

Roadblocks to quality education in a time of climate change

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Executive Summary

In October 2018, the Intergovernmental Panel on Climate Change (IPCC) released a special report that spelled out a dire vision of the future for planet Earth if climate action around the world is not accelerated by 2030.¹ Out of the commentary that emerged, few have championed the report’s acknowledgment that education, especially informed by indigenous and local knowledge, can help to 1) accelerate the widescale behavioral change needed for an equitable system-wide transition to a carbon neutral economy, and 2) build competencies and knowledge to enhance innovation and the policy and technological adaptation required to limit global warming to 1.5° C.²

The lack of education champions within the global climate “policyscape” is fueled in part by an overemphasis of political attention and financial resources—when attention and resources are given at all—toward efforts to reduce greenhouse gas emissions. At the same time, the global education community’s attention and resources have been fractured by many development priorities, diluting the efficacy of its power to be a game-changer in climate action.³

The urgency of the climate crisis demands not only greater coherence and coordination of education efforts, but also a deep reexamination of the education sector’s role in the perpetuation of the status quo. This applies across formal education institutions (primary, secondary, and tertiary school), non-formal programs (often delivered by nongovernmental or community-based organizations), and informal spaces (on the radio, in libraries, museums, or even grocery stores and bus stops). It also demands attention from children, youth, and adults in both high-carbon emitting and low-carbon emitting countries, as well as within and across sectors (e.g., education, energy, transportation, agriculture, and urban planning).

As a starting point for critical discussion among education and non-education actors, this paper focuses on formal education spaces where coordinating local efforts across districts, states, and nations can have impact on a global scale. First, the paper illustrates why more attention to and investment in education as a means of reducing risk and increasing informed action to climate change is needed, lest the technofixes of today lack political will

1 IPCC (2018), p. 32.

2 See chapters four and five in the IPCC Special Report. Note that the language the IPCC used to describe education takes on a behaviorist flavor, which posits that good educators can make people behave in the right way. Such a paradigm contrasts with one that views education as a critical, reflexive process that opens new ways of seeing oneself in relation to the world, and thus leading one to act accordingly (Jickling, B., personal communication, January 23, 2020).

3 In this paper, the term “global education community” is used to loosely describe the sum of education actors, globally (civil society organizations, nongovernmental organizations (NGOs), government ministries, activists and advocates, etc.). The term does not imply that this collective set of actors views themselves as a single, cohesive community. The term “education sector” is used to describe the systems of education delivery (schools, school systems, ministries of education, etc.), while “education” refers to the process of teaching and learning.

and localized solutions for sustained, collective climate change action in the future. Second, it describes the current policy landscape for education in climate action, and climate in education. Third, the paper presents five underlying challenges preventing the formal education sector from taking a more proactive role in climate action. These roadblocks can then become entry points for policy and action. Finally, the paper lays out three actions that education and climate actors can take to not only chart a roadmap for the education sector in climate action, but to generate a new set of game-changing rules.

Why focus on education?

Research suggests that education has a strong role to play in both climate adaptation and mitigation.⁴ Not only are education levels correlated with increased adaptive capacity and reduced risk to climate-related disasters—especially for women—but education also promises to increase the knowledge, skills, and attitudes necessary to mitigate against further environmental damage.⁵ Studies show that there is a strong positive correlation between education, concern for the environment, and the kinds of skills (e.g., problem solving and critical thinking) and behaviors (e.g., signing petitions or participating in demonstrations) that support policies or political decisions that have a positive impact on the environment.⁶

Education also has ripple effects beyond the individual learner, helping to foster greater concern for the environment among family members and helping wider communities reduce their vulnerabilities to a changing climate.⁷ The education of girls may have an even greater ripple effect. For instance, daughters in the U.S. have been found to be more effective at transferring concern for the environment to their parents.⁸ Emerging research in low- and middle-income countries suggest that a gender-transformative education may be key to ensuring girls know about their rights and develop the green skills and leadership skills necessary to lead innovation in green sector industries and participate in climate-relevant decisionmaking.⁹

The formal education system also provides a convenient tiered system for climate action at multiple scales, beginning at the individual school level and continuing to the school district, the state, and the regional or sub-continent and global levels (See Figure 1). Scholars investigating pathways to sustainability transformation suggest that there may be a particular population scale of action in which the collective ability to take meaningful local action and achieve global impact is optimized.¹⁰ One study suggests that a “sweet spot” for reaching the highest reduction of greenhouse gas emissions, number of climate action strategies deployed, and financial benefit from those actions is at groups between 10,000 and 100,000 people—or, roughly at the scale of community, metacommunity (groups of communities), and cities—depending on country context.¹¹ Such a model, called the “Powers of 10 framework,” provides a useful conceptual entry point for thinking about effective climate action through education, especially through the formal education sector. When

⁴ Wals and Benavot (2017).

⁵ Feinstein and Mach (2019); Lutz, Muttarak, and Striessnig (2014); Olsson, Gericke, and Chang Rundgren (2019); Wamsler, Brink, and Rentala (2012).

⁶ Balls (2016); Chankrajang and Muttarak (2017); Chawla and Cushing (2007); Clery and Rhead (2013); Franzen and Vogl (2013); Meyer (2015).

⁷ See for example Lawson, et al. (2019); Muttarak and Lutz (2014); Striessnig, Lutz, and Patt (2013); Save the Children (2015).

⁸ Lawson, et al. (2019).

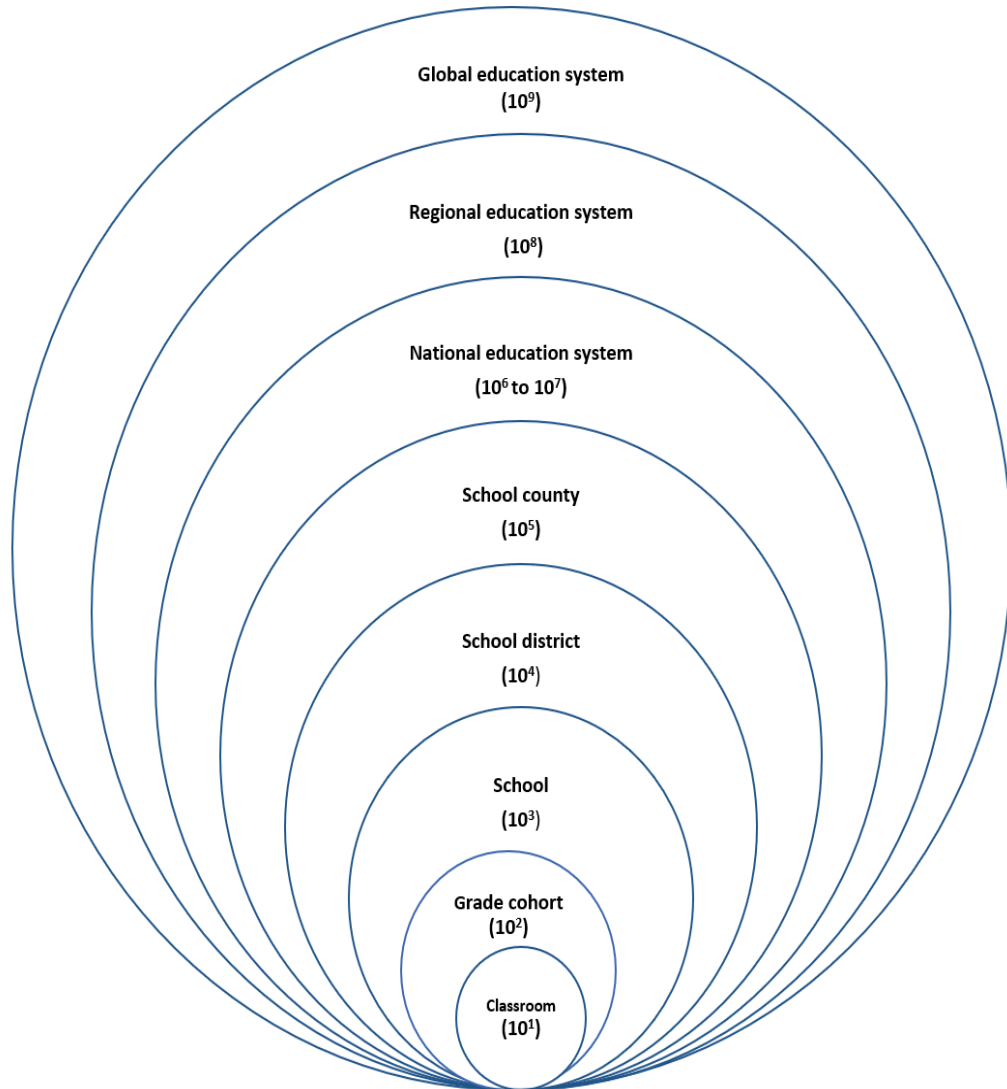
⁹ See Kwauk and Braga (2017); Kwauk (2019).

¹⁰ Bhowmik, McCaffrey, Frischmann, Gaffney, and Ruskey (forthcoming). See also McCaffrey (2017).

¹¹ Ibid.

combined with state- and national-level education and climate policies, as well as grassroots and school-level initiatives, the education system offers a microcosm for global climate action.

Figure 1. Powers of 10 framework of cross-scale optimization for interventions aimed at rapid sustainability transformation, applied to the education system



Note: Labels and their corresponding power of 10 cohort are approximations, and would depend on the size of the country, the reach of its national education system, and whether non-state providers are included. Adapted from Bhowmik, et al. (forthcoming).

Is the education sector standing up to the task of climate action?

The short answer is “no.” The long answer is a little more nuanced. Multilateral organizations and international frameworks recognize the importance of education in climate action. UNESCO, the United Nations’ de facto education arm, posits that education helps populations to address both the causes and impacts of climate change, to adapt more sustainable lifestyles, to enhance human resilience, and to develop the skills needed to transition to a greener economy.¹²

The climate community, including those experts interviewed for this paper, also recognizes the importance of education and training—both in achieving the level of awareness and behavioral change needed to curb further emissions of harmful greenhouse gases, and in adapting to the impacts of climate change and weather-related disasters. Article 6 of the United Nations Framework Convention on Climate Change (UNFCCC) and Article 12 of the Paris Agreement both stipulate that countries enhance their approach to climate change education and training, as well as increase the public’s awareness, participation, and access to information about climate change.¹³ Finally, Sustainable Development Goal (SDG) 12 (responsible consumption and production) and 13 (climate action) include education-related targets (see Table 1).

“Education is critical in helping populations understand and address the impacts of climate change, and in encouraging the changes in attitudes and behaviour needed to help them address the causes of climate change, adopt more sustainable lifestyles and develop skills that support different modules of economies, as well as to adapt to the impact of climate change. In particular, education can enhance the resilience of vulnerable groups and communities, especially in developing countries, who will be disproportionately affected by these changing conditions.” (UNESCO, 2015).

Despite the evidence, and despite recognition of the importance of education by both education and climate frameworks, the global education and climate change communities remain siloed and have done little to advance coordinated education for climate action efforts for, by, or with K-12 children. To illustrate, in a study of 78 countries, nearly three quarters of national curriculum frameworks mentioned sustainable development (73%), while just over a third actually referenced climate change (36%).¹⁴

To be clear, at the global level, UN agencies like UNESCO and UNICEF have spearheaded high-level attention to education in a changing climate through agenda-setting expert groups, reports, and initiatives.¹⁵ These entities, along with other large international NGOs like Plan

¹² UNESCO (2015a).

¹³ Notably, only one of the climate scientists and educators interviewed for this paper was aware of the education mandate contained within both the UNFCCC and the Paris Agreement. See [Article 6](#) of the UNFCCC and [Article 12](#) of the Paris Agreement.

¹⁴ International Bureau of Education (2016).

¹⁵ See for example UNESCO (2015b), UNESCO’s new Futures of education: Learning to become initiative to “reimagine how knowledge and learning can shape the future of humanity and the planet,” and the UN CC:e-Learn [web portal](#).

International and Save the Children, have also been at the forefront of education advocacy in climate policy spheres, including the annual Conference of the Parties meetings. The UNFCCC has also made efforts to formalize implementation of Article 6 with the appointment of Action for Climate Empowerment (ACE) national focal points and through a regular schedule of dialogues, workshops, and youth engagement.¹⁶

At the local level, NGOs (community-based, national, and international) like the Alliance for

Article 6 of the UNFCCC: Education, training and public awareness

In carrying out their commitments under Article 4, paragraph 1 (i), the Parties shall:

(a) Promote and facilitate at the national and, as appropriate, subregional and regional levels, and in accordance with national laws and regulations, and within their respective capacities: (i) the development and implementation of educational and public awareness programmes on climate change and its effects; (ii) public access to information on climate change and its effects; (iii) public participation in addressing climate change and its effects and developing adequate responses; and (iv) training of scientific, technical and managerial personnel;

(b) Cooperate in and promote, at the international level, and, where appropriate, using existing bodies: (i) the development and exchange of educational and public awareness material on climate change and its effects; and (ii) the development and implementation of education and training programmes, including the strengthening of national institutions and the exchange or secondment of personnel to train experts in this field, in particular for developing countries. (UN, 1992)

Climate Education, CARE, Education International, the Foundation for Environmental Education, and VVOB have made noteworthy efforts to translate global ambition through the creation of teacher resources, curriculum, and programming that can be delivered to individual schools or picked up by individual teachers, unions, and other school leadership.¹⁷ Similarly, networks and campaigns like the Climate Action Project, Schools for Climate Action, the Sunrise Movement, and UNESCO's Green Citizens platform have also helped connect isolated grassroots efforts together, sometimes globally, to form a larger patchwork of education for climate action. The challenge with this level of action is that rather than being systemic, these efforts are often isolated and dependent on the initiative of individual pioneers or local-level advocacy.

¹⁶ See the UNFCCC [website](#).

¹⁷ See for example Education International's [guide for education unions and educators](#) and VVOB's [Keep it Cool!](#) Program.

Table 1. Sustainable Development Goals with targets referencing climate change and education or ESD

Target	Indicator
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	
4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development	4.7.1 Extent to which (i) global citizenship education and (ii) education for sustainable development, including gender equality and human rights, are mainstreamed at all levels in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
	4.7.4 Percentage of students by age group (or education level) showing adequate understanding of issues relating to global citizenship and sustainability
	4.7.5 Percentage of 15-year-old students showing proficiency in knowledge of environmental science and geoscience
Goal 12. Ensure sustainable consumption and production patterns	
12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	12.8.1 Extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
Goal 13. Take urgent action to combat climate change and its impacts	
13.3 Improve education, awareness-raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	13.3.1 Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary, and tertiary curricula
	13.3.2 Number of countries that have communicated the strengthening of institutional, systemic, and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions

What's holding back the education sector?

In 2019, millions of school children and adults around the world took to the streets on multiple occasions to demand climate justice. Meanwhile, education officials and teachers were polarized in terms of whether they should join students in their #FridaysForFuture “School Strikes for Climate” or punish children for truancy.¹⁸

Such ambiguity is symptomatic of the education community's overall treatment of climate change. At a micro level, school leadership may recognize the magnitude of the issue, but because taking action (e.g., condoning student participation in climate strikes) would likely run counter to existing policies (e.g., violating school attendance policies) or jeopardize assessment outcomes (e.g., lost instructional time), no action for climate is often the result. At the meso level, where there have been collective efforts by NGOs and social justice campaigns to move the education sector to action, efforts have been either at a scale too small to change the system meaningfully, or at a large enough scale but through action too low-impact to make a difference.

At a macro level, leadership has failed to translate high-level working groups, agenda-setting declarations and commitments, and splashy logo-filled websites into meaningful action for the environment. Scholars have critiqued UNESCO's leadership of the education sector as turning a robust field of environmental education into a 21st century simulacrum of education for sustainable development (ESD) detached from reality—or more precisely, untethered to the planet.¹⁹ While UNESCO promotes ESD as *the* desired vision of education, ESD remains an “empty signifier,” absent of any meaning to actually transform .²⁰ Similarly, the UNFCCC, with its mandate to lead ACE, is falling short of its aspirations. For instance, despite the Doha Work Programme on ACE, which called on all Parties to designate a national ACE focal point to help strengthen coordination of ACE activities, just over half actually do.²¹ Out of the five largest nations—which account for nearly half of the world's population and more than half of global carbon emissions—only one has an ACE focal point (see Table 2).

¹⁸ On one end of the spectrum, nearly 2,000 educators worldwide have declared solidarity with climate striking students. On the other end, Australian Prime Minister Scott Morrison publicly condemned students' climate strikes as well as their activism. Most education officials, however, are caught somewhere in between. For instance, on a personal level, my daughter's school principal offered a swift response in the negative to my request for an excused absence to allow my daughter to join the Global Climate Strike in September 2019: “While I agree the climate crisis is urgent, it is not in my purview to grant permission for the activity. [Your daughter] can attend the march if you deem it necessary; however, her absence will be marked as unlawful as the absence does not meet the criteria for lawful absences per the attached Administrative Procedure.” (School principal, personal communication, September 19, 2019).

¹⁹ Humphreys, Blenkinsop, and Jickling (forthcoming); see also Huckle and Wals (2015); Jickling and Wals (2008).

²⁰ González-Gaudiano (2005, 2006) in Jickling and Sterling (2017); Jickling (2017).

²¹ 102 out of 195 Parties to the UNFCCC, as of 2017.

Table 2. Population, emissions, and ACE focal points

	Population (2018)	MtCO ₂ emissions (2018)	ACE focal points (as of January 31, 2020)
China	1,392,730,000	10,065	
India	1,352,617,330	2,654	
United States	327,167,430	5,416	
Indonesia	267,663,430	615	X
Pakistan	212,215,030	224	
Total	3,552,393,220	18,974	
% of total population and emissions, respectively	46.8%	51.9%	

Source: World Bank, https://data.worldbank.org/indicator/SP.POP.TOTL?most_recent_value_desc=true
 Global Carbon Atlas, <http://www.globalcarbonatlas.org/en/CO2-emissions>
 UNFCCC, <https://unfccc.int/topics/education-and-outreach/focal-points-and-partnerships/ace-focal-points>

Such a lack of leadership translates into a lack of financing at both macro and micro levels to support everything from ensuring teacher training institutions include local and global issues of climate and sustainability, to building assessment systems that measure learning outcomes oriented toward both social and ecological awareness, to integrating concepts of climate change and climate justice across the curriculum and in textbooks, and so on. A lack of leadership and finance also means that communities like ECOS (Education, Communication, and Outreach Stakeholders) that have been tasked with building the capacity of actors across the education and climate change ecosystem are severely under-resourced and unable to scaffold an already struggling cadre of leadership—including the school principal, the NGOs and civil society, and the national ACE focal point mentioned above.²²

What explains the education community’s lukewarm stance on climate action? Based on this analysis,²³ there are five major roadblocks that have prevented the education sector from accelerating action in a time of great urgency. Fortunately, these five roadblocks can also

²² McCaffrey, M., personal communication, January 20, 2020.

²³ The analysis is based on a literature review and landscape analysis of the climate change education for sustainable development field, and to a lesser extent global citizenship education. It also draws on interviews with nearly 20 climate scientists and thought leaders, as well as education actors, on their perceptions of the greatest barriers to effective climate action and the role of education therein.

serve as strategic entry points for policymakers, decisionmakers, and practitioners seeking to intensify the education sector's response.

1. Ecoliteracy is low on the to-do list when basic literacy is still an unmet global goal

Low- and middle-income countries (LMICs) face a double burden in the context of climate change and sustainable development. Many of these countries are highly vulnerable to weather-related disasters and the negative impacts of a changing climate. At the same time, many are struggling to deliver basic education services, to address the learning crisis, to include girls, refugees, and other marginalized or minority communities, and a host of other education-related development challenges. Addressing climate change and delivering gender-transformative education for sustainable development (more on this below) becomes another checkbox on a long list of priorities for governments, civil society, implementers, and donors.²⁴

Indeed, SDG 4 (quality education), the compass guiding the education sector for the next ten years, does not mention climate-vulnerable or climate-affected populations as a vulnerable group; ecoliteracy as a learning outcome; skills relevant for green jobs, sustainability, or planetary thinking; or education facilities powered by renewable energy. Instead, SDG 4 subsumes all climate-relevant concepts under a broader Target 4.7 focused on ESD, global citizenship education, gender equality, and human rights education.²⁵ Notably, “climate change education” does receive a parenthetical acknowledgement, but under the aegis of SDG indicator 12.8.1 under SDG 12 (responsible consumption and production) (see Table 1).

In this context, ESD has largely been viewed as complementary to—rather than fundamental to—the vision of education, and additional to—rather than integrated throughout—the school curriculum. Such a perspective pits sustainability learning outcomes at odds with academic learning outcomes, leaving education systems to choose on where to spend scarce resources. Youth climate activists, however, have pointed to the absurdity of the expectation to attend school to learn knowledge and develop skills that would be irrelevant on a planet headed for ecological collapse. Critical ESD practitioners and research have argued against this false dichotomization of learning priorities—the roadblock here is thus an issue of framing.

2. The global education community lacks a radical vision for education

The UN Decade of Education for Sustainable Development (DESD, 2005-2014) promised to “integrate the principles, values, and practices of sustainable development into all aspects of education and learning.”²⁶ However noble, the DESD fell short in its attempt to reorient education toward sustainability.

Analysis of DESD initiatives reveal efforts failed to address the ethical, political, relational, and scale (e.g., personal versus collective) dimensions of climate change and sustainable development.²⁷ Such failure ultimately meant there was an absence of critical reflection and transformation of the education principles, values, and practices that contributed to our current climate crisis. This enabled the DESD agenda to be co-opted by neoliberal proclivities: Individual action and behavioral change prioritized over collective action and structural change; consumer capitalism rather than social and environmental justice as the

²⁴ Hayhoe, K., interview with the author, June 19, 2019; Sterling (2017a).

²⁵ See Benavot and McKenzie (2019) and UNESCO (2019a) for an overview of how countries are currently treating these concepts in national laws, policies, and intended formal education curriculum.

²⁶ UNESCO (no date).

²⁷ Huckle and Wals (2015).

orienting perspective; and economic practices cognitively disassociated from social and ecological consequences. As a result, education systems around the world continued to focus on preparing children, youth, and adults “to join the local labour market to nourish the global marketplace and satisfy corporate needs”²⁸—now under the guise of achieving *sustainable* development. Today, with climate change reaching crisis levels, the global education community is faced with the reality that it has “greenwashed” business as usual.²⁹

Indeed, since a group of environmental educators began to resound the alarm in the 1960s, 1970s, and 1990s about growing environmental crises around the world,³⁰ much of the global education community has continued to trumpet the neoliberal, capitalist, patriarchal values of a modern western education system designed for the Industrial Revolution.³¹ Such a system posits learners as separate from the non-human world, and positions them to go on to control, dominate, and exploit that world as adults.³² We see this today in the overemphasis of global education discussions around the learning crisis framed in terms of children’s inability to read or to do basic mathematics, affecting their ability to become “productive and successful adults.”³³ This is in contrast to a more radical framing of the learning crisis in terms of children’s inability to understand concepts like human dignity or to engage in planetary or relational thinking, thus affecting their ability to not only be responsible “to distant people and places and past and future generations” but also stewards of the environment and non-human life.³⁴ We also see this in education discussions about how to prepare children for the future of work without a concomitant discussion of whether that work is “green” (driven on renewable energy), sustainable, inclusive, and just; or “brown” (dependent on fossil fuels), destructive, exclusive, and oppressive. All of this is in spite the fact that the UN has already observed a decade of ESD.

Climate change or issues of sustainable development have appeared in broader backdrop discussions of the global education movement, again dating back to the 1970s, focused on “greening” higher education institutions via retrofitting campus buildings and energy, waste management, and transportation systems to be more environmentally sustainable.³⁵ Similarly, the humanitarian and disaster response and recovery communities have pushed the education sector to address the safety of school environments in preparation for disasters and to be more aware of the ability of education infrastructure—both material (e.g., school buildings) and immaterial (e.g., teachers and principals)—to withstand short-term and prolonged weather-related disasters.³⁶ Missing, however, is the radical reimagining of the vision of education that could help reorient schools (especially primary and secondary) away from serving a social reproduction function through standardization and assessment toward catalyzing social, economic, political, and ecological change through transformative learning.³⁷

²⁸ Jickling and Wals (2008), p. 2.

²⁹ For additional critical perspectives of ESD, see: Corcoran, Weakland, and Wals (2011); Kahn (2011).

³⁰ See for example the Belgrade Charter, The Tbilisi Declaration, or Orr (1991).

³¹ For further elaboration, see Jickling and Wals (2008); Khan (2011); Pirgmaier and Steinberger (2019); Silova, Rappleye, and Komatsu (2019); Sterling (2017b).

³² Jickling and Wals (2008); Wals (2012).

³³ See for example, the Education Commission’s framing of the types of transformations needed to achieve the “[learning generation vision](#)” by focusing only within education/learning systems.

³⁴ Huckle and Wals (2015), p. 494. See also Rio+20 Education Group (2012); Barry (2005); Van Poeck, Vandenabeele, and Bruyninckx (2013).

³⁵ See for example Dave, Gou, Prasad, and Li (2014); Haigh (2007); UNEVOC (2017); Zhang, Williams, Kemp, and Smith (2011). A recent study of Canadian climate change education policy also found that efforts are focused on operations-related action that lead to reductions in carbon emissions by schools (Bieler, et al., 2018).

³⁶ See for example FEMA (2017); Feinstein and Mach (2019); UNICEF (no date, 2012).

³⁷ Boström, et al. (2018); Silova, Rappleye, and Komatsu (2019); Sterling (2010-11, 2017b); Wals (2010).

3. ESD has a problem of definition and scope

To reiterate, it's not just any kind of education that we should be aiming for, but rather a certain kind that rejects human exceptionalism and the dominant development paradigm of unfettered growth.³⁸ One study investigating the relationship between education levels (here, a proxy for “any kind of education” measured by completion rates, literacy, and numeracy) and the environment (measured by per capita carbon emissions) found that countries with higher levels of education tend also to have higher levels of emissions, cautioning against making the assumption that more education (as we currently know it) is necessarily better.³⁹ The study also found that countries with more collectivist orientations had lower carbon emissions than those with more individualist orientations, suggesting that education may need to take a deeper epistemological (and political) turn toward reclaiming the commons through social learning.⁴⁰ In other words, sociopsychological constructs of selfhood, identity, and collective existence with the more-than-human world may be just as important to consider as the cognitive components (the subject matter) of education.⁴¹

As roadblock #2, above, indicates, more critical attention is needed to the *quality* of education.⁴² A major challenge, however, is that ESD—the global education sector's (à la UNESCO's) answer to early warnings of our current ecological crisis—took off before the global education community reached a consensus on the definition of sustainable development and, more importantly, education *for* sustainable development.⁴³ Consequently, it is still unclear whether ESD is meant to be an orienting principle, an actual subject, or an umbrella term encompassing environmental education, climate change education, and other permutations of ecologically-oriented disciplines.⁴⁴

Where climate change education does exist in primary or secondary school, it tends to be a separate subject area focused on increasing students' environmental or climate literacy (knowledge about environmental issues or climate science), rather than on increasing their sustainability competencies (e.g., systems thinking, futures thinking, commitment to the preservation of the environment, etc.) or their levels of ecoliteracy (i.e., understanding how people and societies relate to each other and natural systems in a sustainable way).⁴⁵ That is, ESD is more education *about* sustainable development than *for* sustainable development, *about* climate change than *for* climate *action*. Both are necessary.

When strategies for behavioral change and the adoption of more sustainable lifestyles are discussed, they tend to center on low-impact actions like recycling, turning off the lights, or switching to LED lightbulbs, instead of high-impact activities like living car-free or eating a

³⁸ Lefay (2006); Pirgmaier and Steinberger (2019); Orr (2004); Selby and Kagawa (2010); Sterling (2004a).

³⁹ Komatsu and Rappleye (2018). See also McCaffrey (forthcoming) and O'Neil, et al. (2018).

⁴⁰ Komatsu and Rappleye (2018). See Lotz-Sisitka (2017) for a discussion of commons activities.

⁴¹ Ibid.

⁴² Anderson (2010, 2012).

⁴³ The standard definition and scope of sustainable development has often defaulted to that laid out in the Brundtland Report, *Our Common Future*: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” For discussions on the different forms that education in relation to people and planet has taken, and how they compare to each other, see: Wals, Weakland, and Corcoran (2017); Pavlova (2013).

⁴⁴ In this paper, I use ESD, climate change education, and climate change education for sustainable development interchangeably, unless otherwise specified. For a comparative perspective of how the different understandings of ESD have been operationalized by different countries, see: Læssøe, Schnack, Breiting, and Rolls (2009).

⁴⁵ Benavot (2014); Cutter-Mackenzie and Smith (2003); Eizaguirre, Garcia-Feijoo, and Laka (2019); Iyengar and Bajaj (2011); McBride, Brewer, Berkowitz, and Borrie (2013); Orr (1992); Sterling (2017a); Wals (2010); Wiek, Withycombe, and Redman (2011). For an analysis of treatment of climate change education in tertiary institutions, see Molthan-Hill, et al. (2019). For an analysis of how countries are emphasizing the cognitive, socioemotional, and behavioral dimensions of ESD, see Benavot and McKenzie (2019) and UNESCO (2019a).

plant-based diet that could significantly reduce an individual's carbon footprint.⁴⁶ Such an approach shortchanges the potential for education to disrupt the status quo and spur system-level change, even if delivered at scale.

Current iterations of ESD are at odds with principles of transformational learning. Scholars in the field of environmental and sustainability education (ESE) have pointed to the need to ensure outcomes from radical approaches to education do not get “bent back” toward the status quo.⁴⁷ They have called on education to heed the work of critical scholars like Paulo Freire, bell hooks, and David Orr, among others, whose work set in motion counter movements against modern education systems designed to mass produce workers who perpetuate an unjust, inequitable, and unsustainable global economy.⁴⁸ Contributions by indigenous, feminist, and human rights scholars and activists have also pushed to ensure the transformational vision of ESD is not only aimed at sparking a deep shift in consciousness about humanity's relationship with the more-than-human world, but also at dismantling the harmful gender roles, norms, and relations of power fueling the existing inequities of our current human-to-human and human-to-more-than-human systems of relationships.⁴⁹ As such, a gender-transformative ESD would have the potential to cut at the root causes of climate change, unsustainable growth, and gender inequality.⁵⁰

However, ESD as it currently manifests in practice tends to be individualistic, one-directional, and transmissive rather than collective, interactive, and transformative.⁵¹ It tends to view children as receivers rather than co-creators of knowledge.⁵² And, it has tended to overemphasize measurable cognitive learning over socioemotional or behavioral learning.⁵³ Such a pedagogical orientation posits education as a tool to disseminate a pre-determined set of ideas, and lends itself to standardization techniques that are then used to benchmark progress. This “Big Brother” model of ESD teaches students what to think, rather than *how* to think.⁵⁴ More importantly, it also undercuts the transformative potential for education to activate children's political agency, voice, and creativity, and fails to recognize their valuable role in building climate resilience among their communities.⁵⁵

Studies show that effective climate change education exposes youth both to climate science (e.g., factual, declarative knowledge about climate and environmental science) and to ethical, political, affective, and participatory discussions about local barriers to effective sustainable practices or human and non-human system interactions, for example.⁵⁶ Effective climate change education also entails constructivist, action-oriented, transdisciplinary, and engaging pedagogies that include critical reflection about local climate change impact, opportunities to apply learning through project-based problem- and solution-identification, and opportunities to develop scientific thinking skills and relationships with real scientists

⁴⁶ Wynes and Nicholas (2017); Flora, et al. (2014).

⁴⁷ Jickling, Blenkinsop, Timmerman, and De Dannan Sitka-Sage (2018).

⁴⁸ Freire (2008); hooks (1994); Orr (2004).

⁴⁹ Clover (1995); Jickling (2017); Gudynas (2011); Jickling and Wals (2008); Nagendra (2018); Nakashima, et al. (2011); Shiva (2013); Souza, Wals, and Jacobi (2019).

⁵⁰ Clover (1995); Kwauk and Braga (2017).

⁵¹ Komatsu and Rappleye (2018); Wals (2012).

⁵² Cutter-Mackenzie and Rousell (2018).

⁵³ Benavot and McKenzie (2019); UNESCO (2019a). To see how this plays out in country-level climate policy, see Finding 4 in UNESCO (2019b). For a critique of this paradigm in the context of climate change, see also: Silova, Rappleye, and Komatsu (2019).

⁵⁴ Jickling and Wals (2008).

⁵⁵ Cutter-Mackenzie and Rousell (2018); Mitchell, et al. (2008); Peek (2008); Tanner (2010).

⁵⁶ Balgopal, et al. (2014); Boström, et al. (2018); Frisk and Larson (2011); McNeal and Petcovic (2019); Monroe, et al. (2017); Ojala (2017); Sund and Pashby (2019).

and researchers.⁵⁷ Such an interdisciplinary and integrated approach supports the kind of transgressive and transformative learning that leads to change not only in knowledge and beliefs but also in skills, competencies, and behaviors that can lead to action.⁵⁸ After all, research has demonstrated that environmental knowledge alone is not enough to lead to pro-environmental behavior. Rather an assemblage of knowledge, values, attitudes, and affect—together constituting a pro-environmental consciousness—along with a sense of agency is required.⁵⁹ But like any skillset or area of knowledge, research finds that exposure to ESD concepts must be sustained over time, lest the gains in subjective knowledge begin to dissipate.⁶⁰

A narrow focus on climate science means we miss attention to climate justice

Climate change has demonstrated with great consequence how the actions of one country impacts the lives of people in another country. In fact, studies suggest that economic inequality across nations is being exacerbated by climate change.⁶¹ As global temperatures rise, poorer countries have experienced slower if not decreased economic growth than richer countries, whose energy consumption have driven increased temperatures.⁶² In addition to the economic costs of climate change, poorer countries also bear the brunt of the social costs. Although developing countries were responsible for only 21% of carbon emissions from 1850 to 2011, they paid 78% of the social costs of climate change's impact in 2015 due to their greater vulnerability and lack of reserve capital to bounce back from weather-related disasters.⁶³

Indeed, when global data is disaggregated by countries with the highest carbon footprints and those with the lowest, it is clear that education systems of those countries least responsible for our current climate crisis are shouldering the burden of educating their populations about climate change and for climate action. To illustrate, 15 of the top 20 most climate-vulnerable countries' national climate strategies reference education and skills, compared to 7 of the top 20 carbon-emitting countries.⁶⁴ Other research has documented similar patterns of climate inequities when it comes to girls and women, indigenous peoples, and other marginalized, vulnerable, or disadvantaged communities around the world.⁶⁵ These groups are usually the first to suffer the negative effects of climate change, more likely to experience disruptive and life-altering consequences from environmental degradation and weather-related disasters, and yet the least likely to be engaged in climate solutions or invited to climate decisionmaking tables.

⁵⁷ Hargis and McKenzie (2020); Keller, et al. (2019); McCaffrey (2014); McNeal and Petcovic (2019); Monroe, et al. (2017); Lotz-Sisitka, et al. (2017); Redman and Redman (2017).

⁵⁸ Indeed, researchers have developed a framework for thinking about sustainability competencies, which includes skills like future thinking, coping with uncertainty, the ability to plan and implement, and the capacity to take a trans-spatial, trans-temporal, or trans-human point of view, as well as mindsets like a post-normal understanding of science and value pluralism. While it is unclear whether such a framework threatens to "bend" a transformative learning agenda toward neoliberalism, in the short term it offers a promising pathway for the education sector to begin to integrate ESD oriented toward transformational learning outcomes. See: Frisk and Larson (2011); Kerret, Orkibi, and Ronen (2016); Macintyre, et al. (2018); Pirmäier and Steinberger (2019); Rooney-Varga, et al. (2018); Sterling (2010-11); Wals (2010); Wiek, Withycombe, and Redman (2011).

⁵⁹ Doherty and Webler (2016); Kollmuss and Agyeman (2002); Lotz-Sisitka, et al. (2017); Mwaura (2018); Schultz, et al. (2005); Smith and Leiserowitz (2014).

⁶⁰ Redman and Redman (2017).

⁶¹ Roberts and Parks (2007).

⁶² Diffenbaugh and Burke (2019).

⁶³ Busch (2015).

⁶⁴ Kwauk, et al. (2019).

⁶⁵ See for example: McLean (2010); Plan International (2011); Sellers (2016).

The IPCC report emphasizes that “social justice and equity are core aspects of climate-resilient development pathways that aim to limit global warming to 1.5 °C as they address challenges and inevitable trade-offs, widen opportunities, and ensure that options, visions, and values are deliberated, between and within countries and communities, without making the poor and disadvantaged worse off.”⁶⁶ In addition, efforts by scientists to model climate-resilient development pathways that were characterized by a lack of international cooperation, inequality, and poverty could not keep global warming levels within the 1.5 °C limit.⁶⁷ In other words, social justice and equity are requirements for human society to achieve the Paris goal of limiting warming to 1.5 °C.

Unfortunately, the education sector has done little to connect the dots between the goals of the Paris Agreement and SDG 4 (quality education). Despite SDG Target 4.7, the education sector has failed to seize the opportunity to define quality education in terms of the mutually reinforcing goals of ESD, global citizenship, gender equality, and human rights (issue areas covered by Target 4.7).⁶⁸ A study of 1,480 secondary school textbooks in history, civics, social studies, and geography from 98 countries revealed that less than half of textbooks included content on any one of the Target 4.7 issue areas—with the exception of the topic of environmental damage and protection by 80% of textbooks from the Latin American and Caribbean region.⁶⁹ These findings were just in terms of whether or not the issue area was included in textbooks; how they were discussed and whether the intersections between issue areas were discussed in the textbooks—and by teachers and students in the classroom—is likely to be even lower.

As noted earlier, when the education sector has paid attention to ESD, it has placed an outsized emphasis on the science of climate change (e.g., climate science)—in part, due to climate scientists’ and climate stakeholders’ narrow focus on carbon.⁷⁰ The narrow focus of ESD on climate science leaves the education sector with fewer entry points to “multisolve” the climate, gender inequality, and human rights challenges of our time.⁷¹ For that matter, compartmentalizing ESD as a science topic creates a veil that obstructs our ability to see and to engage with issues of care, ethics, and equity that are inherent in climate change.⁷² As such, approaches to ESD are stripped of politics and power, preventing us from seeing climate solutions that could help to address multiple injustices and inequities.

4. Monitoring and accountability mechanisms are oriented toward passive progress

The “2016 UNESCO Global Education Monitoring” report, dedicated to the theme of “education for people and planet,” ushered the education sector into the SDG era. However, as mentioned already, the global education community (i.e., international education institutions, education ministries, etc.) has responded with inertia to both people *and* planet. This includes when it comes to monitoring its progress.

To illustrate, due to conceptual, reporting, and political challenges with measurement, no data has been collected to date for SDG global indicator 4.7.1 (nor any of the indicators in Table 1). Research has attempted to fill some of this gap, but these one-off studies do not offer the level of monitoring needed to hold the education community accountable for its role

⁶⁶ IPCC (2018), p. 32.

⁶⁷ Ibid.

⁶⁸ Domazet, et al. (2012).

⁶⁹ Jimenez, Lerch, and Bromley (2017).

⁷⁰ Denning, S., Interview with the author, June 19, 2019; Sawin, E., Interview with the author, July 3, 2019.

⁷¹ Sawin (2018).

⁷² Denning, S., Interview with the author, June 19, 2019; Hayhoe, K., Interview with the author, June 19, 2019.

in climate action.⁷³ Although collectively the UNESCO Institute for Statistics (UIS), the Global Alliance for Monitoring Learning (GAML), and other actors have collectively attempted to develop a more fulsome data collection methodology, setbacks mired several attempts at upgrading indicator 4.7.1's status from a Tier 3 to a Tier 2 level indicator.⁷⁴ While the UN Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs) finally approved the indicator's upgrade in December 2019, the measurement framework remains focused on prevalence rather than substance—measuring whether or not policy, curriculum, teacher education, and student assessment have adopted ESD (and global citizenship education) concepts, rather than whether such adoption is oriented to action. Such an approach means that as data is collected for target 4.7.1 in the next year, we will have a sense of the global spread of ESD, but we will know relatively little about whether education systems are actively attempting to change the status quo.

A similar scenario exists within the climate “policyscape.” A recent analysis of 160 Nationally Determined Contributions (NDCs, or a country's plan to reduce its greenhouse gas emissions and meet the goals of the Paris Agreement) conducted by Brookings, Plan International, and UNICEF found that although 68% of NDCs reference the term “education,” only 26% of NDCs referenced education as a strategy to increase the knowledge, skills, and capacities of primary and secondary school children to adapt or mitigate climate change.⁷⁵ This illustrates the poor extent to which the global ambition for education as an action for climate empowerment has been translated into policy. Such a gap also removes an important opportunity for monitoring progress toward and holding actors accountable to achieving the education vision of the UNFCCC and Paris Agreement.

5. Teachers lack the systemic support to become change agents for sustainability

If radical, transformative ESD learning is to happen, teachers will ultimately facilitate this. As one scholar articulates:

“For transformation education to occur, teachers must be prepared to challenge their students to engage in critical thought and help learners to recognize and value their own experiences and expertise. [...] This engagement serves to interrupt current patterns of power and power relations, and contributes to a reimagining of existing worldviews, including a reconsideration of the relationships between people and planet.”⁷⁶

Yet, we must not fall into a “blame the teacher” trap. The roadblocks addressed above clearly place the onus of change on the education system (see Figure 2). With priorities placed narrowly on academic outcomes, an absence of an ESD vision, and a lack of clarity on its definition and scope, the downstream result is confusion in the classroom.

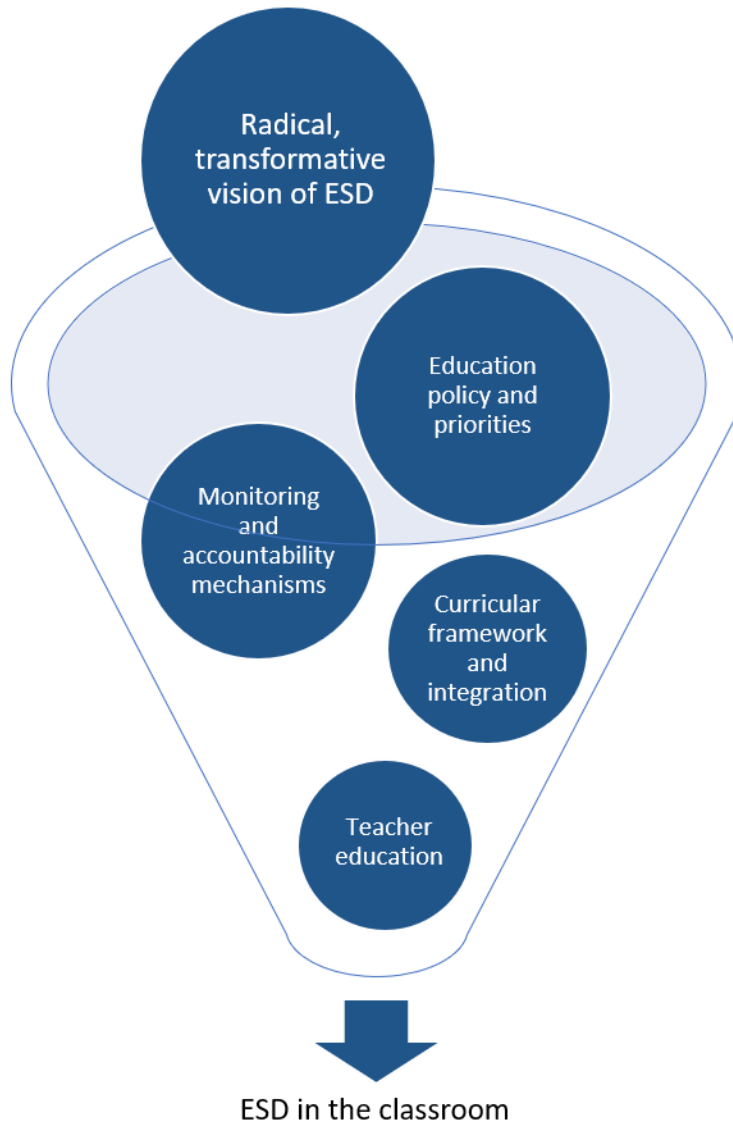
⁷³ See for instance: Benavot and McKenzie (2019); Jimenez, Lerch, and Bromley (2017); UNESCO (2016, 2019a, b).

⁷⁴ The UN [defines](#) a Tier 3 indicator as one that has no internationally established methodology or standard, but such methodology or standards are being developed or tested. A Tier 2 indicator is one that is conceptually clear, has an internationally established methodology/standard, but data are not regularly reported or produced by countries. For more information, see the outcomes of the [Sixth Meeting of the Global Alliance to Monitor Learning](#) (UNESCO 2019c).

⁷⁵ Kwauk, et al. (2019).

⁷⁶ Pavlova (2013), p. 660.

Figure 2. The education system as an enabling environment through which ESD is translated into the classroom



For instance, in the U.S., a recent study showed that 86% of teachers think climate change should be taught in classrooms, yet only 42% actually teach it. The majority of these teachers reported that they do not discuss climate change because they believe it is outside of their subject area, a result of a highly disciplinary approach to schooling.⁷⁷ Another study showed that half of science teachers surveyed in the U.S. taught climate change for less than two hours a year, more than 25% “give equal time” to perspectives that raise doubt about climate change, and nearly 31% send “explicitly contradictory messages” about the cause of climate change.⁷⁸ In some cases, such classroom practices might be a product of teachers’ efforts to be more inclusive of students with diverse experiences, or even a result of pressure from parents or school administrators—or legislation—to either not teach climate change or to

⁷⁷ Kamenetz (2019).

⁷⁸ Plutzer, Hannah, et al. (2016); Plutzer, McCaffrey, et al. (2016).

“teach the controversy.”⁷⁹ However, researchers have shown that these reasons comprise a minority of cases. Rather, such patterns in the classroom are more likely a result of teachers’ own knowledge gaps due to limited training, as well as to a lack of familiarity with strategies for responding to misinformation and misconceptions about climate change.⁸⁰

Clearly, the education system is not supporting teachers (and school leadership) to lead the charge in schools. In places like the U.S., Canada, and Australia, teacher education institutions are not providing teachers with adequate training on ESD concepts, issues, relationships, or pedagogies; nor are they providing teachers with the in-class support, financial and pedagogical resources, creative space, and professional development opportunities to do their craft more effectively.⁸¹ To fill this gap, the UNFCCC, together with UNESCO and other UN agencies, as well as NGOs and researchers, have developed resources for teachers and education leaders to integrate climate change education into school systems.⁸² Whether these efforts have trickled into the average classroom and are utilized by teachers remains unknown, although unlikely.

In countries like India, where teachers are sent to fill positions in rural and urban schools across the country, shortcomings in teacher education are multiplied and teacher needs are magnified. For instance, not only are resources and professional support for ESD scarce in rural communities, but where organizations have tried to build teacher content knowledge, expectations to employ methods like place-based pedagogies using local examples for enriched student learning of ESD mean novice teachers are also expected to become quickly rooted in communities in which they are outsiders.⁸³ Such a student-centered focus—while important in the classroom—means that the needs of new teachers to build their professional resilience, adaptive capacity, and sense of place and community are ignored.⁸⁴

In addition to teacher education, curricular frameworks and the degree to which ESD is integrated in and across the curriculum can also play an (dis-)enabling role for teachers.⁸⁵ Research from the United Kingdom, Australia, Sweden, and other countries suggests that if schools are able to adopt ESD as orienting principles throughout both the curriculum *and* the organization of the school, not only do teachers teach about sustainability and climate change, but school quality is improved and teachers are better supported.⁸⁶ Unfortunately, this is not the norm. As mentioned earlier, a study of 78 countries found that just 36% of national curricular frameworks actually referenced climate change.⁸⁷ While this is trending upwards, the politics of climate denialism and vested interests threaten to impede progress.

For instance in the U.S., corporate interests and conservative actors have seeded doubt on scientific consensus, discouraged teaching for climate action, and distributed fossil fuel industry-sponsored teaching and learning materials into classrooms around the country.⁸⁸ Such action in the absence of proactive climate education leadership leaves little room for

⁷⁹ Colston and Jacqueline (2015).

⁸⁰ Berbeco and McCaffrey (2015); Gwekwerere (2014); Ledley, Rooney-Varga, and Niepold (2017); Plutzer, McCaffrey, et al. (2016); Bourn, Hunt, and Bamber (2017); Wise (2010).

⁸¹ Drewes, Henderson, and Mouza (2018); Gwekwerere (2014); Ferreira, et al. (2009); Jickling and Blenkinsop (forthcoming).

⁸² To name but a few: Bigelow and Swinehart (2014); Pashby and Sund (no date); UNESCO and UNEP (2011); UNESCO (2011); UNESCO (2013); UN CC:Learn (2013); VVOB (2019).

⁸³ Balgopal, M., Interview with the author, July 5, 2019. For examples in southern Africa, see: No author (2018).

⁸⁴ Wright, et al. (2019).

⁸⁵ Sterling (2004b).

⁸⁶ Barratt Hacking, Scott, and Lee (2010); Læssøe, et al. (2009); McMillin and Dyball (2009); Mogren, Gericke, and Scherp (2019).

⁸⁷ International Bureau of Education (2016).

⁸⁸ Brulle (2014); Idso, Carter, and Singer (2015); Mann, M., Interview with the author, July 9, 2019; Zou (2017).

ESD to make headway. And while the Next Generation Science Standards include reference to climate change, only 20 states and the District of Columbia (covering just over 36% of students in the U.S.) have actually adopted the standards. Meanwhile, at least a dozen states have adopted or have proposed legislative measures that require teachers to “teach the controversy”—perpetuating the notion that scientists have not arrived at consensus about climate change—or that require the state to remove material about climate change from science standards.⁸⁹ Such a political environment sends a clear signal to teachers—at least in the U.S.—that if they want to teach about climate change, they are on their own.

What should we do, now?

As others have articulated already, climate change can be tackled through quality education that is gender-transformative and focused on issues of social equity and justice.⁹⁰ Such an education targets the radical transformation of the individual competencies, social values, interpersonal relations, and human systems that determine whether the global economy is brown (fueled by fossil fuels) or green (fueled by renewable energy). By developing students’ self-awareness, social awareness, and ecological awareness, such a transformative education can change the frames of reference needed to create a new set of norms, systems, and relationships between people and planet. To this effect, an ESD that fundamentally reorients education toward ecological justice *is* quality education and *is* sustainable.⁹¹

Despite this vision, a lack of leadership and conceptual and systemic roadblocks inhibit the formal education system from becoming a game-changer in climate action. This does not just negatively impact micro-level actors like school leadership, teachers, and students, but also other sectors like energy, transportation, or waste management do not fully understand the transformative potential of education, nor how to leverage strategically education entry points.

To illustrate, roughly 61% of NDCs that reference education as a climate strategy frame education in four ways:

- 1) As a general, awareness raising activity—almost token in nature—to ensure the success of a climate action strategy deployed by another non-education sector.
- 2) As a positive outcome that is made possible by the success of another sector’s contribution to climate mitigation or adaptation (e.g., an electrification program fueled by renewable energy enables children in those households better access to school).
- 3) As collateral damage in a weather-related disaster.
- 4) As a sector in need of development to improve the country’s demographic variables.⁹²

Such an understanding of education in climate action misses the mark entirely. Rather than viewing education as an action for climate empowerment—and as a legitimate climate

⁸⁹ Glinskis (2017); Czajka (2019).

⁹⁰ Anderson (2010); Bangay and Blum (2010); Feinstein and Mach (2019); Kwauk, et al. (2019).

⁹¹ UNESCO (1997).

⁹² Kwauk, et al. (2019).

strategy in itself—climate policy has overlooked the transformative potential of educating children and youth.

So, what is there to do? Based on the nature of the five roadblocks discussed above, there are at least three immediate tasks for the global (education and non-education) community to take up.

Fill knowledge gaps at scale

As mentioned in the introduction, the education sector offers a unique tiered system of entry points for transformation at scale: at the level of the classroom to the individual school all the way up to the national, regional, and global education system. If we look beyond the formal education system, there is also the non-formal and informal education landscape to consider, as well as education touch points across a person's lifetime. Climate action at one scale among a specific age cohort can have an entirely different impact if deployed at another scale among another age cohort.

But what interventions should be deployed, and at which scale? This is where further conceptual and empirical research, as well as youth-led community-based dialogue, are needed to better understand what can push ESD toward a more radical orientation centered on climate justice and empowerment. For instance, we need to better understand what sustainability competencies are important for a range of adaptive responses and mitigation activities. We also need to better understand what kinds of resources, trainings, and support would help to catalyze transformative change starting from within education systems. To see education for climate action at scale, we especially need to understand how an approach in one locale might be connected, transferred, or translated to another locale, creating metacommunities of climate-oriented education systems for optimal impact.

Create 50-year plans at localized scales⁹³

A challenge that the education sector faces is its timescale. Common perception is that the impact of education on the climate will take years to see, and therefore society needs to focus on climate solutions that can deliver quick results to the Earth's atmosphere. However, this perception is fueled on two misgivings: 1) it is carbon-centric, focusing on the proximal causes of climate change rather than the underlying root causes; and, 2) it is access-centric, focusing on years of schooling as a proxy for transformative learning. Project-level success stories of transformative ESD across sub-Saharan Africa as well as South Asia demonstrate that education can have an immediate impact on both human and climate systems.⁹⁴

The real challenge with time has to do with our bias toward short-term thinking when it comes to climate solutions. Because emissions today can stay in the Earth's atmosphere for hundreds to thousands of years, we need to expand the timescale underlying our solution identification.⁹⁵ While we must do what we can through both technical and sociological solutions to slam the brakes on carbon emissions today, addressing climate change also requires long-term thinking geared toward deep systems change. Rather than our present 15-year timescale as defined by the Sustainable Development Agenda, we need localized 50-year or 100-year plans developed by those embedded within the local knowledge and experience of their communities and who can build local capacity for the future. Short-term goals would then need to be explicitly tied to long-term visions, which would also need to be

⁹³ Morgan (2017).

⁹⁴ See the Campaign for Female Education for an example delivered by an NGO in sub-Saharan Africa.

⁹⁵ Rood (2017); Sawin, E., Interview with the author, July 3, 2019.

adjusted over time. Multiplied across locales, such long-term thinking could guide us gradually toward wider systems transformation.⁹⁶

As such, it is important to recognize that there will be a multitude of 50-year plans depicting relative versions of the good life.⁹⁷ It is insensible to think that there will ever be consensus on what the path should look like.⁹⁸ What's needed is instead common understandings and a set of new norms, practices, processes, and systems grounded in human rights, gender equality, and climate justice that thread together these multitude plans. It is critical, too, that children and youth, women, indigenous peoples, and other groups traditionally excluded from decisionmaking be at the table when crafting these plans.

Build cross-sectoral coalitions for coordinated action

While this paper has focused on the education system, the education sector should not act in isolation. Indeed, the education sector should not be held solely responsible for preparing children, youth, and adults to take action on such a cross-cutting social, political, economic, and ecological issue as climate change. Instead, education should be seen as the site through which multiple sectors, including education, emergency management, energy, gender, finance, health, labor, transportation, urban planning, and others, can come together to “multisolve.”⁹⁹

We already know, for example, that an investment in gender-transformative education for girls can help to multisolve on a number of fronts beyond the education sector's priorities around improving girls' educational outcomes. This includes improving girls' sexual and reproductive health and rights, building important skills and capacities to help transition to a green economy, and increasing girls' and women's participation in leadership and decisionmaking positions.¹⁰⁰ Where the girls' education community has learned to leverage a multisolving approach to education, health, leadership, and climate action, the global community must learn to leverage ESD.

While meaningful cross-sectoral planning and decisionmaking for ESD might be challenging, coordinated action by both ministries of education and environment is possible and could help to leverage multisolving opportunities. Connecting national ACE focal points to existing networks of ESD practitioners, for example, is only the first step to building important cross-sectoral coalitions.¹⁰¹ Linking this network into structures like the European Union's proposed multi-trillion euro Green Deal Investment Plan and Just Transition Mechanism would take cross-sectoral coordination a whole step further. If one of the mechanism's aims is to ensure the EU workforce is equipped with the green skills and competencies needed to build resilience, reduce climate risks, and transition to a carbon-neutral economy by 2050, an investment in education can help to multisolve on a number of fronts. In addition, here is an opportunity to put in play the Powers of 10 Framework to leverage metacommunities of

⁹⁶ Morgan (2017).

⁹⁷ See Gudynas (2011), Mwaura, Pradhan, and Gitahi (2017), and Islam (2012) for example.

⁹⁸ Morgan (2017).

⁹⁹ Sawin (2018). See also Cornell, et al. (2013) for an alternative conceptual model to stimulating cross-sectoral collaboration that is grounded on democratizing knowledge systems, from the production to the transfer and use of knowledge, to eliminate silos across science, policy, and the wider society and to bridge the gap between knowledge and action.

¹⁰⁰ Kwauk and Braga (2017). See Perlman Robinson (2019) for an example of how the education, urban development, and the private sector have connected in informal learning spaces (e.g., libraries, bus stops, grocery stores, etc.) to promote education, community identity, and urban planning solutions at once.

¹⁰¹ Bow, L., Interview with the author, July 1, 2019.

school districts to provide local access to quality and empowering education for climate action.¹⁰²

Conclusion

Given the role that education can play in increasing human resiliency and adaptability to uncertain futures, as well as its role in equipping the population with the knowledge, skills, and attitudes to mitigate against further environmental damage, we must transform education as we currently know it. Inaction on this front would mean that we cannot move at the pace and scale that is required to reverse our current climate breakdown. At the same time, not critically reflecting on whether the education of today is *the* education we need leaves us with the possibility that human society will be in a perpetual battle to shift consumer behaviors, social values, and attitudes. Such an approach is unsustainable.

While the year 2019 may have been marked by polarized action between student activists and school leadership, the year 2020 poses an opportunity to scrutinize the education sector as we have the energy sector. More and more development stakeholders are beginning to recognize that climate change threatens to forestall their sector's progress toward achieving the SDGs.¹⁰³ As school children striking around the world continue to force educators and politicians to ask about the role of the education sector in climate action, the global education community must leverage this political moment for radical educational transformation.

¹⁰² McCaffrey, M., personal communication, January 20, 2020. Notably, the [European Commission](#) does not reference education in its overview of the Green Deal and Just Transition Mechanism.

¹⁰³ See for example, the outcomes of the Global Education Meeting 2018: UNESCO (2018).

References

- Anderson, A. (2010). "Combating Climate Change through Quality Education." Washington, DC: Brookings.
- Anderson, A. (2012) "Climate Change Education for Mitigation and Adaptation." *Journal of Education for Sustainable Development* 6(2): 25-40.
- Balgopal, M.M., J.A. Klein, C.S. Brown, L.B. Sample McMeeking, J.A. Morgan, and W.M. Frasier. (2014). Linking biophysical, socioeconomic, and political effects of climate change on agro-ecosystems. *Journal of Geoscience Education* 62: 343-352.
- Balls, E. (2016). Analysing key debates in education and sustainable development in relation to ESD practice in Viet Nam. *International Journal of Development Education and Global Learning* 8(1): 21-37.
- Bangay, C. and N. Blum. (2010). Education responses to climate change and quality: Two parts of the same agenda? *International Journal of Educational Development* 30: 359-368.
- Barratt Hacking, E., E.W. Scott, and E. Lee. (2010). Evidence of impact of sustainable schools. Sherwood Park, Nottingham: Department for Children, Schools, and Families.
- Barry, J. (2005). "Resistance is fertile: From environmental to sustainability citizenship." In D. Bell and A. Dobson (Eds.), *Environmental citizenship: Getting from here to there?*, pp. 21-48. Shandong: MIT Press.
- Benavot, A. (2014). Education for sustainable development in primary and secondary education. Background paper for the Decade of Education for Sustainable Development. Paris: UNESCO.
- Benavot, A. and M. McKenzie. (2019). The Transitions Project: Education for sustainable development and global citizenship from pre-primary to secondary education. Technical report. UAS Albany and The Sustainability and Education Policy Network.
- Berbeco, M.R. and M. McCaffrey. (2015). Fostering educator resilience: Engaging the educational community to address the natural hazards of climate change. In J.L. Drake, et al. (Eds.) *Communicating climate-change and natural hazard risk and cultivating resilience*, pp. 255-265. Switzerland: Springer.
- Bhowmik, A.K., M.S. McCaffrey, C. Frischmann, O. Gaffney, and A.M. Ruskey. (forthcoming). Powers of 10: A cross-scale optimization framework for rapid sustainability transformation. Available at <https://eartharxiv.org/feaq5/>.
- Bieler, A., R. Haluza-Delay, A. Dale, and M. Mckenzie. (2018). A national overview of climate change education policy: Policy coherence between subnational climate and education policies in Canada (K-12). *Journal of Education for Sustainable Development* 11(2): 63-85.
- Bigelow, B. and T. Swinehart. (2014). *A people's curriculum for the Earth: Teaching climate change and the environmental crisis*. Milwaukee, Wisconsin: Rethinking Schools.
- Boström, M., et al. (2018). Conditions for transformative learning for sustainable development: A theoretical review and approach. *Sustainability* 10(4479).

- Bourn, D., F. Hunt, and P. Bamber. (2017). A review of education for sustainable development and global citizenship education in teacher education. Background paper prepared for the 2017/18 Global Education Monitoring Report. London: University College London.
- Brulle, R.J. (2014). Institutionalizing delay: Foundation funding and the creation of the U.S. climate change counter-movement organizations. *Climatic Change* 122: 681-694.
- Busch, J. (2015). "Climate change and development in three charts." Center for Global Development. Available at <https://www.cgdev.org/blog/climate-change-and-development-three-charts>.
- Campaign for Female Education. (no date). Young women's grassroots action on gender and climate change. CAMFED. Available at https://camfedorg2015.s3.amazonaws.com/uploads/files/CAMFED_grassroots_action_on_gender_and_climate_change.pdf.
- Chankrajang, T. and R. Muttarak. (2017). Green returns to education: Does schooling contribute to pro-environmental behaviours? Evidence from Thailand. *Ecological Economics* 131: 434-448.
- Chawla, L. and D.F. Cushing. (2007). Education for strategic environmental behavior. *Environmental Education Research* 13: 437-452.
- Clery, E. and R. Rhead. (2013). "Education and attitudes towards the environment." Background paper prepared for the Education for All Global Monitoring Report 2013/4. Paris: UNESCO.
- Clover, D. (1995). Gender transformative learning and environmental action. *Gender and Education* 7(3): 243-258.
- Colston, N.M. and M.V. Jacqueline. (2015). A critical political ecology of consensus: On 'teaching both sides' of climate change controversies. *Geoforum* 65: 255-265.
- Corcoran, P.B., J.P. Weakland, and A.E.J. Wals (Eds.), *Envisioning futures for environmental and sustainability education*. Wageningen, Netherlands: Wageningen Academic Publishers.
- Cornel, S., F. Berkhout, W. Tuinstra, J.D. Tàbara, J. Jäger, I. Chabay, B. de Wit, R. Langlais, D. Mills, P. Moll, I.M. Otto, A. Petersen, C. Pohl, and L. van Kerkhoff. (2013). Opening up knowledge systems for better responses to global environmental change. *Environmental Science and Policy* 28: 60-70.
- Cutter-Mackenzie, A. and D. Rousell. (2018). Education for what? Shaping the field of climate change education with children and young people as co-researchers. *Children's Geographies* 17(1): 90-104.
- Cutter-Mackenzie, A. and R. Smith. (2003). Ecological literacy: The 'missing paradigm' in environmental education (Part one). *Environmental Education Research* 9: 497-524.
- Czajka, K. (2019). "States are introducing bills that could prevent teachers from advocating for climate change." *Pacific Standard*. Available at <https://psmag.com/news/state-bills-could-prevent-teachers-from-advocating-for-climate-change>.
- Dave, M., Z. Gou, D. Prasad, and F. Li. (2014). Greening universities toolkit v2.0. UNEP.
- Diffenbaugh, N.S. and M. Burke. (2019). Global warming has increased global economic inequality. *PNAS* 116(20): 9808-9813.

Doherty, K. and T. Webler. (2016). Social norms and efficacy beliefs drive the alarmed segment's public-sphere climate actions. *Nature Climate Change* 6: 879-884.

Domazet, M., D. Dumitru, L. Jurko, and K. Peterson. (2012). "Civil rights and obligations are connected to the environmental issues in the curriculum? A comparative analysis of the ESD in 9 European countries." Zagreb: Network of Education Policy Centres.

Drewes, A., J. Henderson, and C. Mouza. (2018). Professional development design considerations in climate change education: Teacher enactment and student learning. In *International Journal of Science Education* 40(1): 67-89.

Eizaguirre, A., M. Garcia-Feijoo, and J.P Laka. (2019). Defining sustainability core competencies in business and management studies based on multinational stakeholders' perceptions. *Sustainability* 11(2303).

Federal Emergency Management Agency (FEMA). (2017). Safer, stronger, smarter: A guide to improving school natural hazard safety. Washington, DC: FEMA.

Feinstein, N.W. and K.J. Mach. (2019). Three roles for education in climate change adaptation. *Climate Policy*.

Ferreira, J., L. Ryan, J. Davis, M. Cavanagh, and J. Thomas. (2009). Mainstreaming sustainability into pre-service teacher education in Australia. Canberra: Macquarie University.

Flora, J.A., et al. (2014). Evaluation of a national high school entertainment education program: The Alliance for Climate Education. *Climatic Change* 127: 419-434.

Franzen, A. and D. Vogl (2013). Two decades of measuring environmental attitudes: A comparative analysis of 33 countries. *Global Environmental Change* 23(5): 1001-08.

Freire, P. (2008). *Pedagogy of the oppressed*. New York: Continuum International. (Original work published 1970).

Frisk, E. and K.L. Larson. (2011). Educating for sustainability: Competencies and practices for transformative action. *Journal of Sustainability Education* 2.

Glinskis, E. (2017). "A new wave of state bills could allow public schools to teach lies about climate change." *Vice News*. Available at https://www.vice.com/en_us/article/qvz593/six-states-trying-to-pass-climate-denial-in-education-legislation.

Gudynas, E. (2011). Buen vivir: Today's tomorrow. *Development* 54(4): 441-447.

Gwekwerere, Y. (2014). Pre-service teachers' knowledge, participation and perceptions about environmental education in schools. *Australian Journal of Environmental Education* 30(2): 198-214.

Haight, M. (2007). Greening the university curriculum: Appraising an international movement. *Journal of Geography in Higher Education* 29(1): 31-48.

hooks, b. (1994). *Teaching to transgress: Education as the practice of freedom*. New York: Routledge.

Huckle, J. and A.E.J. Wals. (2015). The UN Decade of Education for Sustainable Development: Business as usual in the end. *Environmental Education Research* 21(3): 491-505.

Humphreys, C., S. Blenkinsop, and B. Jickling. (forthcoming). A symphony of Baudrillard: Education, sustainable or otherwise, as simulacra. *Knowledge Cultures*.

Idso, C., R. Carter, and F. Singer. (2015). *Why scientists disagree about global warming—Second edition*. Arlington Heights: Heartland Institute.

Intergovernmental Panel on Climate Change (IPCC). (2018). Summary for Policymakers. In V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (Eds.). *Global warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. Geneva: World Meteorological Organization.

International Bureau of Education. (2016). Global monitoring of target 4.7: Themes in national curriculum frameworks. Background paper prepared for the 2016 Global Education Monitoring Report. Paris: UNESCO.

Islam, M.S. (2012). Old philosophy, new movement: The rise of the Islamic ecological paradigm in the discourse of environmentalism. *Nature and Culture* 7(1): 72-94.

Iyengar, R. and M. Bajaj. (2011). After the smoke clears: Toward education for sustainable development in Bhopal, India. *Comparative Education Review* 55(3): 424-456.

Jickling, B. (2017). "Education revisited: Creating educational experiences that are held, felt, and disruptive." In B. Jickling and S. Sterling (Eds.), *Post-sustainability and environmental education: Remaking education for the future*, pp. 15-30. Cham, Switzerland: Palgrave Macmillan.

Jickling, B. and S. Blenkinsop. (forthcoming). Wilding teacher education: Responding to the cries of nature. *Canadian Journal of Environmental Education*. Jickling, B., S. Blenkinsop, N. Timmerman, and M. De Dannan Sitka-Sage (Eds.). (2018). *Wild pedagogies: Touchstones for renegotiating education and the environment in the Anthropocene*. Cham, Switzerland: Palgrave Macmillan.

Jickling, B. and S. Sterling. (2017). "Post-sustainability and environmental education: Framing issues." In B. Jickling and S. Sterling (Eds.), *Post-sustainability and environmental education: Remaking education for the future*, pp. 1-11. Cham, Switzerland: Palgrave Macmillan.

Jickling, B. and A.E.J. Wals. (2008). Globalization and environmental education: Looking beyond sustainable development. *Journal of Curriculum Studies* 40(1): 1-21.

Jimenez, J.D., J. Lerch, and P. Bromley. (2017). Education for global citizenship and sustainable development in social science textbooks. *European Journal of Education* 52(4), 460-476.

Kahn, R. (2011). "How should global climate change change the climate of our conversation in education?" Available at <http://sustainability.psu.edu/fieldguide/wp-content/uploads/2015/09/kahn-oslotalk2011.pdf>.

Kamenetz, A. (2019). "Most teachers don't teach climate change; 4 in 5 parents wish they did." NPR. Accessed <https://www.npr.org/2019/04/22/714262267/most-teachers-dont-teach-climate-change-4-in-5-parents-wish-they-did>.

Keller, L., J. Stötter, A. Oberrauch, A. Kuthe, A. Körfgen, and K. Hübner. (2019). Changing climate change education: Exploring moderate constructivist and transdisciplinary approaches through the research-education cooperation *k.i.d.Z.21*. *Gaia* 28(1).

Kerret, D., H. Orkibi, and T. Ronen. (2016). Testing a model linking environmental hope and self-control with students' positive emotions and environmental behavior. *The Journal of Environmental Education* 47(4): 307-317.

Kollmuss, A. and J. Agyeman. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research* 8(3): 239-260.

Komatsu, H. and Rappleye, J. (2018). Will SDG4 achieve environmental sustainability? Center for Advanced Studies in Global Education Working Paper #4. Phoenix: Arizona State University.

Kwauk, C. (2019). "Why Captain Planet should have been a woman." *Education Plus Development*, Brookings. Available at <https://www.brookings.edu/blog/education-plus-development/2019/03/28/why-captain-planet-should-have-been-a-woman/>.

Kwauk, C. and A. Braga. (2017). Three Platforms for Girls' Education in Climate Strategies. Washington, DC: Brookings.

Kwauk, C., J. Cooke, E. Hara, and J. Pegram. (2019). Girls' education in climate strategies: Opportunities for improved policy and enhanced action in Nationally Determined Contributions. Working Paper 133. Washington, DC: Brookings.

Læssøe, J., K. Schnack, S. Breiting, and S. Rolls. (2009). Climate change and sustainable development: The response from education. International Alliance of Leading Education Institutes.

Lawson, D.F., et al. (2019). Children can foster climate change concern among their parents. *Nature Climate Change* 9: 458-462.

Ledley, T.S., J. Rooney-Varga, and F. Niepold. (2017). Addressing climate change through education. *Oxford Research Encyclopedias*. Available at <https://oxfordre.com/environmentalscience/abstract/10.1093/acrefore/9780199389414.001.0001/acrefore-9780199389414-e-56>.

Lefay, R. (2006). An ecological critique of education. *International Journal of Children's Spirituality* 11(1): 35-45.

Lotz-Sisitka, H. (2017). "Education and the common good." In B. Jickling and S. Sterling (Eds.), *Post-sustainability and environmental education: Remaking education for the future*, pp. 63-76. Cham, Switzerland: Palgrave Macmillan.

Lotz-Sisitka, H., M. Mukute, C. Chikunda, A. Baloi, and T. Pesanayi. (2017). Transgressing the norm: Transformative agency in community-based learning for sustainability in southern African contexts. *International Review of Education* 63: 897-914.

Lutz, W., R. Muttarak, and E. Striessnig. (2014). Universal education is key to enhanced climate adaptation. *Science* 346: 1061-1062.

Macintyre, T., H. Lotz-Sisitka, A. Wals, C. Vogel, and V. Tassone. (2018). Towards transformative social learning on the path to 1.5 degrees. *Current Opinion in Environmental Sustainability* 31: 80-87.

McBride, B.B., C.A. Brewer, A.R. Berkowitz, and W.T. Borrie. (2013). Environmental literacy, ecological literacy, ecoliteracy: What do we mean and how did we get here? *Ecosphere* 4(5).

McCaffrey, M. (forthcoming). "Education's dark shadow and (how to enlighten it)." Unpublished draft paper.

McCaffrey, M. (2014). *Climate smart and energy wise: Advancing science literacy, knowledge, and know-how*. Corwin Press.

McCaffrey, M. (2017). "From person to planet in ten easy steps." *Medium*. Available at https://medium.com/@markmccaffrey_90684/from-person-to-planet-in-ten-easy-steps-29b08f13edb5.

McLean, K.G. (2010). *Advance guard: Climate change impacts, adaptation, mitigation and indigenous peoples—A compendium of case studies*. Darwin, Australia: United Nations University.

McMillin, J. and R. Dyball. (2009). Developing a whole-of-university approach to educating for sustainability: Linking curriculum, research and sustainable campus operations. *Journal of Education for Sustainable Development* 3: 55-64.

McNeal, P.M. and H.L. Petcovic. (2019). Sound practices in climate change education. *Science Scope* 42(6).

Meyer, A. (2015). Does education increase pro-environmental behavior? Evidence from Europe. *Ecological Economics* 116: 108-121.

Mitchell, T., K. Haynes, N. Hall, W. Choong, and K. Oven. (2008). The roles of children and youth in communicating disaster risk. *Children, Youth, and Environments* 18(1): 254-279.

Mogren, A., N. Gericke, and H. Scherp. (2019). Whole school approaches to education for sustainable development: A model that links to school improvement. *Environmental Education Research* 25(4): 508-531.

Molthan-Hill, P., N. Worsfold, G.J. Nagy, W. Leal Filho, and M. Mifsud. (2019). Climate change education for universities: A conceptual framework from an international study. *Journal of Cleaner Production* 226: 1092-1101.

Monroe, M.C., R.R. Plate, A. Oxarart, A. Bowers, and W.A. Chaves. (2017). Identifying effective climate change education strategies: A systematic review of the research. *Environmental Education Research* 25(6): 791-812.

Morgan, P.A. (2017). "Envisioning education in the Anthropocene: Long-range and game-changing." In Corcoran, P.B., J.P. Weakland, and A.E.J. Wals (Eds.), *Envisioning futures for environmental and sustainability education*, pp. 117-127. Wageningen, Netherlands: Wageningen Academic Publishers.

Muttarak, R. and W. Lutz. (2014). Is education a key to reducing vulnerability to natural disasters and hence unavoidable climate change? *Ecology and Society* 19(1): 42.

- Mwaura, G.M. (2018). “Professional students do not play politics’: How Kenyan students professionalise environmental activism and produce neoliberal subjectivities.” In S. Pickard and J. Bessant (Eds.), *Young people re-generating politics in times of crises*. Cham, Switzerland: Palgrave Macmillan.
- Mwaura, G., M. Pradhan, and K. Gitahi. (2017). “Envisioning youth futures through university students’ education for sustainability initiatives.” In Corcoran, P.B., J.P. Weakland, and A.E.J. Wals (Eds.), *Envisioning futures for environmental and sustainability education*, pp. 181-192. Wageningen, Netherlands: Wageningen Academic Publishers.
- Nagendra, H. (2018). “The global south is rich in sustainability lessons that students deserve to hear.” *Nature*. Available at <https://www.nature.com/articles/d41586-018-05210-0>.
- Nakashima, D.J., K. Galloway McLean, H.D. Thulstrup, A. Ramos Castillo, and J.T. Rubis. (2012). *Weathering uncertainty: Traditional knowledge for climate change assessment and adaptation*. Paris/Darwin: UNESCO/UNU.
- No author. (2018). Sustainability starts with teachers: An ESD Action Learning Programme for Secondary Teacher Educators in Southern Africa. UNESCO.
- Ojala, M. (2017). Facing anxiety in climate change education: From therapeutic practice to hopeful transgressive learning. *Canadian Journal of Environmental Education* 21: 41.
- Olsson, D., N. Gericke, and S.N. Chang Rundgren. (2016). The effect of implementation of education for sustainable development in Swedish compulsory schools—Assessing pupils’ sustainability consciousness. *Environmental Education Research* 22(2): 176-202.
- O’Neil, D.W., A.L. Fanning, W.F. Lamb, and J.K. Steinberger. (2018). A good life for all within planetary boundaries. *Nature Sustainability* 1: 88-95.
- Orr, D. (1991). What is education for? Six myths about the foundations of modern education, and six new principles to replace them. *In Context*. Available from <https://www.eeob.iastate.edu/classes/EEOB-590A/marshcourse/V.5/V.5a%20What%20Is%20Education%20For.htm>.
- Orr, D. (1992). *Ecological literacy: Education and transition to a postmodern world*. Albany, NY: SUNY Press.
- Orr, D. (2004). *Earth in mind: On education, environment, and the human prospect*. Washington: Island Press. (Original work published in 1994).
- Pashby, K. and L. Sund. (no date). Teaching for sustainable development through ethical global issues pedagogy: A resource for secondary teachers. Manchester Metropolitan University. Available at <https://www.mundu.dk/wp-content/uploads/Karen-Pashby-Louise-Sund-EthicalGlobalIssues.pdf>.
- Pavlova, M. (2013). Towards using transformative education as a benchmark for clarifying differences and similarities between environmental education and education for sustainable development. *Environmental Education Research* 19(5): 656-672.
- Peek, L. (2008). Children and disasters: Understanding vulnerability, developing capacities, and promoting resilience—An introduction. *Children, Youth and Environments* 18(1).

Pirgmaier, E. and J.K. Steinberger. (2019). Roots, riots, and radical change—A road less travelled for ecological economics. *Sustainability* 11.

Plan International. (2011). Weather the storm: Adolescent girls and climate change. Available at <https://plan-international.org/publications/weather-storm>.

Plutzer, E., A.L. Hannah, J. Rosenau, M.S. McCaffrey, M. Berbeco, and A.H. Reid. (2016). “Mixed messages: How climate is taught in America’s schools.” Oakland, CA: National Center for Science Education.

Plutzer, E., M. McCaffrey, A.L. Hannah, J. Rosenau, M. Berbeco, and A.H. Reid. (2016). Climate confusion among U.S. teachers: Teachers’ knowledge and values can hinder climate education. *Science* 351(6274): 664-665.

Redman, A. and E. Redman. (2017). Is subjective knowledge the key to fostering sustainable behavior? Mixed evidence from an education intervention in Mexico. *Education Sciences* 7(4).

Rio+20 Education Group (2012). “The education we need for the world we want.” Available at <http://rio20.net/en/propuestas/the-education-we-need-for-the-world-we-want/>.

Roberts, J.T. and B.C. Parks. (2007). Fueling injustice: Globalization, ecologically unequal exchange, and climate change. *Globalizations* 4(2): 193-210.

Rood, R.B. (2017). “If we stopped emitting greenhouse gases right now, would we stop climate change?” *The Conversation*. Available at <http://theconversation.com/if-we-stopped-emitting-greenhouse-gases-right-now-would-we-stop-climate-change-78882>.

Rooney-Varga, J.N, et al. (2018). Combining role-play with interactive stimulation to motivate informed climate action: Evidence from the *World Climate* simulation. *PLOS One* 13(8).

Save the Children. (2015). Mitigating Ethiopia’s drought impacts on children through education.

Sawin, E. (2018). “The magic of ‘multisolving’: Six principles and practices to un-lock cross-sectoral collaboration.” *Stanford Social Innovation Review*. Available at https://ssir.org/articles/entry/the_magic_of_multisolving.

Schultz, P.W., V.V. Gouveia, L.D. Cameron, G. Tankha, P. Schmuck, and M. Franek. (2005). Values and their relationship to environmental concern and conservation behavior. *Journal of Cross-Cultural Psychology* 36(4): 457-475.

Selby, D. and F. Kagawa. (2010). Runaway climate change as challenge to the ‘closing circle’ of education for sustainable development. *Journal of Education for Sustainable Development* 4(1): 37-50.

Sellers, S. (2016). Gender and climate change: A closer look at existing evidence. Global Gender and Climate Alliance.

Shiva, V. (2013). Everything I need to know I learned in the forest. *NAMTA Journal* 38(1): 273-276.

Silova, I., J. Rappleye, and H. Komatsu. (2019). Measuring what *really* matters: Education and large-scale assessments in the time of climate crisis. *ECNU Review of Education* 2(3): 342-346.

Smith, N. and A. Leiserowitz. (2014). The role of emotion in global warming policy support and opposition. *Risk Analysis* 34: 937-948.

Souza, D.T., A.E.J. Wals, and P.R. Jacobi. (2019). Learning-based transformations towards sustainability: A relational approach based on Humberto Maturana and Paulo Freire. *Environmental Education Research*.

Sterling, S. (2004a). Sustainable education: Re-visioning learning and change. *Schumacher Briefings*, 6. Devon: Green Books.

Sterling, S. (2004b). The ecological and environmental dimensions of the holistic curriculum. In *Encyclopedia of life support systems (Theme 6.6.1 'Education for Sustainability')*. EOLSS Publishers; UNESCO.

Sterling, S. (2010-11). Transformative learning and sustainability: Sketching the conceptual ground. *Learning and Teaching in Higher Education* 5: 17-33.

Sterling, S. (2017a). "‘More than scaling up’: A critical and practical inquiry into operationalizing sustainability competencies." In Corcoran, P.B., J.P. Weakland, and A.E.J. Wals (Eds.), *Envisioning futures for environmental and sustainability education*, pp. 153-168. Wageningen, Netherlands: Wageningen Academic Publishers.

Sterling, S. (2017b). "Assuming the future: Repurposing education in a volatile age." In B. Jickling and S. Sterling (Eds.), *Post-sustainability and environmental education: Remaking education for the future*, pp. 31-45. Cham, Switzerland: Palgrave Macmillan.

Striessnig, E., W. Lutz, and A.G. Patt. (2013). Effects of educational attainment on climate risk vulnerability. *Ecology and Society* 18(1): 16.

Sund, L. and K. Pashby. (2019). "Taking up ethical global issues in the classroom." In K.V. Poeck, L. Östman, and J. Öhman (Eds.), *Sustainable development teaching: Ethical and political challenges*, pp. 204-212. London: Routledge.

Tanner, T. (2010). Shifting the narrative: Child-led responses to climate change and disasters in El Salvador and the Philippines. *Children and Society* 24: 339-351.

UN CC:Learn. (2013). Resource guide for advanced learning on integrating climate change in education at primary and secondary level. UNITAR.

UNESCO. (no date) "UN Decade of ESD." [website]. Available at <https://en.unesco.org/themes/education-sustainable-development/what-is-esd/un-decade-of-esd>.

UNESCO. (1997). Educating for a sustainable future: A transdisciplinary vision for concerted action. Paris: UNESCO.

UNESCO. (2011). Climate change starter's guidebook: An issue guide for education planners and practitioners. Paris: UNESCO.

UNESCO. (2013) Climate change in the classroom. Paris: UNESCO.

UNESCO. (2015a). "Not just hot air: Putting climate change education into practice." Paris: UNESCO.

- UNESCO. (2015b). "Rethinking education: Towards a global common good?" Paris: UNESCO.
- UNESCO. (2016). Textbooks pave the way to sustainable development. Policy paper 28. Paris: Global Education Monitoring Report, UNESCO.
- UNESCO. (2018). Global Education Meeting 2018 Synthesis Report. Brussels: UNESCO.
- UNESCO. (2019a). Educational content up close: Examining the learning dimensions of Education for Sustainable Development and Global Citizenship Education. Paris: UNESCO.
- UNESCO. (2019b). Country progress on climate change education, training and public awareness: An analysis of country submissions under the United Nations Framework Convention on Climate Change. Paris: UNESCO.
- UNESCO. (2019c). Sixth meeting of the Global Alliance to Monitor Learning (GAML 6): Results of the consultation on GAML6 items for endorsement. UNESCO. Available at <http://gaml.uis.unesco.org/wp-content/uploads/sites/2/2019/05/GAML-Consultation-Results-final.pdf>.
- UNESCO and UNEP. (2011). YouthXchange Climate change and lifestyle guidebook. Paris and Nairobi: UNESCO and UNEP.
- UNEVOC. (2017). Greening technical and vocational education and training: A practical guide for institutions. Bonn: UNESCO.
- UNICEF. (no date). Climate change and environmental education. New York: UNICEF.
- UNICEF. (2012). Climate change adaptation and disaster risk reduction in the education sector: Resource manual. New York: UNICEF.
- Van Poeck, K., J. Vandenabeele, and H. Bruyninckx. (2013). Sustainable citizenship and education. Available at https://www.researchgate.net/publication/278409752_SUSTAINABLE_CITIZENSHIP_AND_EDUCATION.
- VVOB. (2019). Education: A powerful tool for combatting climate change—A guide for education unions and educators. Available at https://issuu.com/educationinternational/docs/ie_education_a_power_full_tool_for.
- Wals, A.E.J. (2010). Mirroring, Gestaltswitching and transformative social learning: Stepping stones for developing sustainability competence. *International Journal of Sustainability in Higher Education* 11(4): 380-390.
- Wals, A.E.J. (2012). Learning our way out of un-sustainability: The role of environmental education. In S. Clayton (Ed.), *Oxford handbook on environmental and conservation psychology*. London: Oxford University Press.
- Wals, A.E.J. and A. Benavot. (2017). Can we meet the sustainability challenges? The role of education and lifelong learning. *European Journal of Education* 52: 404-413.
- Wals, A.E.J., J. Weakland, and P.B. Corcoran. (2017). "Introduction." In P.B. Corcoran, J.P. Weakland, and A.E.J. Wals (Eds.), *Envisioning futures for environmental and sustainability education*, pp. 19-30. Wageningen, the Netherlands: Wageningen Academic Publishers.

Wamsler, C., E. Brink, and O. Rentala. (2012). Climate change, adaptation, and formal education: The role of schooling for increasing societies' adaptive capacities in El Salvador and Brazil. *Ecology and society* 17(2).

Wiek, A., L. Withycombe, and C.L. Redman. (2011). Key competencies in sustainability—A reference framework for academic program development. *Sustainability Science* 6(2): 203-218.

Wise, S.B. (2010). Climate change in the classroom: Patterns, motivations, and barriers to instruction among Colorado science teachers. *Journal of Geoscience Education* 58(5): 297.

Wright, D.S., M.M. Balgopal, L.B. Sample McMeeking, and A.E. Weinberg. (2019). Developing resilient K-12 STEM teachers. *Advances in Developing Human Resources* 29(1): 16-34.

Wynes, S. and K.A. Nicholas. (2017). The climate mitigation gap: Education and government recommendations miss the most effective individual actions. *Environmental Research Letters* 12.

Zhang, N., I.D. Williams, S. Kemp, and N.F. Smith. (2011). Greening academia: Developing sustainable waste management at higher education institutions. *Waste Management* 31(7): 1606-16.

Zou, J.J. (2017). Oil's pipeline to America's schools: Inside the fossil-fuel industry's not-so-subtle push into K-12 education. The Center for Public Integrity. Available at <https://apps.publicintegrity.org/oil-education/>.