%)**
Australia	6
Kiribati	1
New Zealand	2
Europe	**19 (21.1%)**
Austria	1
Germany	3
Ireland	3
Portugal	1
Sweden	4
Turkey	1
United Kingdom	6
North America	**49 (54.4%)**
Canada	11
United States of America	38
South America	**1 (1.1%)**
Trinidad and Tobago	1

All articles in this review (100%) involved either educators (25.4%), students (41.8%), or both (32.7%), though groups were often observed in combination with other categories. The majority of studies (56.4%) engaged with participants across two or more role categories (up to 5). Of those studies engaging a single role category (43.6%), participants were either solely educators ($n = 6$) or solely students ($n = 18$).

Table 3. Characteristics of education.

Characteristic	Articles	Percentage
Educational Context		
Formal (Classroom)	33	60.0%
Non-formal (Workshops, Camp)	16	29.1%
Activism/Public Outreach	7	12.7%
Informal (Museum, Zoo)	5	9.1%
Extracurricular (After School)	1	1.8%
Unclear	7	12.7%
Length of Engagement		
1–4 days	3	5.5%
1 week	5	9.1%
1–2 months	7	12.7%
3–5 months	6	10.9%
1 School Year (9–10 months)	3	5.5%
2–3 years	5	9.1%
University Degree Program	4	7.3%
Not Specified	10	18.2%
Not Applicable	12	21.8%
Educational Level (Primary)		
Elementary/Primary School	5	9.1%
Middle School	3	5.5%
High School	15	27.3%
College/University	26	47.3%
Youth Non-formal (Ages 12–17)	2	3.6%
Adult Non-formal (Ages 18+) / Public	12	21.8%
University Educators	2	3.6%
K-12 Teachers	6	10.9%
Educational Level (Secondary)		
Elementary/Primary School	3	5.5%
Middle School	5	9.1%
High School	4	7.3%
College	8	14.5%
Adult Non-formal (Ages 18+) / Public	7	12.7%
K-20 Educators	4	7.3%

Education and action dimensions

To summarize the educational activities within each article, including the educational goals and action-oriented properties of studies, each article was coded for the type of program or intervention (e.g. formal classroom, non-formal community workshops) as well as its length, associated discipline(s), and learners' educational level (e.g. primary school, college), which sometimes spanned "primary" and "secondary" learner dimensions, for example studies with pre-service teachers (i.e. college students: primary) developing plans for K-12 classroom instruction (secondary). For example, Liston and Devitt (2020) explored the role teachers can play in facilitating climate action through a qualitative study of student teachers' climate change attitudes following a social and global justice-infused development education module. Table 3 summarizes educational characteristics across studies. Articles exploring teachers' attitudes without direct reference to educational planning or programming (e.g. Bardsley 2017) are classified as "K-12 Teachers" under Educational Level (Primary).

Thematic analysis was used to explore findings related to associated discipline(s), an open-ended item capturing the field or class subject most closely associated with formal classroom learning at the intersections of CCE and justice. Findings, grouped into four categories, spanned a wide range of disciplines across multiple education levels. Specifically, justice-driven CCE research took place in the context of: (1) traditional school subjects, mostly in K-12 settings; (2) CCE as its own subject, mostly in university settings; (3) health fields (e.g. social work, nursing), especially focused on higher education; and (4) pre-service teacher training. Several articles took place beyond formal education contexts (e.g. community programs; activist settings) and were often not associated with a specific field or subject. Below, notable examples are provided

across each context category, with particular emphasis (where possible) on how justice figured into the educational approaches and outcomes.

First, several articles—mostly taking place in K-12 contexts—approached CCE from the lens of traditional fields such as geography, social studies, history, science, and math (e.g. calculus), with greater prevalence of social sciences and humanities over STEM. For example, Chandler and Marri (2012) interviewed social studies teachers to explore how they incorporated ecojustice pedagogies into their work using the "Teaching the Levees" curriculum guide, focused on the devastation and injustices wrought by Hurricane Katrina. Findings document teachers' efforts to explore the root causes of climate injustice and systemic actions to advance justice, including through social movement participation. In another study with seven teachers across grade levels and disciplines (e.g. science, social studies), Morrison (2018) conducted interviews to explore how regular conversations around ecojustice education affected teachers and their practices. Ecojustice education focuses on the cultural roots of ecological and social injustice and empha- sizes community action. Findings of Morrison's study emphasize the emotional and psychological dimensions of "reframing Westernized culture" (p. 111), and the slow process of internalizing perspective shifts before practical applications are possible. In a notable STEM example, Nicol et al. (2019) analyzed teacher dialogue and student interviews surrounding the creation of mathematics problems that integrate STEM with social justice, including climate change (i.e. air quality, crude oil pipelines). Findings of this study highlight the complexity of transcending single disciplines, the risks and discomfort of teaching justice-infused topics, and the importance of overcoming such barriers to offer learning opportunities "through which students can inter- pret and transform the world" (p. 1005).

A noteworthy finding of this review was that few studies in formal K-12 settings reported on how justice-focused CCE impacted students. Rather, most such studies took place in informal settings (e.g. Dittmer & Reimer, 2012; Dittmer et al. 2018; James 2019; Sayal et al. 2016; Stapleton 2019). An important exception is Tagg and Jafry (2018) 18-month "Water for ALL" study with 10-year-olds in Glasgow, Scotland where students learned about disparities in clean water access where they live compared to the challenges faced by children in Malawi and Zambia. During class sessions, students made personal connections to water usage in their everyday lives, explored water access in partner countries, and learned about climate (in)justice through games, quizzes, and action pledges. The project culminated in a showcase for parents and guests where children presented their work through a 'climate justice tree' featuring students' pledges as well as a 'climate just' wall of raindrops featuring children's understanding of climate change, climate justice, and their visions of a climate-just world. Tagg and Jafry's work emphasizes the complexity of translating climate justice research for practical classroom use and concludes that it is not only possible to connect children to this challenging topic, but also that students gained a sense of ownership over the issue by exploring their role in addressing climate injustice.

A second group of articles focused on climate change as its own discipline—mostly in uni- versity settings. For example, Otto et al. (2019) evaluated the impact of two MOOCs (Massive Open Online Courses) focused on climate justice, with specific aims to "empower [learners] to engage critically in climate change and climate justice debates and to be critical observers of the climate conference in Paris (2015)" (p. 13). Findings from learning assessment questionnaires indicated that among the highest observed gains was students' ability to explain how climate change and social justice are interlinked—a message that was incorporated into nearly all lectures and course resource materials. Another study, conducted by Howell and Allen (2019), surveyed 85 people involved with CCE to explore formative influences and significant life expe- riences that shaped their motivation to become involved with CCE and action. Results indicated that justice concerns focused on humans (e.g. pertaining to future generations; vulnerable groups) were more motivating than biospheric concerns focused on nature (e.g. pertaining to wildlife; landscapes)—highlighting the potential of 'justice' in CCE as a key driver of engagement for educators as well as students.

A third subset of articles focused on higher education programs training future practitioners in the fields of social work, nursing, and public health. For example, Nesmith and Smyth (2015) surveyed 373 social work professionals and found that environmental justice was a "significant practice issue" (p. 484), which they felt unprepared to address due to limited education on environmental justice topics. The clients of most respondents (71%) were facing climate-linked environmental injustices ranging from extreme weather and disasters to exposure to air pollution and fracking. In recommending approaches to integrating environmental justice into social work education, respondents commonly advocated linking it to systems theory and emphasizing the relevance of environmental justice to all people. In an empirical example of justice-infused CCE for social work students, Boetto and Bell (2015) qualitatively analyzed students' online discussion posts in response to a six-week online workshop series focused on environmental sustainability and its intersections with social justice and human rights. After demonstrating that students' awareness of climate justice (i.e. "the impact of climate change on vulnerable groups") deepened through their workshop participation, authors called for more widespread justice-infused CCE across the social work curriculum.

Fourth, several articles took place with future teachers, and focused most closely on primary teacher education, early childhood education, and development education. For example, Alvey (2020) explored how pre-service social studies teachers experienced hope, agency, and deferral in making sense of the magnitude, urgency, and injustices of climate change as well as how they envisioned CCE as part of their future work. Relatedly, Mallon (2015) reflected on the pedagogical challenges and possibilities in working with future teachers to develop CCE plans through the lens of development education (DE)—concluding that DE is a "critical space for the consideration of the socio-political dimensions of climate change, through a social and global justice approach" (p. 143).

The educational activities described in several articles took place outside the formal classroom, most notably through community workshops and (summer) camps, adult education, and in activist contexts. For example, Leonard et al. (2016) conducted a two-year informal science education program with 8–12-year-old students of color that focused on paleontology and climate change, with specific elements focused on eco-justice. Findings indicated that the program supported underrepresented students' science content knowledge and interest, which the authors note, contributes to a broader social justice agenda in science education. Some articles spanned categories and were a mix of community-based and formal education, such as Meyer et al. (2018) whose participatory project to build flood resilience in an under-resourced neighborhood in Houston, Texas involved a professor, five graduate students, 25 high school students, two teachers, and a parent who collaborated on a range of activities, including administering household surveys to understand and address health issues in the neighborhood. A main goal of this project was to "align research goals with the community's vision of environmental justice" (p. 4), and outcomes included a range of community-centered resources (e.g. smartphone application, neighborhood maps, water containment report, neighborhood green infrastructure plans) as well as residents' resilience-focused knowledge gains. Finally, several articles explored the educative dimensions of activism for climate justice, such as Grosse (2019) who engaged in participant observation and interviewed 29 young climate justice activists to explore how they build alternative justice-centered culture(s) as a response to climate change. Findings emphasize how activists learn from one another (e.g. about privilege, intersectionality, feminism, organizing, inequality, inclusivity, embracing difference), while also engaging in a process of "radical unlearning" as they strive to embody and advance climate justice through their interactions and movement-building.

Given the diversity of educational settings and approaches at the intersections of climate change and justice, additional analyses investigated how learning was conceptualized in each study. To do so, each article was coded according to the framework developed by Kluttz and Walter (2018), which classifies learning into micro, meso, and/or macro levels; whether learning is organized and/or unorganized; and whether the learning process is

Table 4. Conceptualizing learning across studies.

Characteristic	# Articles	Percentage
Learning Level		
Micro	47	85.5%
Meso	37	67.3%
Macro	27	49.1%
Learning Type		
Organized	45	81.8%
Unorganized	25	45.5%
Learning Process		
Individual	45	81.8%
Collective	29	52.7%
Collaborative	28	50.9%
Learning Focus		
Power	27	49.1%
People	36	65.5%
Place	25	45.5%
Planet	22	40.0%
Temporal Orientation		
Future	14	25.5%
Present	24	43.6%

individual, collective, and/or collaborative in nature (see Table 4). The micro-level, observed in most articles, involves individual or interactive learning through which individual learners gain knowledge, skills, or understanding. At the meso-level, learning is a process of reframing or reorientation, whereby learners engage with their own and others' perspectives and experiences, which can result in a shifted worldview. These forms of critical reflection and/or perspective transformation were observed in more than two-thirds of articles. Finally, macro-level learning, observed in nearly half of articles, is concerned with power structures and differentials (e.g. between classes and groups), which can result in collective conscientization (i.e. understanding how hegemonic structures shape lives) that forms the basis for action. Learning often occurred across levels, as these categories are variously overlapping and mutually constitutive. Most articles (70.9%) combined more than one learning level ($M = 2.02$), and micro-level learning was most commonly seen in isolation. Learning was also conceptualized as organized versus unorganized, whereby organized learning involves classroom instruction, workshop facilitation, and other structured learning environments, and unorganized involves less formal learning, for example through interaction, observation, self-directed inquiry, or other unstructured forms of knowledge acquisition. While most articles described organized learning, this was often seen in combination with less organized approaches. Of 25 articles with unorganized learning, 19 (76.0%) were combined with organized approaches. Finally, learning was conceptualized as individual (i.e. personal), collective (i.e. group-level, many at once), or collaborative (i.e. working together). Nearly two-thirds of articles (65.5%) combined more than one learning process ($M = 1.85$), and more than a quarter (25.5%) combined all three.

To describe the educational goals across articles, each article was coded for whether the educational process was conceptualized as advancing equity (i.e. Power), thriving communities (i.e. People), environmental protection (i.e. Planet), and/or local (built environment) improvements (i.e. Place). Articles at the intersections of justice and CCE most often (56.4%) encompassed more than one educational goal ($M = 2.00$), with the most prominent focal areas being People and Power (over Planet and Place). The subset of studies describing educational programming for youth (K-20) were coded for the primary temporal focus of educational activities, specifically whether educational activities were framed as primarily relevant to youths' future (e.g. literacy, preparation for adult citizenship) or present-day lives (e.g. promoting agency and participation today).

One in five articles ($n = 11$) had a clear action orientation embedded in or associated with the educational activities described. These articles were coded for a range of properties,

Table 5. Characteristics of action across articles.

Characteristic	Articles	%
Scale of Action		
Individual or Lifestyle	2	3.6%
Family or Household	1	1.8%
Classroom or Peer Group	2	3.6%
Neighborhood or Community (e.g. Workplace, Church)	8	14.5%
City or Municipality	3	5.5%
State or Region	2	3.6%
National	4	7.3%
Global/International/Transnational	3	5.5%
Action Context		
Private Sphere (e.g. lifestyle, household)	5	9.1%
Public Sphere (e.g. activism, community projects)	8	10.9%
Action Mode		
Radical	4	7.3%
Reform	8	14.5%
Change Process		
Transformative	1	1.8%
Ameliorative	9	16.4%
Action Target		
Carbon Emissions Reductions (e.g. carbon footprint)	4	7.3%
Interpersonal Influence (e.g. family, peers, community)	8	14.5%
Policy Engagement (e.g. advocacy)	2	3.6%
University Administration (e.g. divestment, degree programs)	5	9.1%
Public Opinion (e.g. broader socio-cultural change)	5	9.1%
Action Outcome		
Mitigation	7	12.7%
Adaptation	4	7.3%

including: geographic scale of action (e.g. individual/lifestyle, classroom, neighborhood), action context (e.g. private vs. public sphere), and whether the actions were radical (i.e. operating beyond formal systems) versus reform-oriented (i.e. seeking to change existing systems) or ameliorative (i.e. minimizing harms within existing systems) versus transformative in nature (i.e. fundamentally changing systems). Each article was further coded for action target (e.g. direct carbon emissions reductions, public opinion) and the outcomes or goals of the action (e.g. adaptation, mitigation). Results are summarized in Table 5. Due to the nested and overlapping nature of some characteristics as well as the range of activities described, articles were often coded for multiple sub-categories within properties. A notable finding here is that most actions were taking place in the public sphere at the community or neighborhood level, focused on changing systems to prevent future climate-driven harms. Most actions involved communicating with others (e.g. family, peers, university administrators, general public) and focused more on mitigation (i.e. reducing carbon emissions) than adaptation (i.e. minimizing inevitable climate-fueled harms). A notable example is Reimer and colleagues' (2016) study of the *Youth Leading Environmental Change* program, an 11-unit workshop series implemented with university students across six countries (i.e. Bangladesh, Canada, Germany, India, Uganda, and the United States), which focused on social, environmental, and climate justice and aimed to facilitate youths' collective, civically-engaged, and systems-focused action. Findings of their longitudinal mixed-methods investigation support the notion that "an environmental justice framework can be a powerful way to simultaneously create motivation for action that is fueled by compassion and empathy rather than self-interest, and to promote systems thinking that helps youth comprehend the complexity of global climate change and sustainability" (p. 184; see also Sayal et al. 2016).

Factors investigated

A final set of coding categories sought to classify and describe what was measured or documented in each article at ecological levels ranging from micro- to macro-level factors. Compared
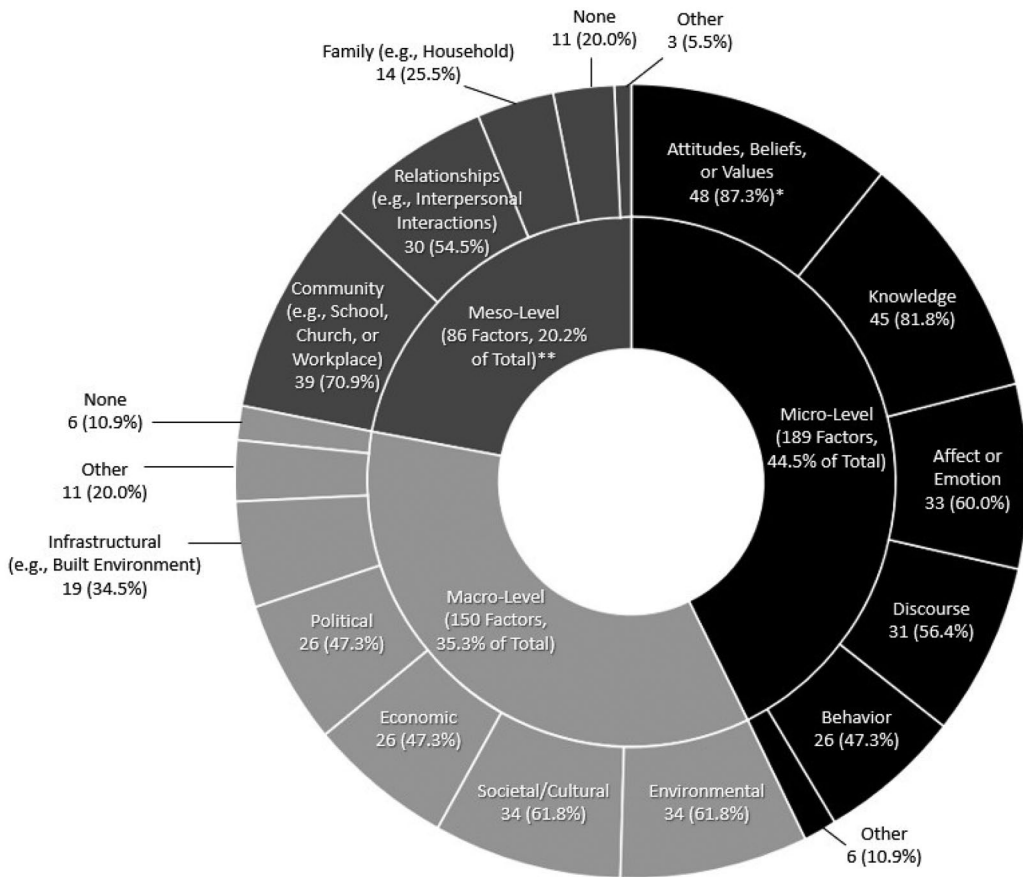
Figure 13. Factors investigated across ecological levels.
Note. * = Number of Articles (% of Total Articles; Sample Coverage); ** = Number of Factors Investigated at this Scale Across Articles (% of Total Factors Investigated; Relative Proportions Across Sample).

to the learning processes described earlier, the ways in which micro-, meso-, and macro-levels were operationalized here aligns more with traditional ecological systems theory (e.g. Bronfenbrenner, 1977), whereby individuals are understood as existing within as well as shaping (and being shaped by) a variety of factors at nested levels. In this review, micro-level factors were conceptualized as properties of individuals, meso-level factors were group-level factors and parts of society (e.g. families, communities), and macro-level factors were considered to be properties of society as a whole. Specifically, studies examining micro-level factors examined individuals' knowledge, attitudes, emotions, values, and behaviors. Meso-level factors encompassed interpersonal interactions (e.g. relationships), family and household dimensions, and community- or organizational-level processes (e.g. in school, workplace, church). Finally, studies examining macro-level factors focused on societal/cultural, policy, economic, infrastructural, and/or environmental change processes (see Figure 13). Factors investigated across levels could be antecedents of, actual or aspirational outcomes of, or processes associated with education at the intersections of justice and climate change.

Factors investigated were spread across ecological levels, with most at the micro-level of analysis. All articles (100%) explored at least one micro-level factor, with all but two articles (96.4%) examining two or more (up to six) factors at the micro-level ($M = 3.4$). The majority of articles (80%) examined at least one meso-level factor, with a more or less even distribution of articles examining one (29.1%), two (25.5%), and three meso-level factors (25.5%, $M = 1.8$).

Similarly, the majority of articles (89.1%) explored at least one macro-level factor, with most (72.7%) exploring two or more (up to six) macro-level factors ($M = 2.7$). Most articles (80%) explored CCE-relevant factors across the full range of ecological levels, with just one in five articles exploring factors on either one (10.9%) or two (9.1%) levels. Summing across ecological levels, articles explored two to 13 factors ($M = 8.0$).

To give these factors a sense of concreteness, studies across contexts are described below—first in terms of where and with whom studies took place as well as in terms of general to specific factors investigated. First, several articles explored how students and (pre-service) teachers make sense of climate change on cognitive and affective levels as well as what this means for teaching and learning as well as taking justice-driven action to address the climate crisis (e.g. Alvey 2020; Armstrong and Krasny 2020; Bardsley 2017; Gaylie 2014; Jimenez, Moorhead, and Wilensky 2021; Torbjörnsson and Molin 2015; Waldron et al. 2019). A related set of articles focused on psychosocial antecedents (e.g. motivations, justice-oriented values) and outcomes (e.g. systems thinking, action competence) of engagement with climate change education and mitigation (e.g. Howell and Allen 2019; Sayal et al. 2016). In these articles, a cross-cutting theme was examining the various ways individuals conceptualize and engage with uncertain futures, and the role of hope, agency, conflicting perspectives, and discomfort in shaping dialogue and action (e.g. Birch 2020; Byrne et al. 2014; Lockley and Jarrath 2013; Morrison 2018). Several articles in this vein assessed outcomes or reflected upon educational programs and curricula incorporating a justice framework to critically examine climate change problems and imagine solutions with students (e.g. Chandler and Marri 2012; Karaali and Khadjavi 2019; Otto et al. 2018; Otto et al. 2019), future teachers (e.g. Liston and Devitt 2020; Mallon, 2015), and teachers (e.g. Nicol et al. 2019). Several studies in this domain focused on institutional policies and barriers as well as corporate interests and obfuscation that must be addressed in order to facilitate instruction that allows teachers and students to challenge the status quo and advance climate justice (e.g. Clark, Sandoval, and Kawasaki 2020; Eaton and Day 2020; Kissling and Bell 2020).

Additionally, several articles explored what climate-focused and justice-oriented pedagogies, practices, and higher education programs would look like across a range of human-centric fields, such as social work (e.g. Chonody, Sultzman, and Hippie 2020), nursing (e.g. Hanley and Jakubec 2019), and public health (e.g. Castleden, Lin, and Darrach 2020). Often, this subset of articles understood their respective disciplines as already anchored in justice—and understanding how people's identities, experiences, and environments are shaped by power and oppression—and envisioned greater engagement with the realities of climate change to benefit students and the profession, while responding to the needs of society (e.g. Beltrán, Hacker, and Begun 2016; Chonody and Olds Sultzman 2022; Krasna et al. 2020; Nesmith and Smyth 2015). A subset of these articles assessed educational programming aimed at addressing the need for greater attention to climate change and environmental justice in these settings (e.g. Boetto and Bell 2015; Crawford et al. 2015), and noted a range of institutional-level barriers impeding curricular transformation at the level required (e.g. Hanley and Jakubec 2019). A notable example in this domain is the study by Neal-Boylan, Breakey, and Nicholas (2019) who document the formation of the first nurse-led Center for Climate Change, Climate Justice and Health, whose justice-driven mission and core values are dedicated in part to "integrating climate change topics into nursing curricula at all levels" (p. 364).

Beyond formal education settings, several articles focused on community-based programs (e.g. arts-based workshops, garden and outdoor learning, summer camps) and international educational efforts (e.g. multi-country programs) designed for age groups corresponding with elementary/primary school (e.g. Djonko-Moore et al. 2018; Leonard et al. 2016), middle and high school/secondary (e.g. Dür and Keller 2018; James 2019; Tayne et al., 2020), and university education (e.g. Gaylie 2014). Most studies in this domain were evaluative in nature, exploring the processes and impacts of community-engaged efforts to shift participants' thinking and

action at the intersections of climate change and justice (e.g. Dittmer & Reimer, 2012; Dittmer et al. 2018; James 2019), though some focused primarily on science content knowledge within programs framed as justice-oriented (e.g. Djonko-Moore et al. 2018; Leonard et al. 2016). A noteworthy study in this domain was Stapleton's (2019) qualitative exploration of the impacts of a climate justice-focused global education program implemented with U.S. high school students who spent four weeks in Bangladesh—a country already facing substantial climate-driven disruption. Upon returning home, students were encouraged to design social action projects in their schools and communities. In making the "case for climate justice education," Stapleton's findings highlight "tremendous personal changes" among youth participants resulting from their program participation, emphasizing the need for climate change education to adopt a human-centric framing, facilitate youths' personal connections to the issue (including grappling with their own culpability), making climate change concrete and tangible (rather than abstract)—for example by experiencing a climate-impacted place first-hand, and fostering a sense of solidarity with impacted groups, while comprehending the power imbalances and injustices that give shape to climate change impacts (p. 745).

Another group of articles consisted of education-focused programming in informal settings, characterized largely by public education and outreach strategies. These articles were often targeted more towards adult community residents than youth, and examined community-led efforts to raise awareness about climate change and its justice dimensions, for example through community radio in Ghana (Harvey 2011), a peer education program with community health workers (*promotoras*) in an underserved area of Tucson, Arizona (Sandhaus et al. 2018), and partnering with community residents using participatory methods to build flood resilience in a socially and physically vulnerable neighborhood of Houston, Texas (Meyer et al. 2018). In a contrasting example in which the study itself was intended to re-envision educational programming (rather than implement it), Timon, Kaunda, and Hewitt (2019) conducted interviews and focus groups with students, educators, pastors, community leaders, and congregation members in Kiribati, inviting them to reflect on their experiences of climate change and, ultimately, to re-envision theological education towards the promotion of justice and a more equitable society that is grounded in local traditions.

Outside of traditional educational settings, several articles looked at how learning is taking place within and through the efforts of community organizations and activist networks. For example, several articles examined how students are shifting the conversation about "sustainability" towards climate justice on college campuses through their collective action (e.g. fossil free divestment campaigns; Bratman et al. 2016; Grady-Benson and Sarathy 2016; Maina, Murray, and McKenzie 2020) as well as how young people are engaging with one another to imagine, embody, and create alternative futures for climate justice through their activism and movement-building (e.g. Grosse 2019). Articles in this domain sometimes focused on collective learning and action within regional coalitions and civil society organizations, for example a study of coalition-building in Oakland, California to reimagine life in cities at the metropolitan regional scale (e.g. Pavel 2015) and another exploring the role of civil society organizations in advocating for justice-focused climate policies in the dual-island Caribbean nation of Trinidad and Tobago (Montoute, Mohammed, and Francis 2019). In contrast to hierarchical educative practices involving top-down knowledge dissemination, education at the intersections of climate change and justice in these articles was often a horizontal process involving information- and resource-sharing within and across egalitarian networks.

Discussion

This systematic review examined the small but growing literature at the intersections of education, climate change, and justice (2007–2020), with aims of bringing visibility to existing efforts as well as to build a foundation for more widespread justice-driven approaches in CCE. Specifically,

this review addressed five key research questions to describe publication trends, how (climate) justice frameworks were being employed, the range of methodological approaches, age groups, and sectors of society represented in this body of research, educational processes and (action-oriented) outcomes, and micro- to macro-level factors investigated by scholars in this critical area of research. Noteworthy findings were that, while this decidedly international and multi-disciplinary research area has seen significant growth in recent years with evidence emerging from all populated regions of the globe, study authors were concentrated in global North countries. These scholars were using a variety of mostly qualitative and mixed-methods approaches with diverse age groups across a range of educational settings, within and beyond formal classrooms. Taken together, these studies demonstrate a remarkable diversity of learning processes and educational and action-oriented outcomes focused on climate change mitigation and adaptation, fueled by aims of advancing equity and thriving communities as much as protecting the environment and the places where they live.

Justice in climate change education: content and context

Revisiting the question, "How and to what extent are justice considerations appearing in climate change educational contexts?", this review identified a range of justice lenses (e.g. social, environmental, climate) applied by scholars in describing the significance and educational content of CCE approaches. Moreover, most studies included in this review employed justice frameworks as central to their efforts, though few articles employing a climate justice lens offered definitions of the term. Moreover, "justice" was mostly likely to appear in articles' introductory sections (e.g. literature reviews) and least likely to appear in articles' method sections, indicating that justice was most commonly employed as a theoretical framework or rationale and less as an explicit content focus (e.g. in educational activities). As research at the intersections of justice and CCE becomes more common—as is clearly the trend identified in this review—it will be increasingly important that scholars clearly articulate how justice figured into the educational process or programming itself. This means not just naming justice, but by identifying specific elements in justice frameworks that shaped educational initiatives or guided their learning or action goals, as well as how they are thought to advance (climate) justice in the context of climate change. In this review, only a handful of articles assessing the impacts of educational programming delivered on this important need (e.g. Reimer et al., 2016; Stapleton 2019; Tagg and Jafry 2018). This has implications for the understanding and practice of education for climate justice because, as has been the case with other social change-oriented pedagogies and methodologies (e.g. transformative learning, photovoice), firm grounding in the original emancipatory intents of frameworks can be lost when used to "tag any learning experience" (Aboytes and Barth 2020, p. 4; Derr and Simons 2020). For example, in the case of photovoice—a participatory action research (PAR) method using photography to document and address community concerns—a recent scoping review found that applications of the method in environmental education often fell short of the method's original goals (i.e. to evaluate community strengths and weaknesses; engage in group-based critical dialogue; and influence policy[-makers]). Importantly, the most commonly missing piece was arguably the most emancipatory: to engage with decision-makers with aims of improving the situation (Derr and Simons 2020). In the case of transformative learning theory, a recent systematic review found that published articles in the field of education for sustainable development (ESD) "far too often implement [the terminology] without a critical exploration of the underlying theory" (p. 12), rendering it a catchphrase and exacerbating fragmentation in the field. Despite varying definitions of climate justice, there are several unifying principles—particularly around procedural, distributional, and recognitional (in)justice—that scholars and practitioners may use in the design and documentation of their approaches to education and action for climate justice (Ogunbode 2022). By making clear linkages between

climate justice principles and educational approaches, scholars can simultaneously contribute to upholding the principles that have served to unify a range of actors under shared aims, while providing concrete avenues for like-minded scholars to join in meaningfully advancing climate justice.

Another key set of findings speaks to important differences between justice-driven CCE and the broader CCE literature. First, studies included in this review were published across a diversity of disciplines—mostly in the social sciences—and took place in educational settings focused on a wide variety of school subjects (e.g. social studies, history, geography) and degree programs (e.g. social work, public health), dominated by the social sciences and humanities. This is a significant departure from well-documented trends in CCE research, which has historically observed CCE taking place in the science classroom (e.g. Monroe et al. 2019). Likewise, the most common learning focus across studies was "People" (i.e. thriving communities) and the least common was "Planet" (i.e. environmental protection), indicating that as non-STEM fields enter the CCE sphere employing a justice lens, so too does a more human-centric approach to framing the climate crisis. Along these lines, the learning focus on "Power" (i.e. advancing equity) was more prevalent than "Place" (i.e. local improvement), pairing social and justice-related learning goals over environmental and biospheric goals in terms of their overall prevalence across studies. These findings highlight key elements that distinguish climate change education for justice from "environmental education" or "climate education" more generally.

It is worth noting that some studies firmly-grounded in STEM education—particularly in math (e.g. Karaali and Khadjavi 2019; Nicol et al. 2019)—were employing a justice lens to engage students in critical conversations about climate change realities and the relationship between STEM fields and social change, demonstrating that justice-infused CCE is of course possible in these spaces. Some common school subjects (e.g. English, Literature, Fine and Performing Arts) were notably absent in study findings, despite their clear relevance to climate change sense-making, dialogue, and social change (i.e. via storytelling; visual media) (Facer 2019; Osnes 2017). In justice-driven CCE, integrating the arts and sciences can be a transformative way to simultaneously examine 'what is' (i.e. content knowledge) while imagining 'what if?' (i.e. envisioning alternatives) (Trott et al. 2020; see also Chandler, Osnes, and Boykoff 2020). Additional research is recommended across all subject areas, but especially those that bring justice-driven CCE into further humanities and social sciences contexts, as well as the arts. For CCE-interested scholars who typically seek partners in STEM, findings of this review demonstrate that educators in non-STEM fields are already experimenting with ways to teach for climate justice, yet remarkably few studies examined student impacts of justice-focused CCE in formal classroom settings. Thus, there is a need for empirical research across disciplines to investigate the views and experiences of students as they engage with justice-driven CCE in the classroom. Moreover, given the inherent interdisciplinarity in education for climate justice, there is a need for scholarly endeavors that bring together researchers and educators within and beyond the STEM disciplines to design and deliver programming that foregrounds the multi-faceted injustices and solutions that students may consider when learning about climate change and envisioning and/or enacting climate-just futures.

Given that climate justice efforts are united by a set of principles intended to guide decision-making and action, a noteworthy finding of the present review was that only a small number of educational programs entailed clearly-defined action opportunities. Still, a significant finding within this subset of studies was that action for climate justice was slightly more likely to be public- than private-sphere action, taking place at the neighborhood or community level, and aimed at generating systems-level change to prevent future climate harms. This is consistent with climate justice action beyond educational settings (Trott et al. 2023). In their recent review examining whether and how climate literacy programs integrate political dimensions, Kranz et al. (2022) defined public-sphere actions as:

> …rang[ing] from different kinds of environmental citizenship (e.g. petitioning on environmental issues, donating to environmental organizations, discussions with politicians, support or acceptance of environmental regulations, and willingness to pay higher environmental taxes) to activistic action such as active participation in environmental organizations and organizing demonstrations (e.g. climate strikes). (p. 6)

These kinds of actions move beyond private-sphere (e.g. lifestyle) forms of climate action that still dominate the CCE literature. As others have argued previously (e.g. Chawla and Cushing 2007; Stern 2000), review authors concluded that "effective mitigation and adaptation are based on public-sphere actions, [so] … effective climate education should discuss those public actions if it is to be effective" (Kranz et al. 2022, p. 1). Likewise, action for climate justice is more appropriately a public- than private-sphere endeavor, which emphasizes collective (rather than individual) responsibility, decision-making, and action-taking to transform systems and spur social change. Given critical gaps in this area, more research is recommended that brings an action focus to climate change education for justice.

Climate change education for justice: challenges and possibilities

Beyond disciplinary diversity, a noteworthy finding of the present study was the variety of settings within which justice-driven CCE was taking place. In contrast with previous systematic reviews of the CCE literature, a strength of the present study was not placing limitations on the educational context (e.g. to formal schooling) or age group involved. Moreover, the boundaries around where "education" could take place were inclusive of nontraditional, less structured forms of learning, for example within and through activist spaces. As the present study found, activists were learning about the justice dimensions of climate change from one another as well as raising awareness of these issues with public audiences. As such, like (preservice) teachers who featured prominently in this review, activists were both the students and the educators, absorbing and disseminating justice-informed climate change knowledge as a form of translation for social change action. We agree with Lange and Chubb (2009), that (student) activists, who "are taking the lead in pressuring and educating for change" are simultaneously "some of the least studied and most underappreciated nonformal adult educators" (p. 66), though this might be changing (e.g. McGregor and Christie 2021). Considering the rise of the youth climate justice movement in the context of the present review findings, more research is needed on the role of young people as agents of change for climate justice, within and beyond formal educational contexts. In particular, studies exploring the educative dimension of youth activism and civic engagement will help educators and practitioners to be attuned to youths' perspectives and experiences relevant to climate justice as well as how to design curricula and programs to support youths' informed action. Relatedly, an overlooked area in CCE has been adult education. The present study identified several examples of justice-driven CCE occurring between and among adults, mostly in community settings. Additional research is needed that explores the perspectives, motivations, and experiences of adults, as they learn about and take action to advance justice in the context of climate change.

Social movement learning and action, in the context of the climate justice movement, "involves contesting what is valued by creating new frames of meaning, at the micro level of the individual and their interactions, as well as the macro level of society and beyond" (McGregor et al. 2018). Indeed, findings of the present study suggest that learning was taking place across the micro- to macro-level spectrum, indicating that many learners—across age groups and settings—were challenging their own previous assumptions about the world and developing critical consciousness (Kluttz and Walter 2018). Findings of the present study further suggest that activism is an important learning space for climate justice as well as a key platform for climate justice action. Future research is recommended that takes seriously the educative nature of social movements—their internal processes as well as their

outward-facing messages—as a form of CCE, and how activists, especially youth, are shifting the climate change conversation on local to global scales. It is important to note that while activist participation can clearly be educative for individuals, this extends to the effect of social movements on formal educational institutions. The educative nature of social movements can permeate more traditional learning environments, as McGregor and colleagues (2021) explain:

> …it is in making visible new ways of thinking and feeling — creating an alternative hegemonic frame of meaning that has wide public appeal — that makes social movement learning in, for, and from CJM [the climate justice movement], an important resource for professional educators in a variety of settings and educational institutions. (p. 502)

However, the extent to which justice-driven CCE is possible in more formal educational settings depends on a variety of institutional factors. Another key set of findings in the present review speaks to the many-layered barriers and constraints faced by educators in K-20 institutions. Several studies noted the possible hesitation and discomfort educators may experience with regard to integrating CCE and justice into their classrooms, rooted in a lack of knowledge and preparation as well as concerns about teaching politically controversial topics (e.g. Kissling and Bell 2020). Rather than educator-level deficiencies, these challenges are rooted in structural and institutional constraints such as a lack of training in teacher education programs, limited resources and support, inhospitable school cultures, and low levels of professional autonomy (e.g. Alvey 2020; Liston and Devitt 2020). As described by Clark, Sandoval, and Kawasaki (2020) of the U.S. context, "the NGSS [Next Generation Science Standards] and its embedded neoliberal agenda create systems of standardization and accountability that place teachers in problematic roles of promoting the status quo and limit their role in supporting climate and social justice" (p. 13). This means that even educators who are motivated and capable of integrating justice-driven CCE into their classrooms will often face challenges (Liston and Devitt 2020). Moreover, educators in the humanities and social sciences who wish to integrate justice-driven CCE into their teaching face additional barriers rooted in the perception that this content falls outside their subject area (e.g. Kissling and Bell 2020) as well as the reality that CCE-related content typically only appears in STEM-focused curricula and standards. Taken together, these studies serve to highlight "the tensions that exist between individual [educators'] concerns for the changing climate and the structural challenges constraining the possibilities for action" (Sainz and Khoo 2020, p. 3). As such, those studies included in this review taking place within formal education settings represent a collection of positive case studies where educators managed to avoid or overcome a range of serious barriers, demonstrating that teaching for climate justice is possible. Still, additional research is needed on the conditions conducive to climate change education for justice, including how educators have navigated structural and institutional barriers and/or successfully advocated for change within their institutions as well as what changes were implemented. For example, White et al. (2022) urge educators to "dare to think differently about education" in the context of climate change, for example to "reimagine and re-form education systems to become spaces where young people learn and refine skills for political engagement," grounded in an "appreciat[ion] that young people require engagement with their political voices" (p. 12). There are countless ways schooling can and should be reimagined to combat climate injustice, so research documenting these change processes is needed. More generally, to support more widespread implementation of education for climate justice, a paradigm shift is needed in teacher training programs within and beyond STEM (e.g. higher education, professional development), education policies and standards, and curriculum development that adequately reflects the realities of climate change as well as a commitment to redressing its multi-faceted injustices.

Limitations and future directions

The present review has a number of limitations. First, this systematic review relied on the specific language choices of publishing authors to identify whether (climate) justice dimensions were being integrated in CCE contexts. Articles not mentioning justice frameworks were either: (1) not identified through initial database searches to be considered for inclusion; or (2) were excluded based on study criteria. This approach necessarily overlooked published research employing terms other than "justice" to describe educational program content, even studies— such as two identified in a recently-published review (i.e. Öhman and Öhman 2013; Siegner and Stapert 2020)—that may engage substantively with justice principles. Additionally, a potential weakness in the search terms used to identify relevant studies was a singular focus on "education" while neglecting to search variations on this terminology. Future reviews in this domain should include additional search terms, such as "teaching," "learning," "pedagogy," and "literacy."

Findings of the present review highlight several key areas for future research at the intersections of education, climate change, and justice. First, this review found that, while the research evidence is emerging from all inhabited regions of the world, scholars from global North institutions make up the vast majority of those publishing on justice in CCE. No doubt, this is in part due to the exclusion of non-English language articles from the present review due to the language limitations of the research team. However, vast differences in the geographical distribution of study authors (i.e. in the global North) versus study participants (i.e. global) suggest that global North scholars may be engaging in international research practices that fall short of "genuinely collaborating with scholars and institutions in the global South" (Heleta 2022, p. 1). Supportive of this notion is the general lack of co-authored global North-South publications in the present review, with important exceptions (e.g. Dittmer et al. 2018; Riemer et al. 2016; Sayal et al. 2016). A limitation of this analysis is that we did not account for the reality that global South scholars sometimes hold global North institutional affiliations, which leaves open the possibility that greater representation of global South scholars exists in the present review than our geographical analyses imply. Nevertheless, as part of a broader climate justice research agenda that endeavors to move beyond "ongoing coloniality" (Sultana 2022b, p. 3) and Euro-American epistemic hegemony (Heleta 2022), future research is recommended centers the work of global South scholars, particularly on the perspectives and experiences of students, educators, activists, and practitioners advancing climate justice through education in global South contexts.

Another limitation of the present study concerns the degree to which we were able to draw out how justice figured into the core activities described within articles. As mentioned, descriptions of educational interventions were sometimes lacking in detail, and explicit connections to justice—particularly in the learning processes or goals—were often unclear. To enable others to reproduce and build on existing programs as well as to aid in the examination of justice-driven CCE in reviews such as this, we recommend substantive descriptions of program content and processes. Finally, we feel it is worth noting that education for climate justice is already happening in many places not captured in this review. To add momentum to existing efforts, as scholars seek to examine justice-driven CCE in practice, we recommend partnerships that serve to document the processes, challenges, benefits, and rewards of this work, which is already being led by teachers, practitioners, and community groups in many places.

Conclusions

Because there is no such thing as "unframed information" (Nisbet 2009, p. 15), all forms of climate change education either intentionally or implicitly bolster particular narratives through the ways in which problems are defined, whose perspectives are centered, and which solutions are explored. When justice considerations are absent, critical dimensions of the real-world challenges posed by climate change are neglected, leaving learners of all ages with a limited conceptualization of the problem and how to adequately respond. As such, when climate change is framed as a

primarily scientific, technical, and/or environmental issue, educational approaches may serve to uphold the status quo by virtue of not challenging it (Eaton and Day 2020; Kagawa and Selby 2015; Nxumalo, Nayak, and Tuck 2022). What is needed, according to the latest IPCC report is "the updating of educational systems from a commercialised, individualised, entrepreneurial training model to an education cognizant of planetary health and human well-being…[to] accelerate climate change awareness and action" (Creutzig et al. 2022, p. 70). We agree, and would take this a step further: towards the goal of advancing awareness and action on climate justice. In the formal classroom, doing so would respond to an as yet missed opportunity to tap into the interests and commitments of young people whose lives will increasingly be affected by climate change and whose perspectives and actions are often overlooked. As demonstrated by studies included in this review (e.g. Grosse 2019) and, more broadly, the rapid growth of the youth climate justice movement, young people are motivated and capable of engaging with complex climate injustice topics as well as acting for systems-level change (O'Brien et al., 2018). Education for climate justice holds the potential to meet young people where they already are as well as cultivate deeper and more widespread awareness of real-world problems among all learners, while positioning them as agents of necessary change. The transformative potential of education for climate justice holds true beyond the classroom and with adult learners. This review identified numerous alternative learning environments where justice-driven climate change education is taking place, including in community and activist spaces. As these studies demonstrate, educating for justice in the context of climate change is not merely a youth-, school-, and future-focused endeavor. Because climate change is taking place everywhere, now, affecting us all, and with unjust consequences, our collective societal response must offer a diversity of spaces and places of learning—for learners of all ages—to facilitate justice-grounded understandings as well as justice-driven actions. If education, in all its varieties, is to become the societal force for change that is increasingly named as its charge, then we hope the creative, life-affirming approaches encompassed within this review help inspire and invigorate a more justice-informed culture of climate change education, one with the potential to be transformative for learners and society at large.

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