



# Strengthening Climate Change Education in the United States



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United States

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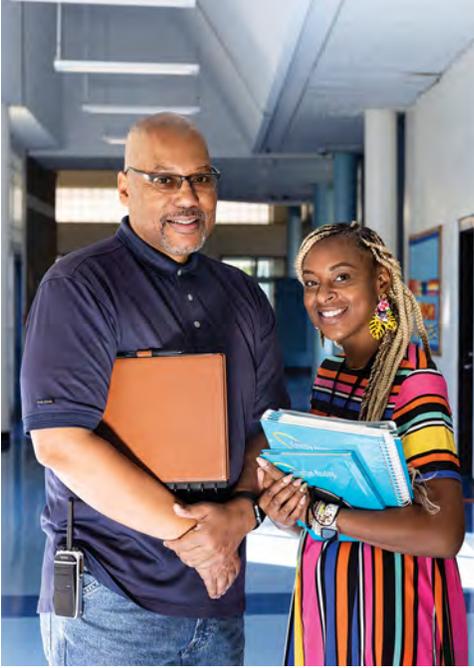
# Strengthening Climate Change Education in the United States

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March 2023





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## Executive Summary



In addition to posing an existential challenge to life on earth, climate change is one of the most serious social justice challenges facing our society today. As greenhouse gas effects accelerate changes throughout the world,<sup>1, 2, 3</sup> people of color and low-income communities face a disproportionate share of the negative effects.<sup>4, 5</sup>

Our current generation of scientists and policymakers must implement a systemic response to the immediate climate crisis. But at the same time, education systems must equip young people with the knowledge and skills they need to prevent and mitigate the long-term effects of climate change, which they will feel for the rest of their lives.

Inspiring youth to do this work won't be difficult. Young people already demonstrate a passion for being part of the solution and put themselves on the front lines of climate change. Globally, youth are demanding stronger action from the educational, political, and industrial institutions around them. Now, American education systems must make strategic and systemic commitments to improve and advance climate change education.

### The question is how.

Based on our analysis of recent research, FHI 360 is making four strategic recommendations to advance climate change education in the United States.

1. **Enact policy to support climate change education at national, state, district, and school levels.** Every tier of education systems must act to improve students' climate change education. Government agencies, economic systems, and political structures must also adapt to better support climate change educators and young people.
2. **Provide access to high-quality curricula and materials that are grounded in scientific evidence.** Climate change education must be grounded in evidence to

provide young people with a foundational scientific understanding. It should build their knowledge, skills, and commitment to participating in ongoing efforts to design solutions for a changing world.<sup>6,7</sup>

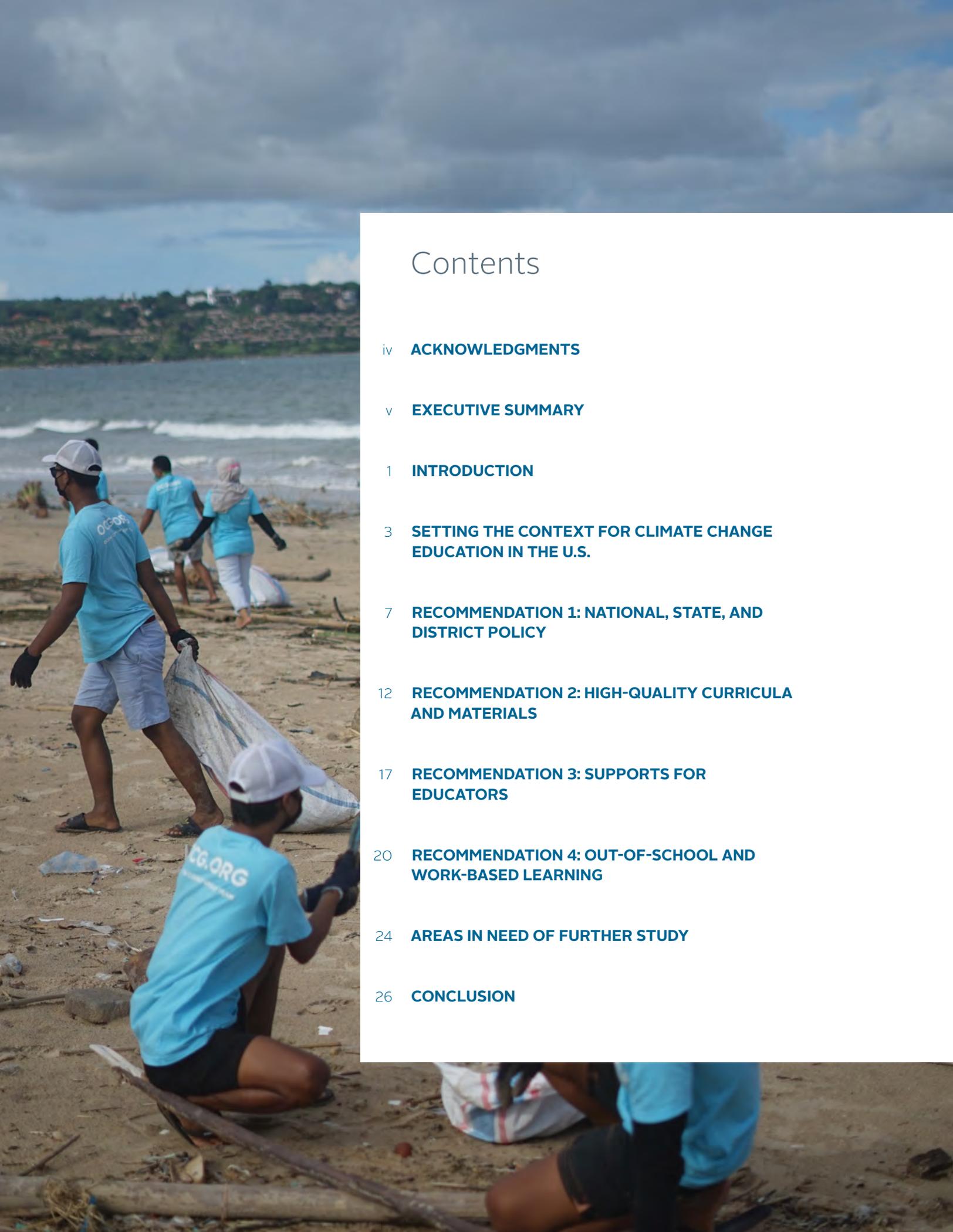
3. **Support educators with training and professional development.** In addition to quality curricula, education leaders and policymakers need to provide educators with effective professional development, so they have the training, resources, and confidence they need to effectively teach about climate change.
4. **Scale up out-of-school time and work-based learning models.** To ensure equitable and systemic access, climate education should be a core topic within standards-based classroom learning. It must also be interdisciplinary and integrated into informal and out-of-school programs, as these outlets provide youth with hands-on opportunities to learn and develop understanding in different contexts.

**Throughout these recommendations, we also highlight the importance of elevating the voices and power of young people, especially those from marginalized populations.**

Educators empower young people to have hope for their futures and continue advocating for responsible environmental changes by supporting their self-efficacy and instilling the values of environmental justice.

By elevating youth voice, leveraging solutions-focused and interdisciplinary approaches, and connecting local and global experiences, climate change education can successfully support young people's engagement in the climate crisis and build their sense of self-efficacy so that they can make a positive difference.





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## Introduction



Young people are not only victims of climate change. They are also valuable contributors to climate action. They are agents of change, entrepreneurs, and innovators. Whether through education, science or technology, young people are scaling up their efforts and using their skills to accelerate climate action.

– United Nations, Youth in Action<sup>129</sup>

Preparing all students in the United States with the knowledge and skills necessary to tackle the climate change crisis requires a cohesive, multi-faceted approach. As climate change accelerates, researchers are working to keep up with new and evolving climate change models. Recent research provides valuable findings that can inform every level of climate change education, ranging from pedagogy to education policy.

While the scope of the climate change crisis demands an urgent, global response, effective climate education strategies must also be locally driven and responsive to community needs. To establish a context for understanding domestic climate education, this report expands upon prior research by highlighting findings from grey literature and articles published between 2014 and 2022 that focus on United States climate education in public K-12 schools and informal education. Many of the existing literature reviews in this field focused on international research and studies prior to 2015, corresponding with UNESCO's "Decade of Education for Sustainable Development."<sup>8, 9, 10</sup>

Grounded in more recent research, this report lays a foundation for climate change education program development and future research to support schools, policymakers, foundations, and community organizations. This report expands upon proposals from other advocates and policymakers, including the K12 Climate Action Plan developed by the Aspen Institute, which provides extensive community-sourced recommendations for strengthening education policy, infrastructure, and funding.<sup>11</sup> We build upon the K12 Climate Action Plan by providing evidence-based research examples that support a comprehensive vision for how specific elements of United States education systems can be strengthened to best advance climate change education.

## HOW WE ORGANIZED THIS REPORT

We begin this report by describing the current context of science standards and youth climate activism in the United States. In each section, we highlight elevating the voices of young people and marginalized populations in all climate change education initiatives. In line with the principles of environmental justice, all people deserve the right to “participate as equal partners” in decision-making that impacts their environmental wellbeing.<sup>12</sup>

Too often, young people and marginalized communities are denied this right, and climate change education can serve as an important means of increasing their power. Every component of climate change education—from systems change to educational materials to professional development to informal education—must empower young people and marginalized groups to gain the knowledge and skills they need to work towards climate justice.

Through this lens, we distill our findings into four key recommendations for strategies to ensure all young people in the country have access to high quality, comprehensive climate change education. This report makes recommendations based on existing evidence and looks to grassroots organizations, educators, policymakers, and funders to determine how best to achieve them.

*All people deserve the right to “participate as equal partners” in decision-making that impacts their environmental wellbeing.*

## EDUCATIONAL AND ENVIRONMENTAL JUSTICE

The effects of climate change are not experienced equally throughout the United States. Communities of color experience the highest levels of air pollution, have the poorest water quality, have less access to nutritional food resources, and are at the greatest risk from extreme weather conditions, including dangerous heat, flooding, storms, and wildfires.<sup>13</sup> These environmental conditions—the result of centuries of slavery and segregation, forced displacement, community disinvestment, and economic exclusion—still harm communities of color today.

Climate change exacerbates these existing social, educational, and economic inequalities—the same factors that make these communities most vulnerable to climate change itself. In addition to worsening physical and mental health, these conditions reduce educational opportunities and positive outcomes for students. To address these challenges, climate change education initiatives must



Principle of Environmental Justice 16 calls for the education of present and future generations which emphasizes social and environmental issues, based on our experience and an appreciation of our diverse cultural perspectives.

– Principles of Environmental Justice<sup>130</sup>



account for existing inequities and prioritize serving students who are most in need.

To guide these efforts, the First National People of Color Environmental Leadership Summit's Principles of Environmental Justice, adopted in October, 1991, call for a strengths-based, community-led approach. Grounded in 17 principles, the environmental justice movement affirms that communities deserve the right to participate in decision-making that impacts their environmental wellbeing, legal and practical protection from environmental harm, and access to critical resources such as health care and education.<sup>14</sup> Environmental justice is paramount to equitable education and student wellbeing.

Throughout this report, we call attention to areas of inequity (see Equity Need boxes in each report section) and highlight examples of promising strategies that can support communities who are most harmed by climate change.

## Setting the context for climate change education in the U.S.

Within the United States, climate change education varies widely—from schools that promote comprehensive and interdisciplinary approaches to classrooms where teachers deny climate change as a legitimate scientific issue.<sup>15</sup> Research shows that across these diverse contexts, young people are setting their own goals for climate change education and action. As young people are defining their own educational experiences, these experiences are also shaped by the standards that guide education systems. Together, youth climate activism and state science standards both have significant effects on the evolving climate education landscape.

### YOUTH ENGAGEMENT IN CLIMATE ADVOCACY

Even across differing learning environments, young people report high engagement with climate change topics. More than any other age group, Gen Z (born 1997–2012) shows greater support for climate-focused government policy, reducing reliance on fossil fuels, and taking personal action to advocate for climate policies.<sup>16</sup> One in four American



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This country, my country, still has to deliver on the promise for justice and equity for me and my people. But let's be clear: we cannot solve the climate crisis until Black lives matter, and no community is disposable.

– Eden Alem, Youth Climate Activist, Sunrise Movement<sup>131</sup>

teenagers report that they have participated in a school walkout, protested, or reached out to a government official about climate change.<sup>17</sup>

In addition to advocating in their own communities, students are organizing and joining national efforts such as the Alliance for Climate Change's Youth Action Network<sup>18</sup> and the Sunrise Movement.<sup>19</sup> Youth also tackle international action through the United Nations (UN) Climate Change Conferences and UN Youth Advisory Group on Climate Change.<sup>20</sup> Throughout this report, we highlight examples of young people's climate action and leadership in "Youth in Action" boxes.

As much as climate change is an area for passion and activism for youth, it is also a cause of stress and anxiety. A 2021 international survey found that over half of young people feel sad, anxious, and powerless about climate change, with 45 percent indicating these feelings impact their daily functioning.<sup>21</sup> A survey of teenagers in the United States found that 84 percent believe climate change must be addressed immediately, or else it will be too late for future generations.<sup>22</sup>

Climate change curricula that focus on solutions to address these challenges have been found to decrease climate anxiety.<sup>23</sup> In addition to these curricula, social emotional support from educators is critical as youth face mounting stress and anxiety about the negative impacts of climate change that impact their overall wellbeing. Knowing this, education systems should develop holistic strategies for supporting young people's social and emotional wellbeing.

By listening to young people's perspectives, helping them express their ideas and concerns, and providing them with meaningful opportunities to learn and get involved, educators can help youth recognize that they are valuable contributors who have the agency to make a difference. Educators can also foster youth civic engagement and activism by partnering with social justice organizations and supporting the development of students' critical consciousness within their classrooms.<sup>24, 25</sup>

## CLIMATE CHANGE EDUCATION STANDARDS AND PRACTICES

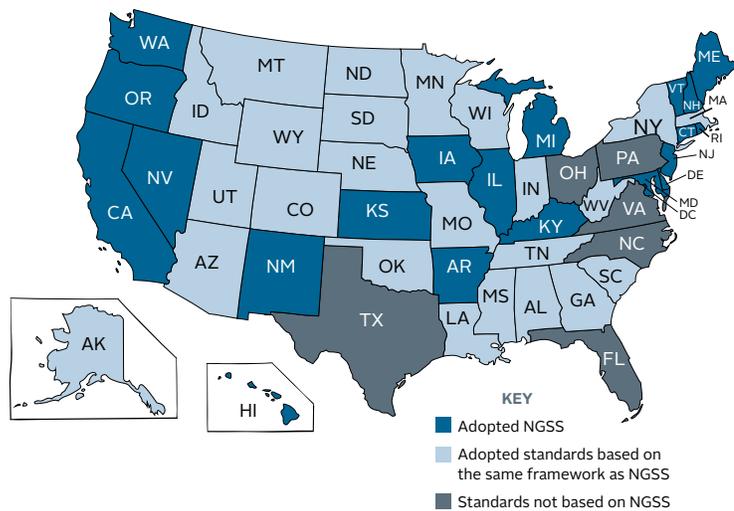
Teaching standards matter, as they impact educational priorities, funding, and policy. A 2018 survey of science

teachers found that 84 percent of middle and high school science teachers and 79 percent of elementary science teachers agreed that most science teachers in their respective schools teach to state standards.<sup>26</sup> In the past decade, many states have adopted the Next Generation Science Standards (NGSS), which are based on A Framework for K-12 Science Education, developed in 2011 by the National Resource Council of the National Academy of Sciences.<sup>27</sup>



These standards have had broad, positive impacts on science education. Students in schools that have adopted NGSS tend to be more engaged in science, benefit from more inclusive participation in activities, and demonstrate better academic outcomes.<sup>28</sup> NGSS also requires climate change instruction, including instruction about how human activity has contributed to climate change, the implications of climate change, and solutions to mitigate its harmful effects. As of 2021, 20 states and the District of Columbia had adopted NGSS, and an additional 24 states drafted standards based on A Framework for K-12 Science Education (the same framework that undergirds NGSS).<sup>29</sup>

NGSS Adoption By State



*Students in schools that have adopted NGSS tend to be more engaged in science, benefit from more inclusive participation in activities, and demonstrate better academic outcomes.*

The remaining six states (Texas, Florida, Ohio, Pennsylvania, Virginia, and North Carolina) are home to 29 percent of students in the country and have science standards that lack critical guidance for climate change education.<sup>30</sup> Policymakers in these states can strengthen the quality and accuracy of climate change education by implementing NGSS, which offers guidance while allowing flexibility for districts and educators to choose activities that best serve their students.

# NGSS Performance Expectation

## Middle School ESS3: Earth and Human Activity<sup>132</sup>

MS-ESS3-1	Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.
MS-ESS3-2	Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.
MS-ESS3-4	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-ESS3-5	Ask questions to clarify evidence of factors that have caused the rise in global temperatures over the past century.

## High School ESS3: Earth and Human Activity<sup>133</sup>

HS-ESS3-1	Construct an evidence-based explanation for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
HS-ESS3-3	Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ESS3-5	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.
HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.



State standards impact the topics and content covered in classrooms, but these standards have less direct influence on pedagogical practices, the scientific rigor of curricular materials, and the quality of professional development opportunities. For instance, a 2016 survey found that about 75 percent of science teachers in the United States devote at least one class session to the topic of climate change, but the total hours of instruction and accuracy of information presented vary considerably.<sup>31</sup> In the same survey, about one third of science teachers presented climate change as an issue that scientists disagree on, rather than emphasizing humans' role in causing climate change as a validated fact, and fewer than half of science teachers had received any formal undergraduate or graduate coursework on climate change.

While strong science standards can encourage educators to focus on climate topics, successful implementation relies on state and school district leaders to provide evidence-based curricular materials and support professional development that equips teachers to successfully prepare for, implement, and assess climate change instruction in the classroom.



## Recommendation 1: Enact policy to support climate change education at national, state, district, and school levels.

The scale and urgency of climate change demands a systemic response. The systems that support educators and students (e.g., district administration, state and federal legislation, philanthropic institutions) must also transform to better promote and sustain climate change education. These groups have the resources and influence to meaningfully shape the climate change education environment. To use this power effectively, these leaders must partner with and be informed by grassroots efforts, youth, educators, and scientists.

## OPPORTUNITIES FOR NATIONAL COORDINATION

Federal policymakers have a responsibility to set a national agenda, and state policymakers must leverage their own power over state standards and classroom curricula to advance climate change education. For example, the K12 Climate Action Plan recommends that the federal government establish climate education offices, fund curriculum development and local climate action plans, and increase support for climate-focused job training programs.<sup>32</sup> Recent successes at the federal level include the establishment of the Office of Environmental Justice within the US Department of Health and Human Services that prioritizes supporting the environmental health of communities most impacted by climate change. Climate education grants and educational resources are also available through multiple government agencies, including the Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA).



*The scale and urgency of climate change demands a systemic response. The systems that support educators and students (e.g., district administration, state and federal legislation, philanthropic institutions) must also transform to better promote and sustain climate change education.*

Beyond requiring educators to seek out grants and online resources, the federal government needs a more comprehensive, coordinated approach to guiding climate change education. Federal government offices have the power to guide school district investments and decision making. For example, the US Department of Education's "Green Ribbon School" designation is an evidence-based incentive program that shapes district priorities.<sup>33</sup> The Green Ribbon Schools initiative supports both climate-friendly infrastructure and educational efforts by recognizing schools that reduce their environmental impact, improve the health and wellness of students, and offer effective environmental education. Green Ribbon Schools receive plaques and participate in networking with other winners to encourage resource sharing and school-to-school learning.<sup>34</sup> To work toward Green Ribbon School status, schools can also work with the Department of Energy's Better Buildings Challenge to identify greener energy models and infrastructure.<sup>35</sup>

## THE POWER OF STATE-LEVEL POLICIES

State policymakers play an important role in selecting science standards and determining educators' access to critical supports. A 2020 report from the National Center for Science Education and the Texas Freedom Network Education Fund graded every state's science standards



based on how well the standards communicate four critical ideas about climate change: 1) it's real, 2) it's us (caused by human activity), 3) it's bad, and 4) there's hope. Just over half of states (27) earned a grade of at least B+.<sup>36</sup> The greatest shortcomings in lower-graded science standards include failing to directly name and address climate change; promoting climate change as a debate; vague and misleading scientific content; and a lack of focus on finding hope and solutions.<sup>37</sup>

While these challenges are common among many states, a few states set positive examples by enacting legislation to strengthen climate change education requirements beyond the NGSS.<sup>38</sup> For example, states can enact policies to increase funding for climate change education and training, require climate change education in science, and include climate change education in other subjects (e.g., social studies). There is room to improve in all of these areas. As of 2020, only 29 states required teaching about human-caused climate change in science classes, and just five states required including the topic in social studies classes.<sup>39</sup>



#### **EQUITY NEED: Systematically prioritize marginalized populations.**

Government and educational institutions have historically excluded—and continue to exclude—low-income communities and students of color from high quality education, perpetuating a multitude of inequities.<sup>134</sup> As these groups are also disproportionately harmed by climate change, it is critical to reform government institutions, political processes, and economy systems that determine how marginalized communities' environmental wellbeing.<sup>135</sup> For example, voting systems must ensure people of color can participate in elections to elect equity-minded, climate-focused candidates. Economic systems must stop targeting low-income communities to house toxic waste sites, which harm both health and educational outcomes.<sup>136</sup>

Beginning in 2023, Connecticut will require climate change education to be taught in science classes.<sup>40</sup> While the state did not allocate funding to support this new requirement, Connecticut's legislation promised to make the state's Department of Energy and Environmental Protection available to support local boards of education in curriculum

development.<sup>41</sup> While this policy may not drastically impact the experiences of students in the state, as 90 percent of schools in the state reported already teaching about climate change, it offers an exemplar policy for other states to consider.<sup>42</sup>

New Jersey offers another example of how state legislatures can get involved to promote climate education. The state first passed legislation in 2020 to add climate change content into non-science subjects, including social studies, computer science, health, performing arts, and world languages.<sup>43</sup> Professional development is critical to the success of an initiative like this, as few teachers out of science classrooms receive any training in climate change, nor have the time and materials easily available to insert into their teaching schedules. In early 2022, New Jersey allocated additional funding to create an office for climate change education and created a resource hub providing guidance for school boards, professional learning, and exemplar lessons—thereby supporting implementation.<sup>44</sup>



A few states have used legislation to target professional development. In 2018, Washington became the first state to appropriate significant funding (\$10 million) for science teacher training with a specific focus on climate change.<sup>45</sup> Maine has since followed suit, enacting legislation in 2022 to fund NGSS and interdisciplinary climate change education training—and to prioritize funding for underserved schools and communities.<sup>46</sup>



While these states have had legislative success, many states have struggled to turn their proposals into reality. Organizations including the National Center for Science Education and the Campaign for Climate Literacy track ongoing legislation that impacts climate change education. Most of the legislation proposed since 2020 have failed to pass,<sup>47</sup> including in Virginia,<sup>48</sup> Massachusetts,<sup>49</sup> Wisconsin,<sup>50</sup> Minnesota,<sup>51</sup> New York,<sup>52</sup> and Rhode Island.<sup>53</sup> Still, these attempts demonstrate growing interest in legislative support for climate change education in states led by both political parties. Each attempt at passing such legislation can offer lessons and inspiration for other states to continue pushing for climate change education in their own contexts.

State legislators must continue to pursue legislative support for climate change education and vocally advocate for climate educators. Research has shown that school districts in sustainability-oriented municipalities or states with strong environmental movements are more likely to

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adopt environmental education policies.<sup>54</sup> Legislators and policymakers must continue pushing for climate change education legislation by learning from successful states and elevating the voices of educators and scientific experts in the process.

## **DISTRICT AND SCHOOL RESPONSIBILITIES**

For schools and districts to fully engage with climate change education, they must take all possible action to maximize access to high-quality climate change education and reduce schools' carbon footprints. Schools and districts have the responsibility of selecting science curricula (in cases where the state is not doing this for them), supporting teacher training, and designing policies to incentivize action. District administrators can also seize all available opportunities to embrace climate change education. For some, this could mean transitioning to cleaner energy sources, promoting sustainable food programs, and investing in cleaner transportation options.

### **YOUTH IN ACTION: Support student leaders.**

Young people are reforming their education systems by running for offices and campaigning for climate action. Idaho student Shiva Rajbhandari was elected to the Boise School District Board of Trustees 2022 on a campaign based on equity, climate education, mental health, and youth empowerment.<sup>137</sup> Throughout high school, Shiva worked to increase access to climate change education opportunities for himself and his classmates. He even wrote to actress and environmentalist Jane Fonda to request funding for a class, and she agreed.<sup>138</sup> As a board member, Shiva aims to reduce his school's greenhouse emissions, integrate climate education across all grade levels, and improve access to mental health resources.<sup>139</sup>

For others, change may come more gradually, such as through installing recycling bins on school grounds or drafting public commitments to sustainability. Districts can also support investments in out-of-school programming and the creation of outdoor classrooms that teachers can use for climate change lessons.<sup>55, 56, 57</sup>



## Recommendation 2: Provide access to high-quality curricula and materials that are grounded in scientific evidence.



The majority of the United States population recognize the need for climate change education, but political support varies.<sup>58</sup> Educators in states that lack political support are more likely to have limited or no access to high-quality climate education materials, either because state standards do not require climate change education or school districts do not select such curricula.<sup>59</sup> Even if educators seek out climate change curricula on their own initiative, it can be difficult to determine which educational materials are grounded in science. With thousands of educational resources available online, it can be challenging and time-consuming for educators to distinguish the good from the bad.

To address these challenges, educators need state policymakers and district administrators to demand and supply science curricula that factually describe the causes and implications of climate change and prepare students to design solutions. District staff can support educators by vetting curriculum, compiling supplementary teaching materials, and ensuring educators have the necessary resources to teach the content. In this section, we describe tools that professionals need to identify quality curricula and evidence-based educational strategies that should be incorporated across all climate change education.

*Educators need state policymakers and district administrators to demand and supply science curricula that factually describe the causes and implications of climate change and prepare students to design solutions.*

### **SELECTING EDUCATIONAL MATERIALS**

Research demonstrates that having a high-quality curriculum is hugely important for student learning, rivaled only by the quality of educators.<sup>60</sup> There are an overwhelming number of climate change education curricula and materials available in the United States, making it hard for educators to sort through and select those that are aligned with NGSS and proven effective.

Many of the commercially available comprehensive science curricula, which are supposed to support a full year of

science learning, leave critical gaps when it comes to climate change. Ed Reports, an organization that procedurally reviews comprehensive curricula, found that none of the 18 middle school curricula they reviewed fully aligned with NGSS.<sup>61</sup> In addition to falling short of NGSS, comprehensive curricula often miss important climate change concepts. Many commonly accepted science textbooks downplay the scientific consensus about the causes and urgency of climate change, which often results in misinformation, confusion, or a further politicizing of basic scientific facts.<sup>62</sup> To appear more politically palatable, curricula may only ask students to observe the changing climate, without interrogating the causes or future implications.

Educators can fill these gaps with supplemental curricula that align with both the scientific evidence base and NGSS. There are many options to choose from, but not all are evidence-based. The CLEAN Network, an organization of scientists and educators that reviews the scientific rigor of climate change educational materials, has evaluated over 14,000 climate change activities and found fewer than 800 acceptable.<sup>63, 64</sup> Though these are a small share of available resources, there are still plenty—perhaps too many—to choose from. To support alignment with NGSS, the CLEAN Network categorizes materials and provides crosswalks between NGSS objectives and available activities.<sup>65</sup>



These resources can be helpful, but only to teachers who have the time and capacity to seek them out. Educators and policymakers must aggressively pursue efforts to integrate scientifically accurate climate change content into big-market textbooks and comprehensive science curricula.



## STRATEGIES FOR TEACHING CLIMATE CHANGE

While science must serve as the foundation of climate change curricula, research indicates that there are other elements of curricula that lead to strong student outcomes. For educators to convey the scale, complexity, and urgency of climate change to their students, they must take a solutions-focused, strengths-based approach. While other resources, including the CLEAN Network, evaluate the scientific rigor of curricula, we highlight strategies that educators can apply across curriculum activities to increase student engagement, learning, and empowerment.

Decades of researchers agree: hope is critical to climate education.<sup>66, 67</sup> A review of climate change curriculum

literature published between 1993 and 2014 found that curricula are more engaging and effective when they encourage students to engage with potential solutions, rather than focus only on challenges.<sup>68</sup> Based on this study, researchers identified a need for more creative, participatory, and solutions-focused curricula that give students greater voice and power to participate in climate action.<sup>69</sup> In line with that evidence, both the NGSS and CLEAN Network encourage educators to work with students to understand solutions to climate change and highlight students' own power to address change.<sup>70, 71</sup>



## EVIDENCE-BASED ACTIVITIES IN ACTION

Many climate change curricula have demonstrated positive impacts on student learning. Here, we highlight a few of the many curricula developed in recent years. As these activities focus on specific learning objectives, they still must be integrated into comprehensive science curricula.



**Meaningful Watershed Educational Experience:** Investigating local watersheds increases student interest and environmental literacy.<sup>140</sup>



**The Green Ninja Film Academy:** Combining digital storytelling and climate change concepts leads to stronger environmental identity and agency.<sup>141</sup>



**It's a Gassy World:** Students' wondering questions about oceanic temperature and carbon dioxide absorption support instructors' teaching.<sup>142</sup>



**People in Ecosystems Watershed Integration:** Digital games support student learning and can align with NGSS.<sup>143</sup>

Other research affirms the notion that students require more than scientific knowledge to combat climate change; they also need to examine their own beliefs, understand their personal role with respect to climate change, and



*Decades of researchers agree: hope is critical to climate education.*

understand how climate change relates to broader political and social environments.

Many of these overlapping skills fall into the category of social-emotional learning (SEL). Through SEL, young people build social awareness and relationship skills, self-management and awareness, and strategies for responsible decision-making.<sup>72</sup> All of these skills are critical to climate action, and reviews of the literature support this overlap: while climate education initiatives vary widely in focus,<sup>73</sup> many climate change education activities improve student knowledge, competencies, and self-esteem.<sup>74</sup> These types of skills and climate-relevant knowledge can exist outside of the science classroom, such as in psychology and social studies activities that examine how and why humans act on various behaviors.

Some of the best models for engaging students in climate change topics include building “eco-literacy” through inquiry-based learning, digging into misconceptions about climate change, and exploring ways to reduce or mitigate effects of climate change.<sup>75, 76, 77</sup> The most effective activities affect students’ beliefs about humans’ role in causing climate change and their sense of stewardship—their own beliefs about their responsibility to counteract these human-created climate issues.<sup>78</sup> One study found that activities that focus on building students’ voice and self-efficacy and strengthening their sense of social norms are more likely to induce taking action than activities that target attitude change alone.<sup>79</sup> Promoting positive emotional beliefs, including hope,<sup>80</sup> care,<sup>81</sup> and love,<sup>82</sup> also help ensure that students find positive connections to the work of climate change.

These strategies can be especially important for students who hold misconceptions about climate change or who do not feel personally impacted by its effects. Teaching empathy, for example, has been found to help students internalize the urgency of climate change and the notion of a collective responsibility to address it.<sup>83</sup> The strategies described here can be threaded through climate change education regardless of the specific textbooks or curricular resources that educators may use.

## **INTERDISCIPLINARY CURRICULA**

When educators from different disciplines (e.g., social studies, the arts) collaborate with science teachers to integrate climate change education into their subject areas,

it helps youth see climate change as a cross-cutting global issue that needs more than just a scientific response. This type of interdisciplinary approach can also provide more on-ramps and supports for students with different interests and perspectives.



### **YOUTH IN ACTION: Teach according to the Principles of Youth Engagement in Climate Change.**

Student members of the Youth Perspectives on Climate Change Work Group (2016–2018) developed the Principles of Youth Engagement on Climate Change to inform the national agenda for environmental justice. These principles can serve as a youth-catered teaching tool for educators, administrators, and community organizations. Not only can educators learn from and implement these principles, but they can also share them with current students to demonstrate their commitment to elevating youth voices and power.

#### **Principles of Youth Engagement on Climate Change<sup>144</sup>**

- 1. Let youth speak for themselves.**  
Create youth advisory groups for all government agencies and prioritize working with partners that have representative and community-based hiring practices.
- 2. Invest in rising leadership.**  
Provide living wages to support youth training, education, and organizing. Make climate change education and work opportunities more accessible through investments in transportation, language services, and professional development.
- 3. Uplift intergenerational collaboration.**  
Value youth expertise by implementing policies to mitigate power dynamics, learning from partners that already have the trust of youth leaders, and acknowledging youths' intersectional identities.

Interdisciplinary climate change education can integrate concepts outside of science that are also critical to climate action. For example, combining the studies of history and

environmental science can be integral to teaching students about environmental justice and providing opportunities for community-based projects and partnerships.<sup>84</sup> Through expanding climate change education beyond science classes, schools can expand access to climate change information and increase student engagement.

## Recommendation 3: Support educators with training and professional development.



To create a national community of educators who can facilitate comprehensive climate change education, the field needs to prepare pre-service educators with accurate content and best practices and foster ongoing professional development to build and nurture their capacity. Educators also need support in tailoring effective off-the-shelf curricula to work best for their students. Climate change education strategies for youth are more powerful when they allow students to understand global realities through their own local lens. To confidently adapt educational activities to make them relevant and engaging for students in every classroom, educators need opportunities for peer learning and innovation as well as a solid foundation of science knowledge.

*As of 2016, fewer than half of science teachers received formal pre-service training on climate change education.*

### **PRE-SERVICE TRAINING FOR EDUCATORS**

As of 2016, fewer than half of science teachers received formal pre-service training on climate change education.<sup>85</sup> As a result, many teachers enter classrooms without foundational knowledge about climate change and little confidence to tackle the issue with students. A 2016 survey found that only two thirds of science teachers in the United States believed human activity to be the primary driver of recent climate change, and less than half of were aware that almost all climate scientists are in consensus about that fact.<sup>86</sup> Surveys also indicate that teachers are interested in more climate change education training to better prepare them to teach it.<sup>87, 88</sup>

While limited research has been done to explore what works best for preparing educators to teach about climate

change in the United States, emerging evidence suggests that climate change education training should focus on both changing teachers' attitudes about climate change<sup>89, 90</sup> and increasing scientific knowledge about its causes and implications.<sup>91, 92, 93</sup> Research also indicates that pre-service training should help science educators strengthen their identities as climate change educators.<sup>94</sup> Given the complex, interdisciplinary nature of climate education, effective climate educators will embrace multiple identities including environmentalists, student interest engagers, knowledgeable content educators, and civic skills promoters.<sup>95</sup> To support and encourage interdisciplinary climate change education, such training should also be available to educators outside of STEM fields.



**EQUITY NEED: All teachers need STEM supports.**

While professional associations and online resource hubs do exist, educators in rural, small, and low-resourced districts are least likely to have the capacity and support to take advantage of training and supports.<sup>145</sup> Peer networks and virtual coaching could be strategies to support these educators and foster collective learning.<sup>146</sup> Virtual and in-person opportunities for collaboration and information sharing could help educators build community, co-design creative solutions, and gain confidence.



Policymakers and teacher educators should commit to not only improving existing climate change education training, but also increasing its supply. Following the examples of Maine and Washington (see Recommendation 1), these efforts could include allocating funding for climate change training in the form of grants or scholarships for pre-service educators. Other actions could include funding more positions for climate change educators in teacher preparation programs and institutions of higher education.

**ONGOING PROFESSIONAL DEVELOPMENT AND SUPPORT**

Even teachers who receive strong pre-service training in climate change education need ongoing professional development to strengthen their practice. Just as doctors and nurses need ongoing training to stay informed of evolving best medical practices, educators need support



*Pre-service training should help science educators strengthen their identities as climate change educators. Given the complex, interdisciplinary nature of climate education, effective climate educators will embrace multiple identities including environmentalists, student interest engagers, knowledgeable content educators, and civic skills promoters.*

to stay current on rapidly-changing climate science. To teach effectively over time, educators need agency to bring new climate change work into classrooms and design interdisciplinary activities that meet the specific needs of every class.<sup>96</sup> Research offers best practices in professional development such as helping teachers design activities to change students' climate change beliefs<sup>97</sup> and improving students' reflexive skills (their ability to reflect on personal experiences to improve their own learning).<sup>98</sup> There are also evidence-based professional development models for more niche domains of climate education, including outdoor learning,<sup>99</sup> online environmental education,<sup>100</sup> and arts-integrated environmental education.<sup>101</sup> As the evidence base continues to grow, these programs can continue to spur innovation, support further research, and provide even more professional development options for teachers.

**YOUTH IN ACTION: Give young people voice in teacher professional development.**

Young people can also support and inform professional development when educators provide them with opportunities to participate. Programs in the United States have already found success by including middle school students in summer professional development workshops.<sup>147</sup> Youth perspectives should be considered especially important for climate change professional development, as educators can collaborate with students to ensure content is locally relevant and engaging. To include student perspectives while remaining cognizant of power dynamics and diverse student needs, professional development facilitators should establish clear goals of honoring youths' ideas, experimenting with multiple formats of engagement, and demonstrating follow-through.<sup>148</sup>

For professional development to be effective, training must be ongoing, sustainable, and accessible to all teachers. While professional development is available to most teachers, it is difficult to ascertain access to supports specific to climate change education. Research indicates that most teachers have access to professional supports such as workshops (92 percent) and subject-specific activities (85 percent), but less than a third of teachers find these supports useful.<sup>102</sup> Further, teachers in schools with high rates of poverty are less likely to access professional



supports than teachers in low-poverty schools.<sup>103</sup> While these findings describe access to any professional development, access to professional development that is specific to climate change is even more rare, often occurring in the form of small-scale conferences and summer workshops. Extending these opportunities to educators in under-resourced districts will require more coordinated planning, supplemental funding, and more virtual learning opportunities that connect educators from a range of locations without requiring them to travel.

### FORMATIVE ASSESSMENT TOOLS

In addition to high-quality curricula and supportive policies, educators need access to evaluation tools to measure student learning and growth. Scaling up and adapting existing climate change models to work in new contexts will require educators to understand how well those practices work in their contexts.

While some research-based tools exist, they are not widely available or easily accessible for most educators. Examples include measurement instruments to assess students' sense of stewardship,<sup>104</sup> environmental attitudes in middle childhood,<sup>105</sup> and environmental literacy for adolescents.<sup>106</sup> While these research-based tools may be helpful to some, they are unlikely to reach most educators, who lack the time and capacity to wade through academic literature. In addition to more open access to evaluation tools, educators will require training and support to assess the progress of their own climate change education efforts. To ease these tensions, researchers must be more intentional about tailoring their products to educators and providing technical assistance when necessary.

## Recommendation 4: Scale up out-of-school time and work-based learning models.

Climate science is an integrated field, spanning issues of environmental science, health, ethics, engineering, economics, history, and politics. Mitigating the current risks and preventing future harm will require a coordinated,

*In addition to more open access to evaluation tools, educators will require training and support to assess the progress of their own climate change education efforts.*



cross-sectoral effort. Climate change education can thus benefit from an interdisciplinary approach. Innovation in climate change education is happening throughout the country in settings such as museums, summer camps, scouting programs, zoos, and community gardens. Education systems and funders can support these interdisciplinary approaches by promoting climate-focused out-of-school time (OST) programs and the integration of climate change learning across multiple learning subjects. Work-based learning can also be used to increase awareness about climate-focused careers.

### **EMBRACE OST OPPORTUNITIES**

A great deal of climate change education happens outside of traditional K-12 in afterschool and informal education programs. Participation in after school STEM programs increases not only STEM identity— how students self-identify as “science people;” but also critical thinking and perseverance, especially for female students.<sup>107</sup> OST providers often find unique ways to engage students and help youth connect the broader climate change agenda to their own lives. Local youth organizations like 4-H, Scouts of America, and afterschool clubs offer research-supported climate change programming to students in more creative ways than are sometimes possible in the confines of school hours and science standards.<sup>108, 109</sup> Girl Scouts has launched climate-specific initiatives including the Girl Scout Climate Challenge and environmental stewardship badges to incentivize increased engagement.<sup>110, 111</sup>

#### **YOUTH IN ACTION: Fund youth-led community projects in out-of-school time.**

OST programs that partner with schools provide opportunities for students to build on in-class learning through projects and multi-organization partnerships. In one example, the Clean Air Green Corridor of 182<sup>nd</sup> Street,<sup>149</sup> high school students from New York City’s Washington Heights Expeditionary Learning School used an EcoRise grant to survey their community about environmental health needs and propose solutions. Students partnered with Columbia University’s Center for Resilient Cities and Landscapes and WE ACT for Environmental Justice<sup>150</sup> to facilitate public engagement, conduct field work, and coordinate with local transit improvements.



Nature-focused organizations also tend to be well equipped to develop engaging climate-related curricula and activities that are hyper-specific to students' local ecosystems. For example, zoos have developed interventions related to the animals in their care, and local branches of the Forest Service have designed lessons about the impact of climate change for their local forest.<sup>112, 113</sup>

University faculty and students can partner with local public schools to conduct joint activities and lessons, provide mentorship, and encourage students to continue pursuing climate change education.<sup>114, 115</sup> Beyond these opportunities, education systems can support OST climate education by building partnerships with community-based organizations and local affiliates of national OST education groups.



**EQUITY NEED:**  
Increase access to OST programs in low-resourced school districts.

Out-of-school time and innovative in-school climate change programs offer great opportunities for climate change education, but access to these programs can be inequitable.<sup>151</sup> Some research has found that STEM-focused summer programs geared towards students of color increased college success and STEM degree obtainment.<sup>152</sup> However, not all summer programs are designed effectively. Other research suggests that informal programs that encourage students from underrepresented backgrounds to pursue careers in environmental fields fall short of increasing representation, as program goals often fail to align with the needs of marginalized populations.<sup>153</sup> Using climate change education as a means of achieving climate justice means that funders and government institutions should prioritize increasing resources for school districts with students who lack access to OST opportunities. Research demonstrates that the best way to build capacity toward environmental justice is through transdisciplinary teams that are comprised of leaders in education, psychology, health, and STEM fields.<sup>154</sup> Together, these diverse teams provide a more holistic and transformative climate change landscape that is critical to serving students in low-resourced school districts.



*Nature-focused organizations tend to be well equipped to develop engaging climate-related curricula and activities that are hyper-specific to students' local ecosystems.*

## INTERDISCIPLINARY OST PROGRAMMING

OST programs also offer educators flexibility in integrating climate change concepts across disciplines. For example, arts programs have been shown to increase engagement in science topics. The evidence base also includes multiple examples of museums, summer camps, and college volunteer program that have successfully incorporated relevant science topics and art activities to deepen student learning and engagement.<sup>116, 117, 118</sup> Other activities including filmmaking can also increase understanding of climate change concepts and increase engagement in science, especially for youth who initially demonstrate lower levels of engagement in environmental sciences.<sup>119, 120</sup> Leveraging learning opportunities across all subjects—including those that most interest students with weaker STEM identities—can expand engagement with climate change education.

## WORK-BASED LEARNING

Work-based learning OST opportunities, such as internships and apprenticeships, can also help students gain skills and experience to pursue climate-focused careers. Some opportunities, like apprenticeships, are most often designed for older youth, but K-12 educators and OST providers can still play important roles in exposing students to climate-related careers.

School districts can both increase climate career awareness and support work-based learning in climate-related fields. For younger students, districts can encourage teachers to incorporate guest speakers, informational interviews, college and career fairs, and job shadows into curricula. School districts can also support work-based learning opportunities by helping students identify opportunities, awarding class credit for internships and work-based learning, and allowing scheduling flexibility.

Climate-focused work-based learning opportunities are likely to grow in coming years, bringing benefits for interested students. Apprenticeships have been shown to increase participants' employability, decrease training costs for employers, and help labor markets adjust to changing trends more nimbly.<sup>121</sup> Federal funding for apprenticeships has risen in the past decade, fueling increases in participation among youth ages 16-24. As of 2022, the most popular apprenticeship programs were for electricians, plumbers, and construction workers.<sup>122</sup> However, there are ample opportunities to both integrate

climate education into these existing apprenticeship programs and to expand the offerings in STEM and climate-focused fields, such as energy and environmental science.<sup>123</sup>

Black, Hispanic, and women students remain underrepresented in STEM apprenticeship positions, pointing to a need for school districts, state agencies, OST providers, and employers to prioritize work-based learning opportunities with these populations.<sup>124</sup>

## Areas in need of further study

The research evidence base for climate change education is growing, but many areas remain understudied and not understood in the United States. Youth activists, policymakers, administrators, and educators are innovating new strategies and programs for training the next generation of climate scientists and activists, creating ample opportunities to study which strategies work best, under what conditions, and for whom. We highlight a few of the many topics that merit further study and investment.



- Researchers should investigate the role and power of youth-led climate change initiatives to better understand what young people need most from education systems and to inform how we transform those systems. Researchers should strive to support participatory research, meaning research that is designed and conducted in partnership with young people, to ensure youths' perspectives guide and inform the research process.
- Research must also explore the myriad of external factors that influence the successful implementation of climate education. Specifically, research should explore the conditions that support successful implementation, especially in areas with challenging political climates and restricted financial resources. More research is needed to better understand how American political landscapes, school leadership, coaching and mentorship, and ongoing professional development work to support teachers. While there is some research on these topics in other countries, the political, geographical, and cultural diversity of the United States warrants the need for more work in this area.



*More research must focus on climate change teaching and learning in predominantly Black, Latinx, and Indigenous communities, as these are the populations that face disproportionate harm in the wake of climate change and are more likely to have underfunded school systems.*

- More research on the implementation of promising climate curricula and programs is needed to inform the expansion and scaling up of successful strategies. Given the benefits of participatory, interdisciplinary, place-based models, educators need more evidence on best practices for adapting climate change education to best serve students in their local contexts.<sup>125</sup> Further, as states experiment with requiring non-science teachers to integrate climate change into other subjects, more research is needed to understand promising teaching strategies in other content areas. This work should focus more on systemic changes, such as full district implementation and policy changes, compared to interventions that are limited in scope, population, and duration.

Future research should also intentionally apply an environmental justice lens. While some existing studies highlight justice-centered approaches, much of the recent literature examined climate change education in well-resourced, predominantly white populations, which poses challenges for educators working in lower-income and more racially diverse communities. More research must focus on climate change teaching and learning in predominantly Black, Latinx, and Indigenous communities, as these are the populations that face disproportionate harm in the wake of climate change and are more likely to have underfunded school systems.<sup>126, 127, 128</sup> People in these communities—including young people—should be the ones setting national research agendas.



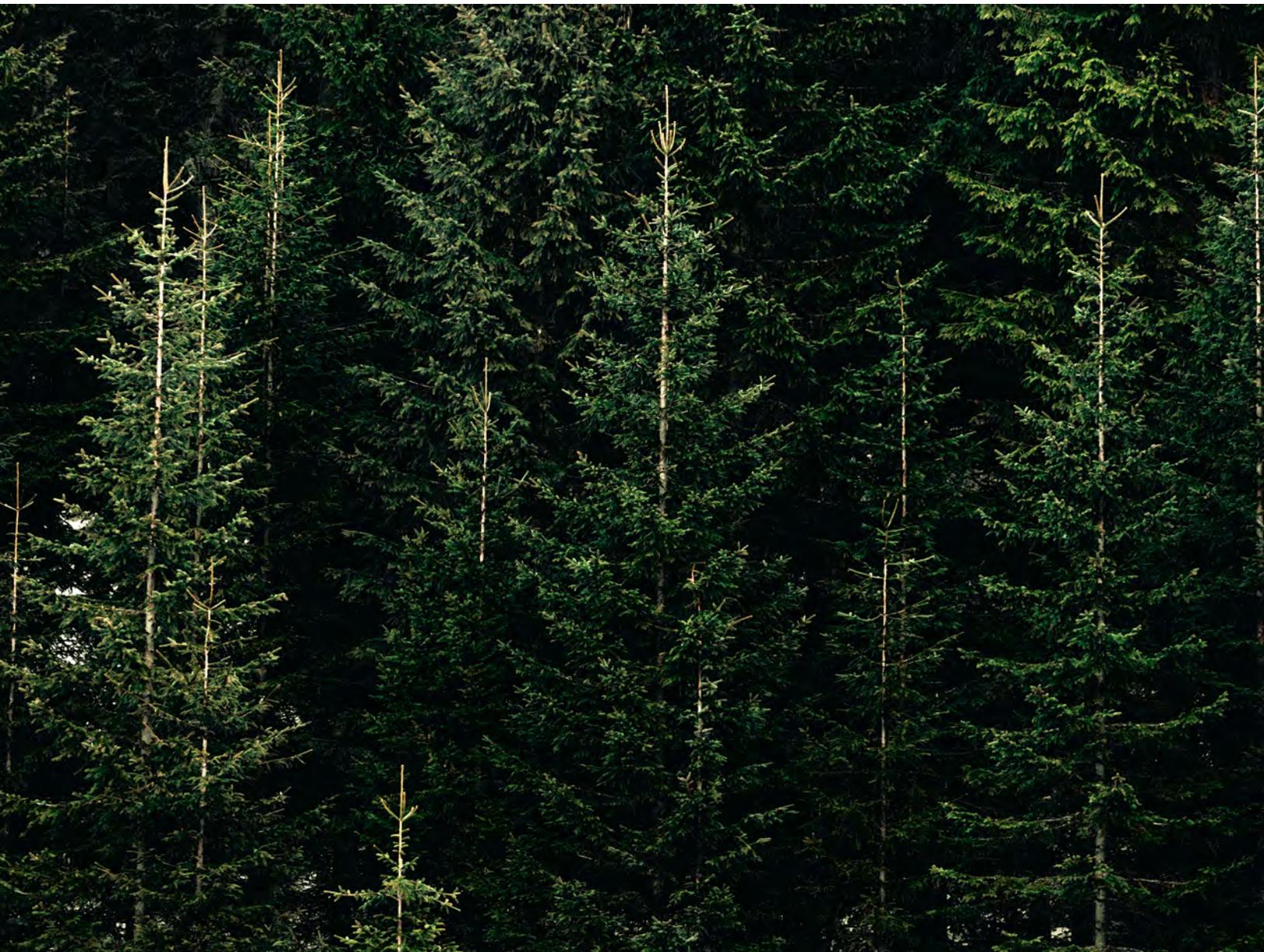
*Equipped with skills, knowledge, and systemic supports, young people can continue to lead the way to climate solutions.*

## Conclusion

Virtually every educator, OST education provider, education policymaker, school district administrator, and philanthropic funder can take action to strengthen climate change education in the United States. The urgency of climate change requires these stakeholders to leverage their own resources and capacities to support climate change education—especially for young people from marginalized groups. Supporters of climate change education must partner with organizations and educators who have been leading work in this space in order to build their capacity to support young people and extend their reach. As the bedrock of education in the United States, public K-12 education must maximize its ability to provide scientifically grounded climate change education to all students. However, traditional in-school climate education is not enough to fully prepare and reach all young people—we must also leverage the strengths and opportunities of informal and OST education providers. State policymakers and local education agencies can support these goals by strengthening science standards, allocating greater funding for climate change education, and publicly advocating for climate action. Some educators may need more support than others, such as those teaching in communities that deny the existence of climate change and in districts that lack resources to invest in climate change education. This support must come from a broad range of stakeholders, including youth activists, community-based organizations, peer networks, and funders. With the necessary resources and training, in-school and OST educators can all work to build the self-efficacy of young people and empower them to actively participate in climate action. Equipped with skills, knowledge, and systemic supports, young people can continue to lead the way to climate solutions.



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