

# **Climate Change Conversations with Children: Making Sustainability Meaningful, Tangible, and Actionable**

By

**Alexander Crease**

Bachelor of Science in Engineering, Olin College of Engineering, 2016

and

**Natha Singhasaneh**

Bachelor of Science in Mechanical Engineering, Carnegie Mellon University, 2018

Submitted to the Integrated Design and Management Program  
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Authored By: Alexander Crease  
Integrated Design and Management  
May 19th, 2023

Authored By: Natha Singhasaneh  
Integrated Design and Management  
May 19th, 2023

Certified By: Antonio Hu  
Integrated Design and Management Program Director, Thesis Advisor

Accepted By: Warren Seering  
Weber-Shaughness Professor of Mechanical Engineering

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## Abstract

For many of us, negative emotions surface when confronted with the environmental issues we face as a society. Young people in particular can experience high levels of eco-anxiety due to climate change. Adults do not feel informed enough to facilitate constructive conversations with young people about climate change, and often feel stressed and disempowered from doing so. A myriad of issues, including lack of confidence, friction in the education system, pessimistic messaging, misinformation, and polarization perpetuate a "spiral of silence" around the subject, making it one that adults do not like bringing up with each other, let alone their children. Value-based behavioral change surrounding sustainability at the individual, communal, and societal levels is essential for an environmentally resilient future. It is our responsibility to equip the next generation with the values, mindsets, and habits that prepare them for the environmental challenges they will face in the future. To help break the spiral of silence, we examined how conversations and action around sustainability can be normalized. Specifically, we explored how we might make discussion of sustainability meaningful, tangible, and actionable for children, while providing adults with an approachable, adaptable, and empowering resource for these conversations. Our work reviews academic research on eco-anxiety and the effectiveness of various communication pedagogies with existing solutions and their implications. In addition to our secondary research, we engaged a wide range of stakeholders – including parents, educators, researchers, and children – through interviews and workshops to develop the Sustainability Communication Framework. This framework includes Design Elements critical for engaging children in sustainable thinking and action, as well as Design Principles which guide how ideas can be most effectively communicated. Case studies are provided to demonstrate how effective solutions can be viewed through the lens of the framework. The framework can be applied in a variety of settings to guide experiences that normalize and reinforce values around sustainability. By supporting adults in making sustainability education age-appropriate to children, we hope to create a long-term impact by changing the way that children view and interact with the world, nurturing them into critical thinkers and active changemakers.

*Keywords:* sustainability, climate change, education, communication, human-centered design, design research

Thesis Supervisor: Antonio Hu

Title: Integrated Design and Management Program Director

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I am motivated by family and friends who love me for who I am and believe in the silly things I do. I would like to thank Gunn for supporting me in all ways imaginable, and my sister, Rada, whose presence provides me with the greatest comfort. Last but not least, I am forever grateful to my mom. The numerous opportunities she has provided me with have shaped me into who I am today. For her selflessness and love, this thesis is dedicated to her. — *Bam*



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# 1

## Introduction

### 1.1 The Role of Education in Mitigating Climate Change

The United Nations Brundtland Commission defines sustainability as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations, 2017). Today, we are meeting the needs of the present at the expense of those of future generations, and young people will predominantly be affected by climate change. If no action is taken, we place the burden on future generations to both live with and mitigate our climate impact. As we work toward limiting temperature rise from increasing 1.5 °C above pre-industrial levels by 2050, the measure agreed upon internationally during the Paris Agreement to limit global warming, countries can hopefully cooperate with actions to reduce their climate impact and invest in sustainable solutions (United Nations Framework Convention on Climate Change, 2020). But in order to do so, we need to fundamentally shift the way in which business and governments operate with intentional collective action (UNESCO, 2020, 8).

According to the World Resources Institute (WRI), it is still possible to take action on climate change to limit global temperature rise from increasing 1.5 degrees Celsius above industrial levels, but our window for action is closing quickly (Boehm et al., 2022, 3). Both the Intergovernmental Panel on Climate Change (IPCC) and the WRI recommend immediate, collective action to minimize the impact of climate change and reduce our dependence on limited resources (IPCC, 2018, 4-5; Boehm et al., 2022, 3-4). Doing so will reduce the likelihood of severe climate-related risks such as sea level rise, reduced crop yields, and acute weather events that will have a disproportionate effect on vulnerable communities (IPCC, 2018, 4-5). By reducing emissions and other environmental impacts globally, we can build a sustainable world resilient to the impacts of climate change.

Transforming public policy, the way we do business, and what solutions and actions we invest in are all critical to enabling this shift. Many of the solutions to reducing climate change are known, including transitioning to zero-carbon power, reducing the emissions from buildings and industry, and shifting to a sustainable food supply (Boehm et al., 2022, 11-16). Achieving them is the challenge, because it means redesigning the ways in which industries do business, realigning priorities in our lives and in our communities, and creating policies that incentivize sustainability. There is a collective “skills gap” that society faces in taking meaningful action



toward climate change, and the inertia of “business as usual” in industry and governance disempowers progress toward a sustainable future. (UNESCO, 2020, 8)

Effective education and communication are critical to shifting individual, organizational, and societal behaviors to respond and adapt to climate change (UNESCO, 2020, 8). We will not be able to take collective action without effective ways of communicating and teaching. According to a study by Cordero et al., if 16% of young people receive effective climate education, we can reduce greenhouse gas emissions by 19 gigatons (Cordero et al., 2020, 16; Bahri & Lamba, 2022). To build a sustainable and resilient future, we need to change how we engage young people in discussing, thinking about, and acting upon environmental issues.

This is why Quality Education, Sustainable Development Goal #4, is part of the United Nations' Sustainable Development Goals (SDGs). In addition to ensuring accessible high-quality education for young people around the world, SDG 4 highlights the relevance and importance of education on sustainable development:

**SDG Target 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.** (UNESCO, 2020, 14)

Today, climate and environmental topics are next to non-existent in national education frameworks. Nearly 90% of national curriculum standards have no or very minimal reference to climate change and sustainability. In the United States, even when climate change is covered, most teachers only spend 1-2 hours per year on it (Plutzer et al., 2016, 664-665). As a result, young people learn about climate change through social media sites such as YouTube, TikTok, and Instagram once they start being active on these platforms (Prothero & Page, 2023). However, some educators have made strides in their states or districts toward better environmental education. States such as New Jersey and Connecticut have introduced policies to teach climate change in all grade levels and disciplines, but their policies are rare across the U.S. (Cho, 2023). A majority of teachers — nearly 95% globally and 86% in the U.S. — want to integrate climate change into their curriculum, but lack the confidence, pedagogical know-how, or subject understanding to do so (UNESCO, 2021, 2-4; Kamenetz, 2019).

**All I know is I want to do something, because I care, but I don't know what to do.**  
(Participant 17, Elementary Classroom Teacher)

Parents also experience this burden, citing feelings of guilt, anxiety, and insufficient knowledge when trying to discuss climate change with their children, especially when they know that many of their actions contribute to the problem (Gaziulusoy, 2020, 5-6). The helplessness that parents and teachers feel when discussing climate change with young people has negative consequences. It reinforces a negative stigma around climate change discourse, which leads to higher levels of anxiety — especially for young people — creating a misperception that nobody else in their community is thinking about climate change but them. Today, nearly 84% of young adults aged 16-25 are moderately to extremely worried about climate change, feeling betrayal, anxiety, and hopelessness because it puts their future in jeopardy (Hickman et al., 2021, 863-867). Without a community that supports climate change discourse and action, climate anxiety and inaction will continue to fester. The ways that parents, teachers, and other members of a young person's community discuss and act can shape their perspectives, link issues to actions, and show young people that mitigating climate change is still achievable (Ojala & Bengtsson, 2018, 912-913).

## 1.2 Research Questions

Sustainability education is an underutilized tool for mitigating climate change. Our goal is to nurture sustainable thinking and action in children to prepare them for challenges they may face in the future. This paper revisits existing research and solutions for climate and sustainability education, and shares a method for adults—whether they are teachers, parents, or community members—to normalize climate change discourse with young people. We explore ways in which adults can facilitate children's development of value-based behavioral changes surrounding sustainability. We approached this problem from the perspectives of both the child and the adult.

To create more effective learning experiences surrounding sustainability for children, we explore the following research question:

***How might we make sustainability meaningful, tangible, and actionable for children?***

This research question introduces three elements to the topic of sustainability education:

- **Meaningful:** How can sustainability education connect to the lives of young people in ways that are relevant to them?
- **Tangible:** How can we make a complex topic such as sustainability concrete and comprehensible?
- **Actionable:** How might we enable young people to act upon what they have learned and build their confidence in taking action on issues important to them?

In order to support adults with the means and methods for communicating sustainability with children, we explore the following research question:

***How might we provide adults with an approachable, adaptable, and empowering resource for educating children about sustainability?***

Similarly, this research question considers three features that make an effective resource for teaching about sustainability.

- **Approachable:** How can we enable various groups of adults to utilize the resource in an accessible way?
- **Adaptable:** How can we enhance the versatility of the resource such that it can be applied across various settings?
- **Empowering:** How can the resource empower adults as advocates to sustainability and sustainability education?

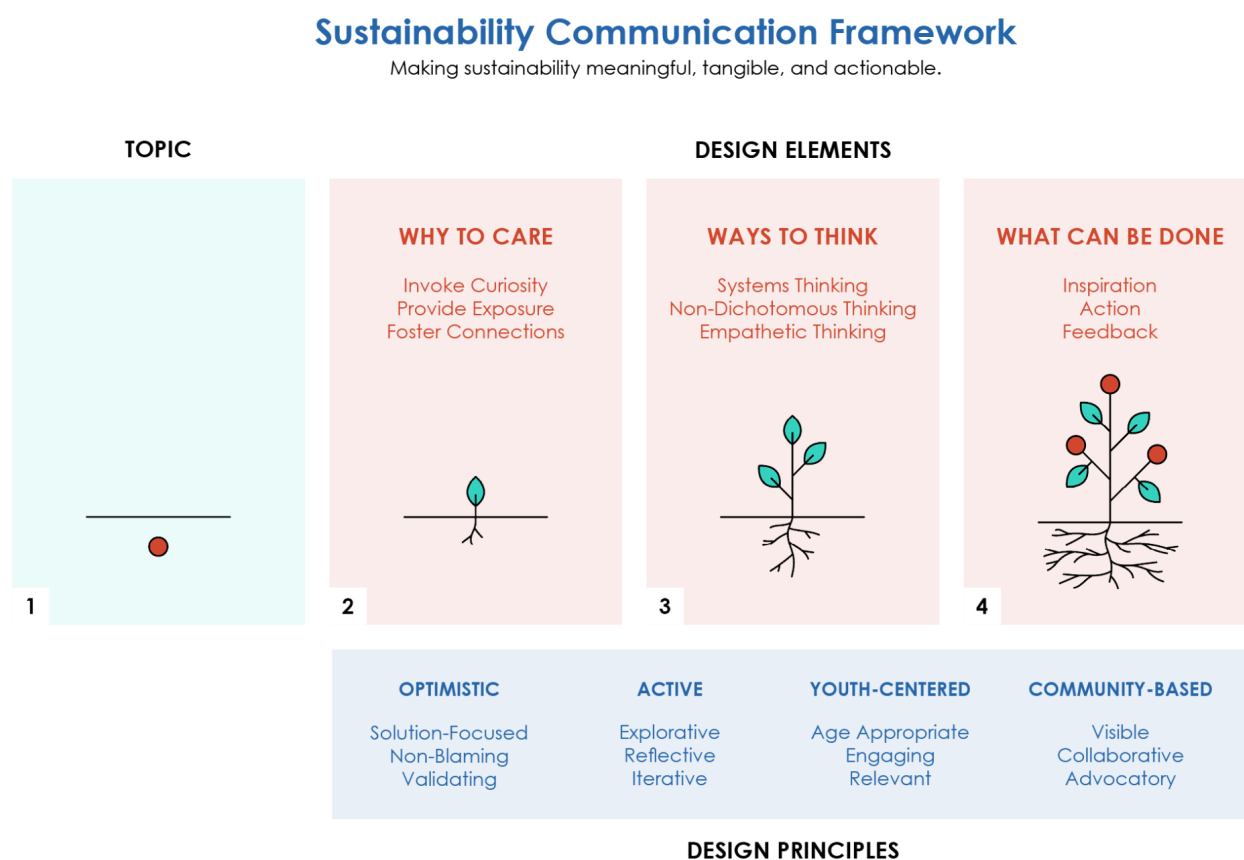
### **1.3 The Sustainability Communication Framework: A Preview**

In response to the research questions outlined above, we have developed a framework intended to normalize sustainability conversations by helping adults bridge the emotional, technical, and actionable aspects of sustainability communication. After selecting a topic, communicators build activities and curricula meeting three core elements: “Why to Care,” “Ways to Think,” and “What Can Be Done.” Activities within the created curriculum can be enhanced using four design principles: “Active,” “Optimistic,” “Youth-Centered,” and “Community-Based.” Creating opportunities for young people to connect the dots between the three elements empowers them to care, think, and act with a sustainability-oriented mindset.

This framework is expounded in detail in Sections 6 and 7. Section 8 provides examples of how the framework could be applied.

**Figure 1a**

The Sustainability Communication Framework



## 1.4 Glossary of Terms

- Climate Change:** Climate change refers to shifts in temperature and weather patterns as a result of human activities. When we speak of climate change, we may also use it as an umbrella term covering local environmental changes as well, such as ocean acidification, deforestation, and ecosystem change.
- Sustainability:** While the definition of sustainability varies broadly, the high-level view this paper takes is that sustainability is what is needed to mitigate climate change and environmental damage now and in perpetuity. This is in relation to the United Nations Bruntland Commission's definition of sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 2017).

- **Environmental Issues:** In this paper, the term 'environmental issues' is used to broadly refer to climate change and sustainability together. It covers both local and global problems related to environment and climate, along with sustainable actions we can take to prevent further harm.
- **Education & Teaching:** Within the context of this paper, education includes any form of learning and any environment in which it takes place. Learning is holistic to our entire lives, and can happen in many different settings, not limited to the confines of a school. Teaching is a means of facilitating learning moments with children, so teaching takes a broad definition in this paper as well. In-classroom education will be referred to as "formal education" where appropriate.
- **Sustainability Communicators:** We refer to 'sustainability communicators,' or simply "communicators" in short, broadly in this paper to refer to anyone interested in teaching young people about sustainability. Any adult can learn to become a communicator, be they parents, caregivers, educators, or community members.

# 2

## Research & Development Methods

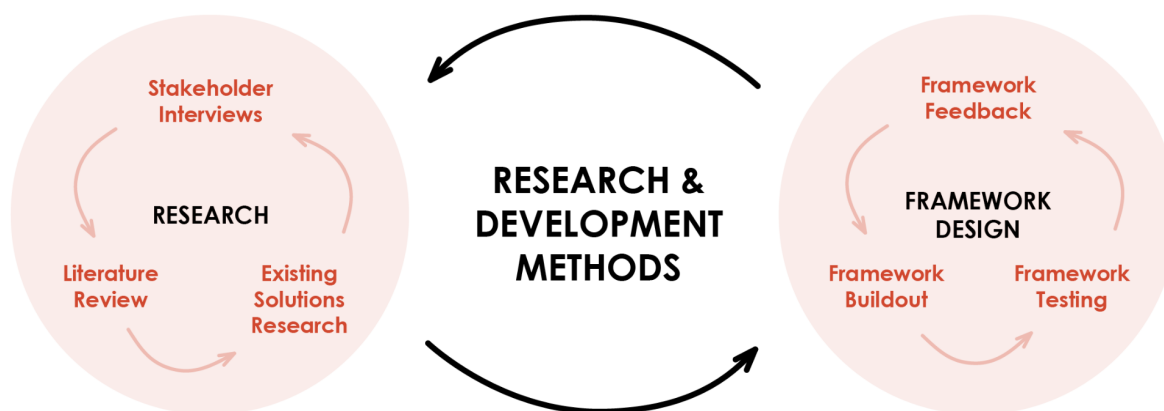
### 2.1 Methods Overview

In exploring sustainability communication, we knew that such a complex problem space required an initially broad approach, without assumptions. The interdisciplinary and systemic nature of our problem space required interaction with a diverse group of stakeholders and research from different lenses and perspectives. From a high-level, our research method is two-pronged, covering research and framework design. We took a cyclical approach, as illustrated in Figure 2a below. The combination of primary and secondary research uncovered how climate change and sustainability learning happens within home, classroom, and communal spaces, which helped us build, test, and receive feedback on our framework.

With each loop of our process, we refined our understanding of the problem space, narrowed the scope of our solution, and further developed our framework via testing and feedback. Each cycle allowed us to focus more narrowly as we learned more.

**Figure 2a**

*Overview of Research Methods*



The first loop of our process focused on holistic problem understanding: why sustainability education is important, where the gaps were in current communication pedagogies, and where our stakeholders were impacted the most. This allowed us to determine from a high level where solutions might be needed, and what might be of most value to our stakeholders. We were able

to test some of the core ideas via a workshop run at a local elementary school, from which we received feedback.

After our initial research, workshop, and feedback, we looked more deeply into the teacher and parent perspectives on climate change and sustainability communication to understand how they structured their activities and curricula on environmental issues, and what they found engaged children the most. This helped us identify gaps in sustainability communication resources. One of the large gaps we identified at this stage was that communicators lacked clarity on helping young people connect the dots between different elements of their sustainability education. From there, we built a high-level draft of a framework that our stakeholders could use to structure their work, and received feedback from our stakeholders again on how it could be developed further.

With a basic framework and some direction on where it needed work, we returned to education and communication research to make our framework more actionable to our stakeholders. In this phase of the project, we spent time listening to educators, parents, and caregivers talk about specific examples of successful activities they did with their children, and connected the steps they took in their activities with our developing framework. Here we worked with them to figure out how they could make their projects resonate better with their children, and we used co-design sessions to further inform our framework.

## 2.2 Literature Review

Throughout our process, we reinforced our problem exploration with secondary research providing us with current data and trends in climate change and sustainability education. Our literature review covers the following topics, and can be found in Section 3.

- **Problem Framing:** Causes for climate change anxiety in young people, and systemic issues and policies that cause challenges in climate change education and communication.
- **Incentives & Trends:** Incentives for climate change and sustainability to be taught, and high-level goals adding pressure to educators to introduce climate education.
- **Leading Pedagogies & Recommendations:** Existing research on best practices for integrating climate change and sustainability into curricula effectively.

## 2.3 Stakeholder Interviews

Throughout our research, we connected with a diverse group of stakeholders to understand their perspectives, needs, and strategies for sustainability communication and curricula. We continued to gain depth in our research as we were directed to additional literary

work and existing solutions via our interview progress. At the same time, we continued to expand our network of educators, researchers, and communicators in the sustainability communication space. Our primary research was limited to U.S. stakeholders. We engaged with the following groups of stakeholders:

- **Parents & Caregivers (11):** We spoke with parents and caregivers to understand what their goals are when teaching their children about climate change and sustainability, what approaches they take, and what challenges they face. These participants were obtained via personal connections and via flyers sent out within our communities and those of friends and family.
- **Children (18):** We ran workshops in a first-grade classroom in partnership with a local school to understand what experiences and messages resonated with them as they learned about sustainability and climate change. Some children were also present during our interviews with parents and caregivers. We focused our research on children aged 6 to 10 years old.
- **In-Classroom Educators (5):** Speaking with in-classroom teachers in K-12 education provided insights into current standards for teaching climate change and sustainability to young people, what they have tried, and what worked or didn't work. We sourced teachers via personal connections, flyers sent out within our network, and at climate and sustainability education conferences.
- **Out-of-Classroom Educators (4):** Out-of-classroom educators, such as people who work for climate-focused nonprofits or community programs, provided us with insight into alternative approaches to climate education, and a closer look on how young people learn and take action on climate change in their communities. We found these participants via personal connections and flyers sent out within our communities, friend groups, and families.
- **Climate Change Communication Experts (14):** Talking to climate change communication experts gave us an overview of what is important to communicate, what the best practices and leading research focus on, and where there may be opportunities for innovation.

These numbers include overlaps between different stakeholder groups: three parents/caregivers are also climate change communication experts, one parent/caregiver is also an out-of-classroom educator, and one out-of-classroom educator is also a communications expert. A full participant list is provided in Appendix B. We used a semi-structured interview format with sets of questions for each stakeholder group listed in Appendix C. Insights from our stakeholder interviews about the problem space are discussed in Section 4, and about our framework in Section 7 and 9.



### 2.3.1 Recruitment Methods

Due to our participant acquisition methods, the participants were likely to already have an affinity for sustainability and climate change education. In order to source participating parents, we sent digital flyers to our network and asked individuals in our network to share the flyers with any parents or educators they were connected with. Since the flyers, shown in Appendix A, reference speaking to young people about sustainability, it is likely that those who responded to the flyer were those who recognized that speaking with their children about climate change was a problem they faced. We assumed that parents or educators who did not care about the subject may have been disinterested and unlikely to respond. In addition to the flyers, we also introduced our work to educators at a Climate Action Through Education (CATE) conference (MIT Climate Action Through Education (CATE), 2023). This conference was meant for educators interested in teaching their students about climate change, so the educators sourced at this conference were also likely to have an existing interest in climate education.

Due to the constraints in our stakeholder sourcing methods, we did not end up speaking with parents or educators who had dismissive views about climate change and sustainability. However, our research is aimed at adults who care about teaching environmental issues to young people, but do not know how to act. Therefore, climate change dismissers and deniers are out of scope of our work.

Our study focuses on children ages 6-10 because we have identified that this age group has the largest need when it comes to climate change and sustainability education. This is further explored in Section 3.4.

- **Childhood Development and Habit Formation:** Below the age of 9, young people are building their mental model of how the world works by asking questions, learning from experiences and habits built from their environment and community (Darling-Hammond et al., 2019, 97-98; Pressman et al., 2014, 347). By working sustainability into home and school discourse early, young people are more likely to form sustainability-oriented mindsets by the time they reach adulthood.
- **Climate Change Exposure via Social Media:** Initial exposure to climate change discourse often happens via social media, and 12 is the average age that young people create social media accounts (Bozzola et al., 2022, 1; Prothero & Page, 2023). Introducing them to environmental issues before the age of 12 equips them with the language and understanding to evaluate and critique what they see online.
- **Gap in Climate Change and Sustainability Education:** Most climate educational initiatives focus on high school and college, with some in middle school and very few examples in elementary school (Next Generation Science Standards, 2014; National Research

Council et al., 2012, pp. 175-182, 191-199). To effectively build sustainable mindsets and give young people the tools to think about it and discuss it before they engage in social media, education on environmental issues should begin in elementary schools.

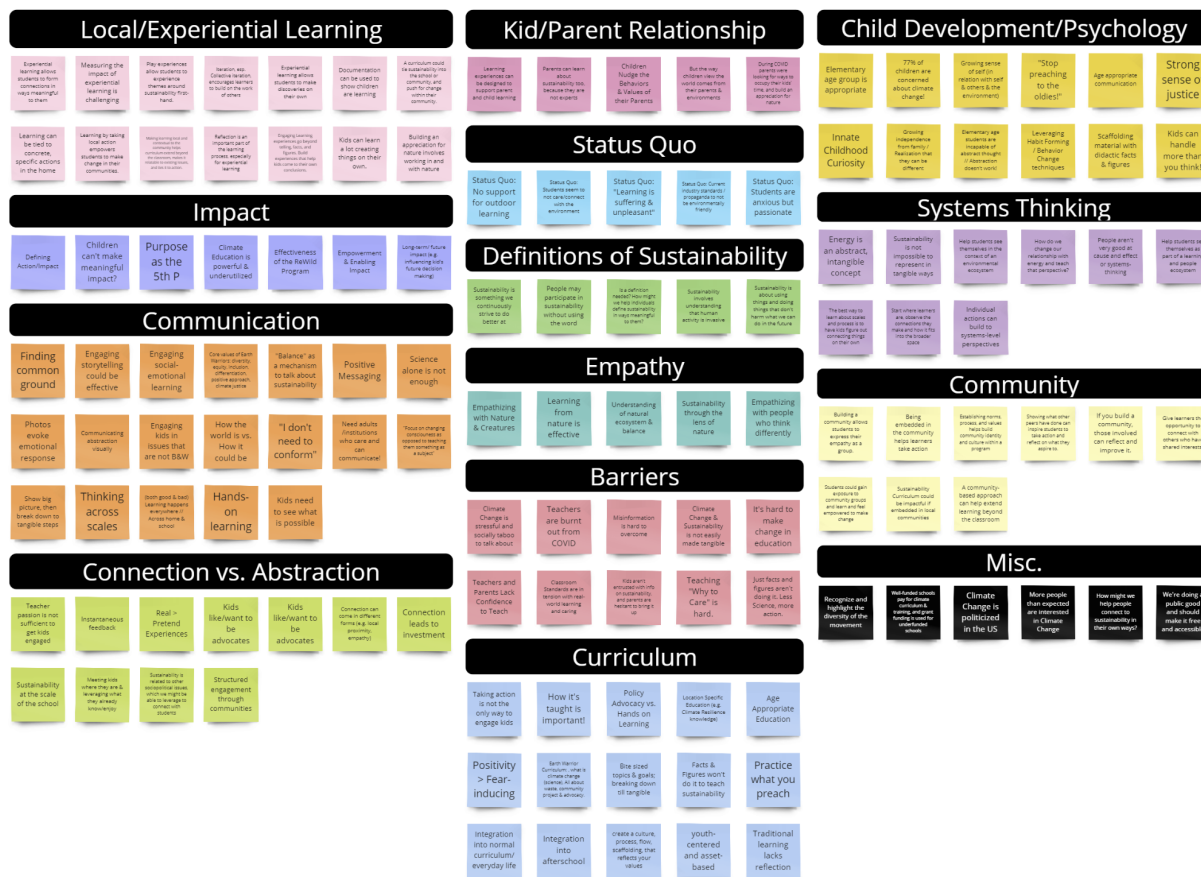
## **2.4 Existing Solutions Research**

Existing solutions research explored what climate change and sustainability education methods are in use today. These ranged from how climate change and sustainability are integrated into national education frameworks, to resources that parents use to talk about sustainability with their children. This research identified the different touchpoints that affect young people's perspectives on sustainability, and uncovered where there are missing links between effective strategies (determined by our secondary academic research) and the sentiment of our stakeholders from our primary research. Our existing solutions research is documented in Section 5.

## **2.5 Framework Buildout**

Drawing primarily from our primary research, we synthesized interview data using affinity grouping (grouping similar ideas, which may be from different sources, together). Then, we formed key ideas around data points and slowly built up common themes, such as "Community," "Experiential Learning," "Connection," "Barriers," "Empathy," and "Child Psychology."

**Figure 2b**  
Affinity Grouping of Key Insights From Primary Research



Next, we grouped ideas into “Who,” “What,” “Where,” “When,” “Why,” and “How” to communicate sustainability further synthesized data within those groups. The “Why” section gave us preliminary insight into the problem space, the “What” and “How” sections informed the first version of our framework, while the “Who,” “Where,” and “When” sections helped us understand how the framework could be applied.

Following this initial buildout, as described in Section 2.1, our framework continued to evolve through multiple iteration cycles, as we received feedback from stakeholders and continued to supplement it with additional secondary and existing solutions research.

## **2.6 Framework Testing & Feedback**

### **2.6.1 Testing Through Workshops with Children**

Based on our initial interviews with climate communicators, we learned the importance of systems thinking and found that it is seldom included in traditional climate change curriculum for younger age groups. However, we still had questions about how children within our target age group of 6-10 years old would respond to a systems thinking class. In order to test out our idea, we ran two workshops in a first grade classroom at a local elementary school, including the “Materials Workshop” and “Energy Workshop,” which we describe in detail in Section 8.1. The workshop allowed us to test out good practices for communicating sustainability, which later informed our framework design principles. Materials for these workshops are provided in Appendices F and G.

### **2.6.2 Feedback Sessions with Parents & Educators**

Once we created an initial version of our framework, we presented it to three educators and two climate communication experts for feedback. Based on those conversations, we were able to understand what aspects of the framework resonated with them, identify gaps to be filled, and define the direction of our next iteration cycle. A breakdown of comments from our stakeholders is outlined in Section 9, and presentation materials are in Appendix D. Additionally, we hosted a workshop with climate change and sustainability experts in which we presented our framework and asked participants to provide feedback and brainstorm ways to implement it. Materials for this session are in Appendix D and H.

## **2.7 Case Studies**

As we engaged with stakeholders, we gained a better understanding of communication strategies that work well. Specifically, we learned that in order for communication to be effective, the learning experience must be made meaningful, tangible, and actionable to children. Two stories we heard from our interviews caught our attention because they involved all these three elements and served as proof points for the validity of our framework. These are described in detail in Sections 8.2 and 8.3. We utilized these case studies to put the framework in the context of the real world and explore how it could be effectively applied in both home and school settings.

# 3

## Secondary Research: Climate Anxiety and Intervention Opportunities

### 3.1 Overview

This section reviews the leading research on how educators, family members, and communities can support young people as they learn about climate change. According to the Office of the Surgeon General, climate change anxiety is one of several large contributors to youth mental health issues (Office of the Surgeon General, 2021, 3-4). Hickman et al. found that climate change anxiety in young people is extreme enough to “impact the daily functioning” of 45% of young people (Hickman et al., 2021, 863). At the same time, effective climate education has the potential to drastically reduce our global environmental impact (Cordero et al., 2020, 16). Various touchpoints in the home and in schools influence how young people feel about climate change, and what they think can be done to mitigate it.

Holistically, we examine what contributes to youth climate anxiety and what adults can do to reduce it. In schools, we explore the leading pedagogies and gaps in climate education, and in the home, we uncover how parents can have productive conversations with young people to enable their learning while being aware of their anxieties and concerns.

### 3.2 Climate Anxiety in Young People

Research on youth climate anxiety, also referred to as eco-anxiety, has primarily focused on children and young adults ages 10 - 25 (Léger-Goodes et al., 2022, 6). The most extensive study, run by Hickman et al., surveyed over 10,000 teens and young adults in different countries around the world between the ages of 16 and 25 (Hickman et al., 2021, 866). While there is no research on eco-anxiety below the age of 10, there is research on the manifestation of other anxieties and phobias, such as general anxiety disorder, social anxiety disorder, separation anxiety disorder, and specific phobias in early childhood (Beesdo et al., 2009, pp. 486-488, 511). Findings suggest that most anxiety disorders are onset by events or circumstances during phases of early childhood development, particularly below the age of 12 but also extending to 18 (Beesdo et al., 2009, pp. 485, 511). For example, disaster-related events in the 5-7 age range can manifest post-traumatic stress disorder, generalized anxiety disorder, or other stresses and phobias later in life (Beesdo et al., 2009, 511). The onset and development of these anxieties can

be influenced by parenting style, childhood adversities, and life events, among other external factors (Beesdo et al., 2009, 495-496). In Hickman et al.'s survey on climate anxiety they found the following:

**Respondents across all countries were worried about climate change (59% were very or extremely worried and 84% were at least moderately worried). More than 50% reported each of the following emotions: sad, anxious, angry, powerless, helpless, and guilty. More than 45% of respondents said their feelings about climate change negatively affected their daily life and functioning, and many reported a high number of negative thoughts about climate change (eg, 75% said that they think the future is frightening and 83% said that they think people have failed to take care of the planet). Respondents rated governmental responses to climate change negatively and reported greater feelings of betrayal than of reassurance. Climate anxiety and distress were correlated with perceived inadequate government response and associated feelings of betrayal.**  
(Hickman et al., 2021, 863)

Although the prevalence of climate anxiety has not been directly studied below the age of 10, the high levels of climate anxiety in young adults indicated by Hickman et al. in conjunction with research on the development of other anxieties suggest that eco-anxiety may be triggered and reinforced by childhood exposure prior to adolescence. An understanding of what adolescents and young adults are feeling about climate change is therefore still indicative of earlier exposure to the topic. Additionally, proactive measures and interventions can be taken at early ages to reduce the likelihood that other anxieties take hold long-term (Beesdo et al., 2009, 485). This indicates that similar measures can be taken prior to adolescence to reduce eco-anxiety. The different factors that may address climate anxiety specifically are covered later in this section, which include family conversations, community discourse, and exposure via news and media.

Polls conducted via Gallup Research suggest that young adults in the United States are more concerned about climate change than older generations (Reinhart, 2018). In their survey results, 70% of people aged 18-34 reported concern for climate change, 62% of people aged 35-54 reported similar concern, and only 55% of those above the age of 56 reported concern (Reinhart, 2018). Young people are likely more worried about the impacts of climate change because it has a greater effect on their futures than those of older generations (Gaziulusoy, 2020, 1). Climate anxiety causes greater fear of the future, which explains why young people feel that governments have not responded adequately to the threat of climate change (Hickman et al., 2021, 863). To summarize, anxiety in young people is influenced by three causes: young people feeling a lack of agency toward collective climate action, a lack of discourse

and action in community settings, and negative news and imagery about climate change. These causes and their implications are discussed below.

### **3.2.1 Discontinuity Between Values, Actions, and Impact**

One of the major reasons for youth anxiety on climate change is that young people feel disempowered: 59% of young adults in Hickman's survey felt powerless in their ability to contribute to mitigating climate change, and further shared feeling that their government has betrayed them and has not adequately responded to the climate crisis (Hickman et al., 2021, 867-869). Young people do not feel like actions they may take as individuals will make a difference.

Feelings of disempowerment are coupled with the realization that young people's lived experiences are directly in conflict with reducing climate impact (Gaziulusoy, 2020, 1-2). Interviews conducted by Gaziulusoy included examples of parents feeling guilt for the discontinuity between the environmental values they were instilling on their children, and their own actions: "Having those conversations is sometimes difficult since, as a family, we are not consistent in every way; we still have a car, we still fly...you cannot model your behavior on [your advice] or when it is impractical..." (Gaziulusoy, 2020, 5). Children who have learned how to reduce their footprint, and tried to speak with their friends about it, were often judged or mocked by their peers (Gaziulusoy, 2020, 5). Young people can understand how different actions affect the planet, yet see these negative actions being routinely taken by their own families, by their communities, and by their societies. This perpetuates the feeling that even if a young person can make a change in their own life, the inertia of societal behaviors is too widespread to stop.

All this being said, current sentiment around climate change is that it is not too late to take action: people still do have hope that change can still be made to prevent the climate crisis from getting much worse (Leiserowitz et al., 2022, 20). Tapping into that hope can motivate young people, and their parents, to see what they can do to make an impact as individuals and as communities.

### **3.2.2 The Influence of Family and Communities on Climate Anxiety**

Most Americans believe that climate change is real, and that it is human-caused (Leiserowitz et al., 2022, 4-7). In *Climate Change in the American Mind*, a collaborative report between the Yale Program on Climate Change Communication and the George Mason Center for Climate Change Communication, 72% of Americans acknowledged that global warming is happening, 64% are worried about it, and 56% reported that global warming is mostly

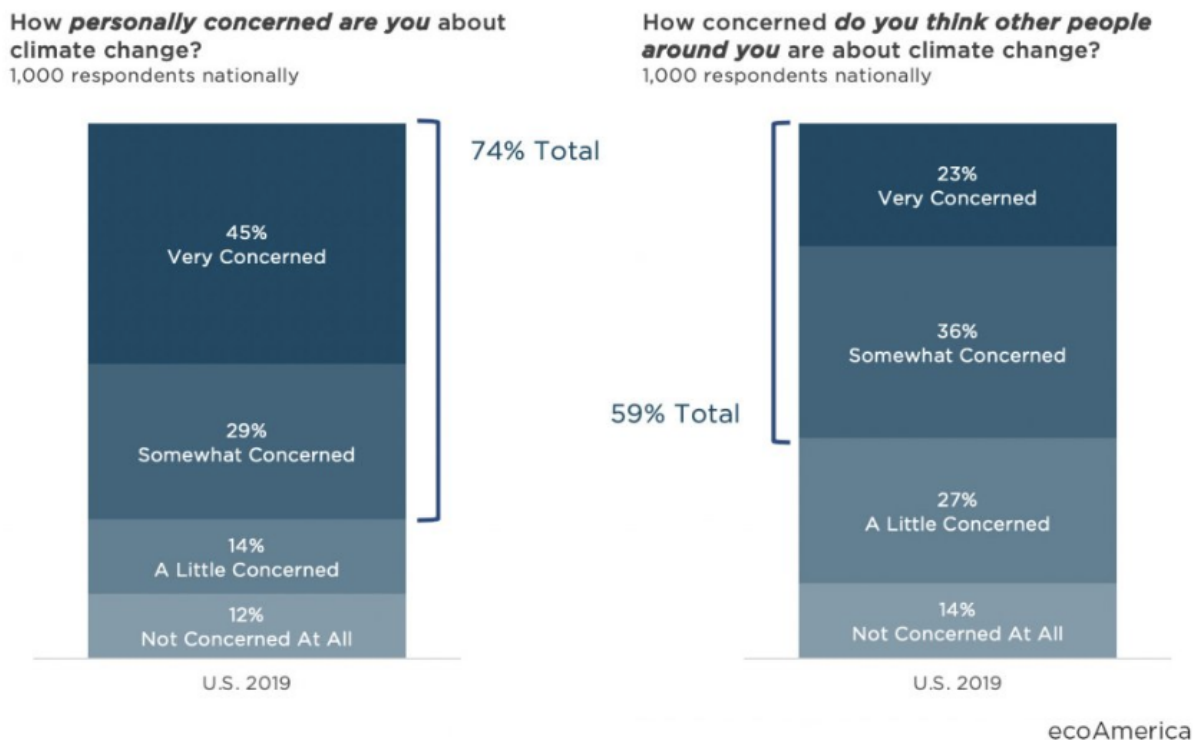
human-caused (Leiserowitz et al., 2022, 4-10). In addition, roughly half of the US population acknowledges that climate change is harming people right now, but largely acknowledges that future generations will be most affected by it, especially to people in poor communities or developing countries (Leiserowitz et al., 2022, 13-14).

Despite acknowledging the importance of climate change and its impact on current and future generations, climate change is not commonly discussed in the United States. According to *Climate Change in the American Mind*, “two in three Americans (67%) shared they ‘rarely ‘ or ‘never‘ discuss global warming with family and friends” (Leiserowitz et al., 2022, 16). Although the acknowledgement that climate change is happening has increased over the last 10 years, the amount that it is discussed between family and friends has stayed relatively stable (Leiserowitz et al., 2022, pp. 6, 16). Few Americans hear people that they know discussing climate change more than once a month (Leiserowitz et al., 2022, 17). Instead, they reported that they only hear about it from friends or family a few times per year (Leiserowitz et al., 2022, 17). Overall, although most Americans are concerned about climate change, they do not think that others around them are as concerned, so they stay quiet (Buttel et al., 2020, 1-2). This disconnect is shown in Figure 3a.



**Figure 3a**

Concerns About Climate Change and Perceived Concerns About Climate Change



Note. The percentage of people who are concerned about climate change is higher than the percentage of people who think others are concerned about climate change. From "Americans May Feel Isolated in Their Climate Concern," by Buttel, L., Kobayashi, N. M., Kobayashi, N. P., Lake, C., Logan, D., Speiser, M., & Voss, J., 2020, *American Climate Perspectives Survey 2020, Volume II*, (<https://ecoamerica.org/american-climate-perspectives-survey-2020-vol-ii/>).

What the data from *Climate Change in the American Mind* and Hickman's research on climate anxiety shows is that even though climate change is top of mind for many young people, there is a lack of discourse around it. Discourse around climate change, especially in family and community settings, is important to helping young people feel that something can be done about it (Ojala & Bengtsson, 2018, 907). Ojala & Bengtsson's research showed how family and friends who were dismissive about climate change increased youth anxiety about the topic, while supportive discourse intended to help young people understand climate change and process their feelings reduced anxiety (Ojala & Bengtsson, 2018, 920-926).

Yet, Ojala & Bengtsson's research in conjunction with the surveys by Gallup Research and Hickman et al. indicate that discourse within family settings is unlikely to happen. If 84% of

young people (ages 16-25) are worried about climate change, but only 56% of adults over age 55 are (which is within the age range for parents of the young adults surveyed), the research indicates a sentiment gap between parents and young adults on climate change (Hickman et al., 2021, 863; Reinhart, 2018). Parents being supportive in helping young people understand climate change reduces youth anxiety, but young people do not regularly speak with their families about climate change either because of a sentiment gap, or because these conversations are not normalized in the family. This reveals an opportunity to teach adults how they can effectively engage with the young people in their lives about climate change. In fact, parents who engage in discourse about climate change with their children are more likely to shift their perspectives on it, discussed in more depth in Section 3.5 (Lawson et al., 2019, 459-461). If we can destigmatize conversations about climate change, then this will reduce climate anxiety in young people and help older generations learn and act toward a climate-conscious future as well.

### **3.2.3 Negative Media and Imagery**

Negative imagery can go a long way toward motivating people to take action. For example, in a study done on using imagery to value biodiversity, Gehlbach et al. found that photographs of biodiversity loss spurred negative emotions, which increased participants' value for biodiversity (Gehlbach et al., 2022, 102-103). Photos that spurred positive emotions were not as effective (Gehlbach et al., 2022, 102). While the selected photos did prompt an emotional response that spurred action on behalf of the participants (in the form of a donation to a biodiversity-focused charity), they still create a negative stress response (Gehlbach et al., 2022, 102). Without an ability to act upon their emotions, these feelings continue to linger.

Even though climate change is not discussed frequently, people hear about it in the news and media at least once per month (Leiserowitz et al., 2022, 17). Young people most often learn about climate change through news and social media (Prothero & Page, 2023). We elaborate upon this further in Section 3.4.1. Much of the news about climate change is negative and problem-oriented, which increases fear and decreases the belief that any changes will be effective (Feldman & Hart, 2021, 1-2). People are being constantly exposed to negative imagery and news relating to climate change, and typically media sources do not share what actions can be taken to mitigate climate crises in the future.

An APA study on Mental Health and our Changing Climate shares that disasters and severe weather events create psychological trauma not only for those that experience them, but also for those who might have observed or overheard the events second-hand (Clayton et al., 2021, 28-32). While those who experience these disasters first-hand are more likely to develop post-traumatic stress disorder (PTSD) or other mental health challenges as a result of these

events, sharing their stories can have a similar effect on those who listened in (Clayton et al., 2021, 28-32).

Eco-anxiety can not only come from “direct” (first-hand) or “indirect” (second-hand) exposure to climate events, but also through what Léger-Goodes et al. describes as “vicarious” exposure through media (Léger-Goodes et al., 2022, 02). Because more climate disasters happen each year and information about these events is regularly propagated through the news and social media, young people are being increasingly exposed to the consequences of climate change, even if disaster events have not affected them personally (Clayton et al., 2021, 32). This leads them to imagine future states in which they might be personally affected by similar experiences. This creates a “pre-traumatic stress,” as explained by Van Susteren in the APA report:

**Experiencing, witnessing, or even hearing the details of life-threatening events can cause deep and persistent psychological trauma, unleashing a multitude of conditions including post-traumatic stress disorder (PTSD). Struggling with images of future harm they can't put out of their minds, some children suffer pre-traumatic stress.** (Clayton et al., 2021, 32)

The constant stream of media relating to climate change, with no way to act upon it, and without anyone willing to talk about it, all contribute to young people's growing anxiety, which in some cases affects their day-to-day functioning.

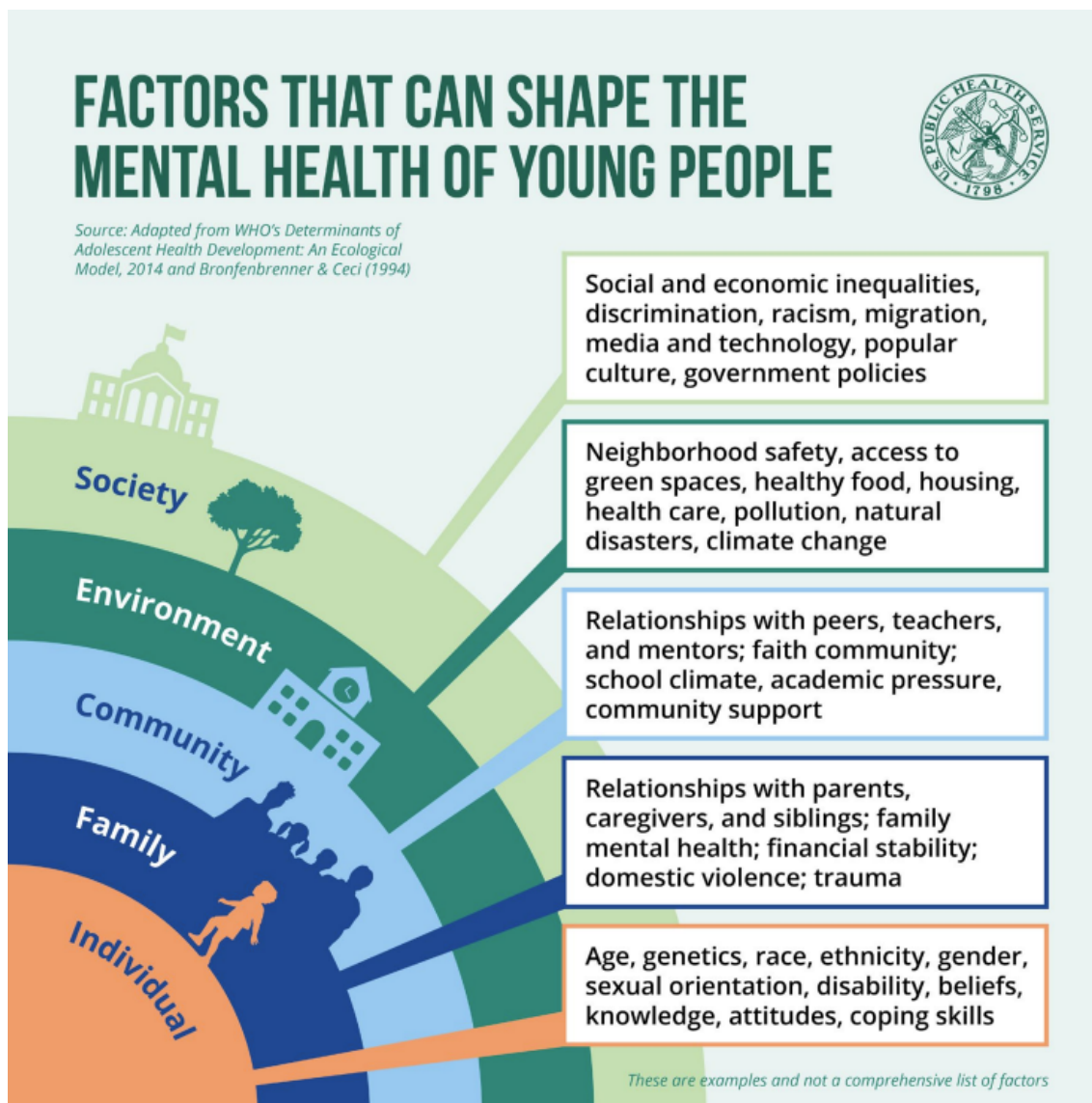
### **3.2.4 Addressing Climate Anxiety & Youth Mental Health in America**

Reports and research on climate anxiety come amidst a growing youth mental health crisis in the United States, according to the US Surgeon General's public health advisory in 2021 (Office of the Surgeon General, 2021, 3-4). Between 2009 and 2019, mental health symptoms such as “persistent feelings of sadness or hopelessness” in high school age students increased from 26.1% to 36.7%, along with increased suicidal thoughts and attempts (Centers for Disease Control and Prevention, 2020, 58). Today, one in three high school students shared feelings of hopelessness, to the extent that it affects their daily activities, with even higher ratios for young people in historically disadvantaged groups such as women, minorities, and LGBTQ+ young people (Centers for Disease Control and Prevention, 2020, 59-60). The Surgeon General's report cites several research-based hypotheses for this sharp increase in adverse mental health symptoms over the last decade in the United States, including topics such as the rise of social media, increased academic pressure, financial insecurity, increasing gun violence, and climate change (Office of the Surgeon General, 2021, 8-9). Many of these issues affect young people's well being from different scales - from an individual's personal identity to environmental and

societal factors that affect access to resources and opportunities at a systemic level, as shown in Figure 3b (Office of the Surgeon General, 2021, 7). These issues espouse feelings of anxiety, depression, or hopelessness that affect their mood and behaviors on a day-to-day basis (Centers for Disease Control and Prevention, 2020, 58).

**Figure 3b**

*Factors Affecting Youth Mental Health*



Note: From "Protecting Youth Mental Health," by Office of the Surgeon General, 2021, *The US Surgeon General's Advisory*, p. 7

(<https://www.hhs.gov/sites/default/files/surgeon-general-youth-mental-health-advisory.pdf>).

Although climate change is just one of the issues affecting the mental health of young people, the Surgeon General's report and the APA's study map out actions that can be taken at different scales and by different groups in order to support children's mental health and effectively reduce anxiety. Many of these recommendations can be applied to climate change anxiety specifically:

### **Spend Time in Nature**

Children who spend time outdoors in natural environments see measurable benefits in reducing stress, anxiety, and depression: "There is increasing evidence that regular connection to nature helps children — and all of us — feel calmer and less stressed". In addition to the mental health benefits, spending time outdoors deepens people's connection with and value for nature - meaning they are more likely to care about how their actions affect the environment. Families can foster a value for nature while also reducing anxiety for all families by spending time outdoors regularly for as little as 10-20 minutes per day. (Clayton et al., 2021, 39).

Green spaces in urban areas have multiple benefits, in that they decrease local temperatures, increase carbon sequestration, and improve resident mental health (Clayton et al., 2021, 60). However, access to public green spaces is inequitable: affluent residents are more likely to have access to green spaces either via proximity or transportation, while impoverished communities do not have the same privilege (Clayton et al., 2021, 41). It is the responsibility of policymakers to create accessible and safe green spaces for all people in their communities to benefit from.

### **Acknowledge Your Feelings & Share Them With Others**

Feelings on climate change are valid, and more common than many people may think - about 74% of Americans are concerned about climate change but do not think others are as worried about it (Buttel et al., 2020, 2). Individuals can reduce their own anxieties by sharing their feelings with others. In turn, this helps others feel comfortable expressing their own concerns, and can normalize conversations about climate change (Clayton et al., 2021, 67). This depends upon a healthy support network of trusted connections who individuals can ask for help when processing complex feelings and stressful situations, such as climate emergencies (Office of the Surgeon General, 2021, 14). Families can provide their children with emotional support by establishing safe, supportive homes, tuning in to the socio-emotional needs of their children, and helping their children build a trusted support network of peers, friends, and family (Office of the Surgeon General, 2021, 16; Sheldon, 2022). Communities can also help reduce climate anxieties by normalizing conversations and public discourse through events, programs, and visible actions in their neighborhoods (Clayton et al., 2021, pp. 22, 67).

### **Cultivate Coping & Self-Regulation**

Individuals can establish and reinforce habits to help regulate their emotions and cope with climate anxiety (Office of the Surgeon General, 2021, 14-15; Clayton et al., 2021, 63). This involves identifying actions or triggers that affect an individual's emotional state, and creating intervention strategies as an individual or with family when negative emotions do arise (Office of the Surgeon General, 2021, 15; Clayton et al., 2021, 63). Managing time and negative influences is a key aspect of this, and parents can cultivate positive habits with their children and also model mental health awareness and regulation (Office of the Surgeon General, 2021, 16). Examples of behavior management for mental health include time management on social media, spending regular time outdoors, or building emotional reflection routines (Office of the Surgeon General, 2021, 16).

### **Learn About Community Impacts of Climate Change**

Understanding the personal and local implications of climate change can help make the subject more meaningful and tangible to individuals and communities. Further, learning about climate change resilience and mitigation strategies will uncover actionable ways for individuals and communities to reduce their environmental impact and advocate for change at larger scales (Clayton et al., 2021, 66-67). In learning about community-level climate impacts and their resilience strategies, people can become more confident and hopeful that crises can be averted (Clayton et al., 2021, pp. 22-23, 52).

### **Advocate & Act in Your Community**

One of the highest-leverage actions an individual can take on climate change is participating in and leading change in their community. This builds confidence that meaningful change can, and is, being made. After learning about climate change mitigation and resilience strategies, discussing their implications with the broader community will raise awareness of environmental issues, their local effects, and their solutions. Speaking up in community settings with evidence-based recommendations can normalize climate change conversations at the community level, and spur support for new policies and initiatives that protect the community and its residents. (Clayton et al., 2021, 55-60)

The two key themes that connect all of these insights are learning and community. While these actions are broad strokes on how to address youth climate anxiety at different scales, they highlight tangible steps that can be taken by adults with their own children and in their communities to teach young people about climate change, and reduce climate change anxiety in young people at the same time. Effective education, communication, and community involvement are clear cornerstones for action. In Sections 3.3 - 3.5, we look at

different touchpoints in which young people are exposed to climate change topics, and how we can leverage educational and community touchpoints to reduce climate anxiety.

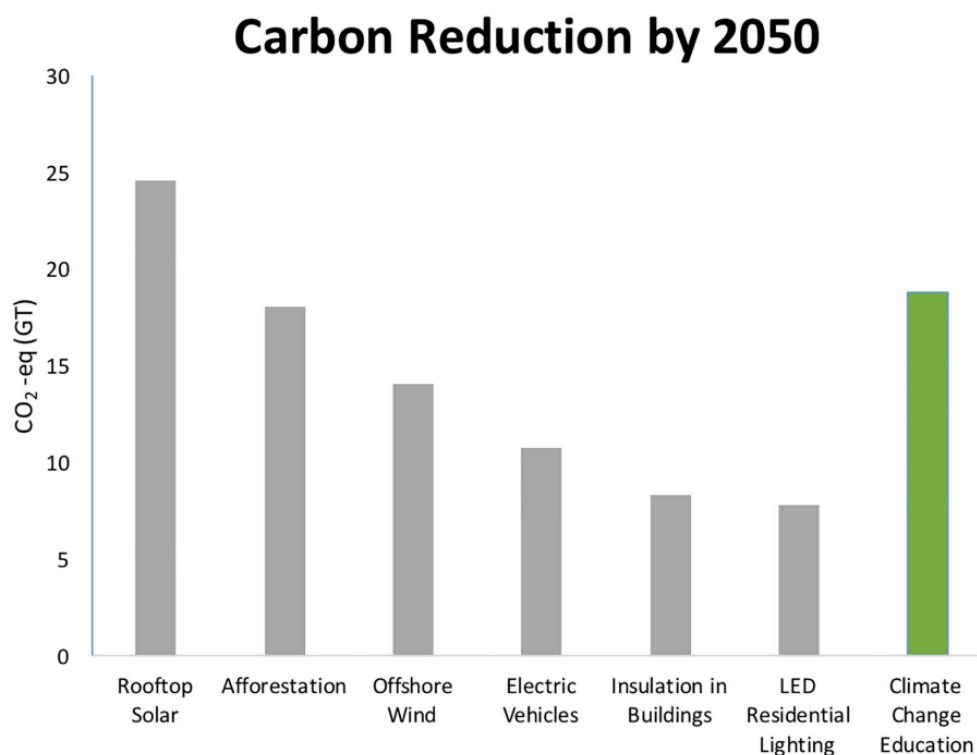
### 3.3 Climate Change Content in Formal Education

Shifting toward a sustainable future is a global priority, and education plays a key role in doing so. The United Nations Sustainable Development Goals (SDGs) lay out 17 global goals to achieve a “shared blueprint for peace and prosperity for people and the planet, now and into the future” (United Nations, 2015). These goals cover topics ranging from sustainable cities and communities, to reduced inequalities, to quality education for all. UNESCO, the United Nations Educational, Scientific, and Cultural Organization, views education as a cornerstone to sustainable development: “Education is UNESCO’s top priority because it is a basic human right and the foundation on which to build peace and drive sustainable development” (UNESCO, 2020, i). By effectively teaching climate change and sustainability, we can drastically reduce humanity’s impact on the environment today and in the future.

Cordero et al.’s research shows that if just 16% of children globally are effectively taught about climate change and reducing their impact, it can lead to a 19 gigaton reduction in CO<sub>2</sub>e (CO<sub>2</sub> equivalent) emissions by 2050 (Cordero et al., 2020, 15). In their study, over 500 students enrolled in a two-semester course on climate change over five years (Cordero et al., 2020, 3). Five years after each respective course was completed, Cordero et al. surveyed former students on the choices they make relating to climate change and sustainability, asking questions about their home energy, waste, food, and transportation choices (Cordero et al., 2020, 8). Cordero et al. compared these results to that of an average resident of California, where the classes were taught (Cordero et al., 2020, 15). Estimating 25.1 tons of CO<sub>2</sub>e produced per year by an average California resident, Cordero et al. found an emissions reduction of 2.86 tons of CO<sub>2</sub>e (11.4% reduction) per year for those who enrolled in the course (Cordero et al., 2020, 15). Making some assumptions about similar educational programs scaling globally to teach 16% of all students by 2050 (based on program reach and number of high school age students in middle- or high-income countries), Cordero et al. approximates a 19 gigaton reduction in CO<sub>2</sub>e with well-designed climate education programs, comparable to technological sustainability initiatives being implemented by 2050, as shown in Figure 3c (Cordero et al., 2020, 15). According to Friedlingstein et al. via the Global Carbon Project, about 36.6 gigatons of CO<sub>2</sub>e were emitted worldwide in 2022 (Friedlingstein et al., 2022, 4814). For further context, the U.S. produces about 6.2 gigatons of CO<sub>2</sub>e per year (United Nations Environment Programme, 2021). Assuming these numbers remain constant, this would lead to 1098 gigatons of CO<sub>2</sub>e between 2020 and 2050, and 200 gigatons of CO<sub>2</sub>e within the United States. A 19 gigaton reduction in emissions would account for 1.7% of global emissions, or 9.5% of the U.S.’s emissions over that time period.

**Figure 3c**

The Effect Of Various Carbon Reduction Initiatives On Global CO<sub>2</sub> Reduction By 2050



Note: From "The role of climate change education on individual lifetime carbon emissions," by Cordero, E. C., Centeno, D., & Todd, A. M, 2020, *PLOS ONE*, 15(2), p. 16 (<https://doi.org/10.1371/journal.pone.0206266>).

Despite the demand for climate change and sustainability education, and its role in the UN's Sustainable Development Goals, climate change and sustainability are rarely part of standard national curricula today. A study from UNESCO shows that 47% of national education frameworks from 100 surveyed countries make no reference to climate change in their standard curricula. Of those that do, the integration of climate change into curriculum is minimal. These studies were done by quantifying the frequency of key terms relating to climate change and sustainability in national education frameworks, so they are not wholly inclusive of what might be taught at the school or regional level. However, they provide insight into what education standards are set via national policy, and what would be considered the bare minimum for students to learn about in their respective countries. (UNESCO, 2021, 4)

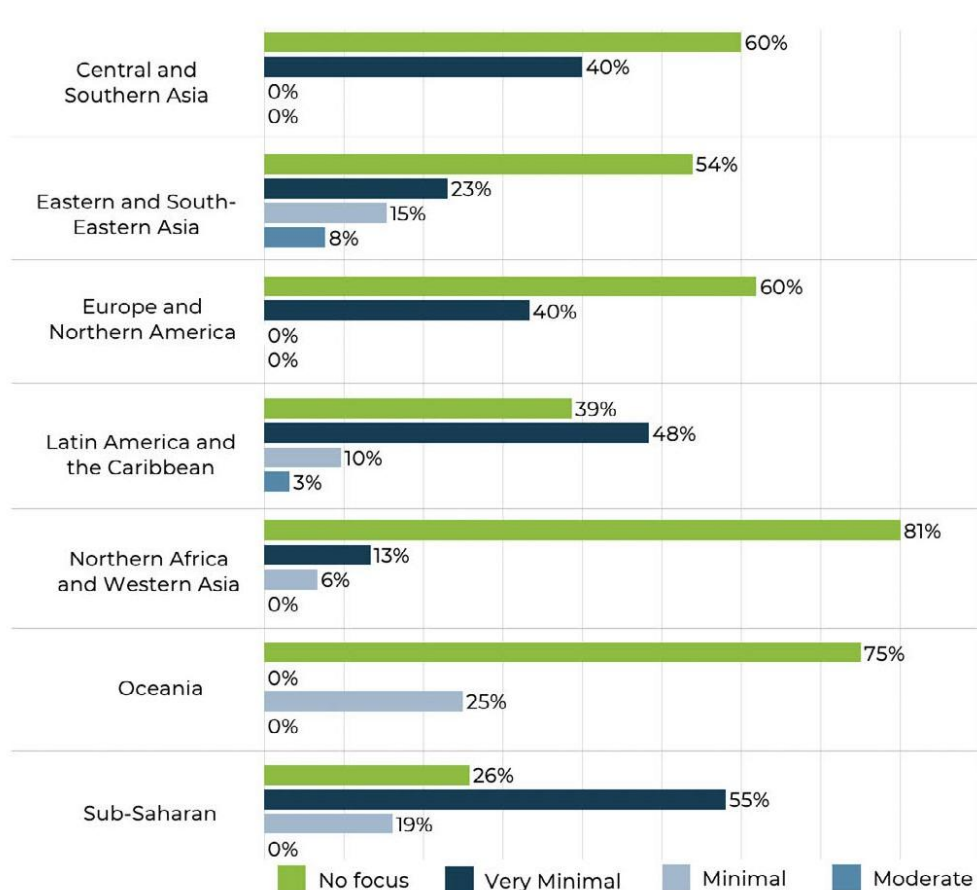
Further, the study found that countries with more emphasis on climate change education tended to be in areas that are more heavily affected by the impacts of climate



change, while countries with less emphasis on climate change education tend to be larger contributors to climate change (UNESCO, 2021, 5). Countries in the global south as well as island nations, for example, have experienced greater effects of climate change and are more susceptible to climate risks than countries in Europe and North America, who are larger contributors to climate change but do not experience such risks (Diffenbaugh & Burke, 2019, 9810). As shown in Figure 3d, these countries, including those in Eastern and South-Eastern Asia, Latin America and the Caribbean, Oceania, and Sub-Saharan Africa already have some integration of climate change in their curriculum, albeit minimal or moderate (UNESCO, 2021, 5).

**Figure 3d**

*Percentage of Climate Change Content in National Education Frameworks by Region*



\*Percentages for each region total 100%

Note: "Getting Every School Climate-Ready: How Countries are Integrating Climate Change Issues in Education," by UNESCO, 2021, *Education 2030*, p. 5 (<https://unesdoc.unesco.org/ark:/48223/pf0000379591>).

While national curriculum standards have minimal reference to climate change and sustainability, that does not mean that it is not present in education. It just means that local districts, schools, or teachers set policies and create this content themselves. About 95% of teachers in UNESCO's 2021 survey felt it was important to teach climate change, highlighting the desire to teach this issue (UNESCO, 2021, 6). In the locations where teachers were surveyed, about 35% of students were taking some actions on climate change and environmental issues once per month, showing that students have a desire to act on this issue. Many parents also support teaching climate change in schools: a poll run by NPR found that 68% of parents think climate change and its impacts should be taught in schools (Kamenetz, 2019).

However, only 40% of teachers surveyed felt they had the confidence to teach climate change, and even fewer could explain its effects on the region they operate in (UNESCO, 2021, 6). There is a desire to teach climate change by parents and teachers, but a lack of understanding of the best ways to teach it. Teachers and administrators do not feel they have the proper training in order to teach it effectively.

The lack of adequate national climate change education standards does not mean that climate change is not taught. The United States has two science K-12 education frameworks developed for and by states. The Next Generation Science Standards (NGSS) and the National Research Council Framework for K-12 Science Education (NRC), both integrate climate change into their standards and are accepted by 44 states in total (National Science Teaching Association, 2018). In fact, the National Center for Science Education found that 75% of public school science teachers in the US cover climate change (Cho, 2023; Plutzer et al., 2016, 664-665). These two frameworks are reviewed further in Section 5.2.

However, this data may be misleading, as most teachers may only dedicate 1-2 hours to climate change content over the course of an entire school year (Plutzer et al., 2016, 664-665). The amount of climate change content is highly dependent on the state, district, and individual teacher. The NGSS and NRC frameworks are treated as recommendations for what states should adopt, but they can be modified at the state level. For example, New Jersey and Connecticut have passed legislation mandating that climate change and sustainability be taught holistically at all grade levels starting from kindergarten and going through 12th grade, which is elaborated upon in Section 5.3 (Cho, 2023). Individual schools may also choose to integrate sustainability more deeply into their curriculum, such as outdoor schools that focus on learning in the context of the natural world. These schools are typically private schools that are not required to meet public education standards. More examples are provided in Section 5.4.

### 3.3.1 Climate Change Curriculum by Grade Level in the US

Most of the research, publications, and frameworks on climate change in education report on high school and college curricula, which indicates where climate change is most likely to be formally introduced in educational settings today. For example, in the Next Generation Science Standards (NGSS) framework, adopted by 20 US states for public school science education, direct references to climate change appear starting in grades 6 and above, and direct references to sustainability appear in curricula for grades 9-12 (Next Generation Science Standards, 2014). In earth and life science classes below the 6th grade, the NGSS states “Assessment does not include climate change” (Next Generation Science Standards, 2013). In the NRC Framework for K-12 Science Education, which is adopted by 24 states, climate change is not directly referenced in science requirements until grades 9-12, but concepts about sustainability and humanity's impact on earth systems is referenced throughout grades K-12 (National Research Council et al., 2012, pp. 175-182, 191-199). So while climate change may not be specifically included in curricula, the themes related to climate change may be taught in earlier grade levels without their explicit ties to environmental issues. These findings were based on a search of the standards for key terms related to environmental issues. As discussed above, states or districts may choose to adapt these frameworks to suit their needs, meaning that they may elect to include or exclude climate change and sustainability content (National Science Teaching Association, 2018). See Section 5.3 for a more detailed review of the NGSS and NRC standards.

Internationally, from the perspective of the UN's Sustainable Development Goals, the Higher Education Sustainability Initiative (HESI) was created to address gaps in sustainability education and research - but its focus is at the collegiate level (United Nations: Department of Economic and Social Affairs, 2022). This group is focused on creating learning experiences and research that drive sustainable development in collegiate environments and in continued education and professional programs - focused on transitioning current or upcoming professionals into sustainability-oriented modes of thinking (United Nations, 2020). There are comparatively fewer initiatives for primary school. There are three potential hypotheses explaining the skewing of climate change education toward higher education:

#### **Assumed Knowledge Requirements for Climate Change Education**

A possible explanation for the bias of climate change toward higher education is the assumed level of knowledge required to comprehend a problem with such global scale, complexity, and implications. The “traditional” mode of teaching climate change, occurs in science-focused classes, and assumes an understanding of ecological systems, life sciences, earth science, some physics and chemistry, and the ability to comprehend large, complex

systems. The NGSS and NRC standards imply these prerequisites through their recommended structures around core ideas (Next Generation Science Standards, 2014; National Research Council et al., 2012, pp. 156-167, 192-198). Many of these subjects are taught starting in middle or high school, so in order for students to understand a subject as complex as climate change, there may be an assumption they need to have a solid foundation in the sciences before they can begin learning about climate change.

### **Higher Education Can Respond And Adapt More Quickly Than K-12 Education Can**

Because universities are not always publicly funded and not subject to the same level of scrutiny and standardization that K-12 institutions are, they can adapt more quickly to new pedagogies and research. K-12 schools are held to strict curriculum and test standards that disincentivize deviation from core subjects and curriculum (Jorgenson, 2006). These standards and practices are informed by both state-wide and nation-wide policies, and schools are granted public funding based on standardized testing. Education policies take a long time to update with new learning pedagogies and subject matter expertise for a number of reasons, including pushback from parents and local authorities, rewriting of learning materials, political agendas, and retraining of educators (Jorgenson, 2006).

On the university side, individual students and faculty are given more freedom to dive into areas of expertise, so there are more opportunities and interest in specialized or experimental curricula. Funding sources come from elsewhere, and are not tied so closely to standardized tests or academic performance. Universities as research hubs also feed more knowledge into their educational ecosystems, meaning that faculty are closer to new discoveries and ways of thinking about cutting-edge topics. This means that faculty can more easily propose curricula on climate change and sustainability: they have the knowledge and the flexibility to do so, along with fewer regulation requirements. (Zomer & Benneworth, 2011, 81-88)

### **Universities As A Hub Of Societal Advancement**

While primary and secondary education is traditionally viewed as a means for teaching young people the basic skills to be functioning members of society, universities have traditionally been viewed as having “two missions”: institutions for teaching and research. However, recent discourse on the role of universities has pointed toward a “Third Mission”:

**Universities engaged in [Third Mission] activities are becoming engines that contribute to the social, economic and cultural development of the regions in which they operate, by transferring knowledge and technologies to industry and to society at large.**

(Compagnucci & Spigarelli, 2020, 1)

The idea of the “Third Mission” of a university stems from a university’s role in driving innovation by working with government and industry. In doing so, universities affect and contribute to social, economic, and cultural advancement (Zomer & Benneworth, 2011, 81-82). Universities investing in entrepreneurship, for example, are a concrete way that they can contribute to economic growth in a region (Compagnucci & Spigarelli, 2020, 4). As we globally work toward the UN’s Sustainable Development Goals, educational institutions play an important part in figuring out how to make the 17 SDGs achievable (König et al., 2020, 9-12). Ideally, by partnering with communities, governments, and industries, universities can advance sustainability and climate change mitigation practices by interweaving research with action. In addition, because universities are tightly tied into current research, new findings can be quickly interwoven into the classroom.

### **3.3.2 Climate Change Education Implications**

Based on the publications, research, and recommendations on climate change education, four key themes emerge as recommendations for educators looking to teach climate change to young people:

#### **Sustainability and Climate Change Education Should Be Action-Oriented and Collaborative**

Understanding how to think about and act upon environmental issues requires different competencies, including analytical skills such as systems thinking, anticipatory thinking, and process evaluation, social skills such as negotiation, communication, and empathy-building, and contextual awareness on topics such as social and environmental justice, policy, and history (Lozano et al., 2017, 6-7). These different competencies and subjects each have select pedagogical approaches that have been shown to work well. For example, empathy- and perspective-building competencies are best taught through experiences that involve members of a particular community, while skills such as systems thinking may best be taught via case studies and project-based learning (Lozano et al., 2017, 8-9).

According to Lozano et al., the most effective way to teach sustainability is by blending different pedagogical approaches to cover different sustainability competencies. A map of different competencies relevant to climate education, and their corresponding effective learning pedagogies, is shown in Figure 3e. Note that the most effective pedagogies for teaching multiple sustainability competencies include pedagogies such as “Place-Based Environmental Education,” “Jigsaw/Interlinked Teams,” “Eco-Justice and Community,” and “Case Studies” (Lozano et al., 2017, 10). These pedagogies and others deemed effective share similarities in being action-oriented, collaborative, project- or problem-based, and concrete rather than theoretical (Lozano et al., 2017, 10). Pedagogies that are the least effective at

teaching sustainability competencies across the board include “Lecturing” and “Traditional Ecological Knowledge” (Lozano et al., 2017, 10).

**Figure 3e**

*Mapping Between Learning Pedagogies to Sustainability-focused Competencies*

Competence	Pedagogy											
	Universal					Community and social justice				Environmental Education		
	Case studies	Interdisciplinary team teaching	Lecturing	Mind and concept maps	Project and/or Problem-based learning	Community Service Learning	Jayaw / Interlinked Teams	Participatory Action Research	Key-justice and community	Place-Based Environmental Education	Supply chain/ Life Cycle Analysis	Traditional ecological knowledge
Systems thinking	Green	Yellow	Yellow	Green	Green	White	White	White	Green	Green	Green	Yellow
Interdisciplinary work	Green	Green	White	White	White	White	White	White	Green	White	White	White
Anticipatory thinking	Yellow	White	White	White	White	White	White	White	Green	White	White	White
Justice, responsibility, and ethics	Yellow	White	White	White	White	White	White	White	Green	White	White	White
Critical thinking and analysis	Green	White	White	White	White	White	White	White	Green	White	White	White
Interpersonal relations and collaboration	Yellow	Yellow	White	White	Green	Green	White	White	Yellow	Yellow	White	White
Empathy and change of perspective	Yellow	White	White	White	White	Green	White	White	Green	White	White	White
Communication and use of media	Yellow	White	White	White	White	Green	White	White	White	White	White	White
Strategic action	Yellow	White	White	White	Green	Green	White	White	Yellow	Yellow	White	White
Personal involvement	Yellow	White	White	White	Green	Green	White	White	Yellow	Yellow	White	White
Assessment and evaluation	Yellow	White	White	White	White	White	White	White	Yellow	Green	White	White
Tolerance for ambiguity and uncertainty	Yellow	White	White	White	White	White	White	White	White	White	White	White

Note: Green indicates high likelihood of addressing the competency, yellow indicates the pedagogy possibly addresses the competency, and white indicates the pedagogy does not address the competency. From “Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework Proposal,” by Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J., 2017, *Sustainability*, 9(10), p. 10 (<https://doi.org/10.3390/su9101889>).

### **Sustainability And Climate Change Education Should Include Empathy and Action**

Climate change and sustainability education is not very effective when taught in the “traditional” pedagogies of lectures and ecological science. These learning modes are not enough to get students engaged and involved in taking climate action (Schneider, 2021). They typically do the opposite - create fear and disempowerment since no solutions are presented (Schneider, 2021). Climate education needs to include emotion, empathy, and action. This means teaching why climate change is important to study, who it affects and how, and what can be done about it (Schneider, 2021). These additional elements help frame the problem by making environmental issues meaningful, and pointing toward actions that can be taken to mitigate their effects (Schneider, 2021).

### **Sustainability and Climate Change Education Should be Interdisciplinary**

Sustainability education spans multiple disciplines and modes of thinking, making learning in interdisciplinary contexts important (Lozano et al., 2017, 4). Unlike other subjects, in which much of the theory is straightforward and can be taught within a disciplinary silo, environmental issues cover topics ranging from ecology and life sciences to social studies and history (Lozano et al., 2017, 4). In project-based learning, all of these topics can be used as different lenses for problem understanding and action. UNESCO includes interdisciplinarity as part of a “whole-institution approach” - in which a sustainability topic can be explored from the context of multiple different disciplines, all interwoven with one-another (UNESCO, 2020, 28).

### **Sustainability and Climate Change Education Should Be Embedded in Local Communities**

Engaging with local communities through climate education helps empower young people to take action (UNESCO, 2020, 34). Local project-based learning for sustainability has multiple benefits. First, it is interdisciplinary by nature, requiring that learners practice different skills and explore subject areas to understand local environmental issues and what might be needed to overcome them (UNESCO, 2020, 28). Two, it facilitates peer-to-peer learning and collaboration since projects can be done in groups or as a class. Three, it normalizes climate action in the community. High-visibility projects designed and created by young people will spur more climate conversations, discourse, and action (UNESCO, 2020, 32-34). By working on community-based projects, we can create positive learning experiences that shift the collective mindset of the community toward action.

## **3.4 Age Range for Climate Change Introduction**

As discussed in Section 3.3.1, climate change education is minimal in elementary school. Students are typically not exposed to climate change in formal learning environments until middle school and high school, and most of the research into climate change education focuses on teenagers. Whether they are prepared for it or not, young people are being introduced to climate change at earlier and earlier ages due to social media. Additionally, young people begin to build lifelong habits, mindsets, and mental models of how the world works before the age of 10. Creating meaningful learning moments about environmental issues before these exposure points is critical. Doing so can prepare young people to engage in climate change discourse, and can help them build a lasting sustainability-focused mindset.

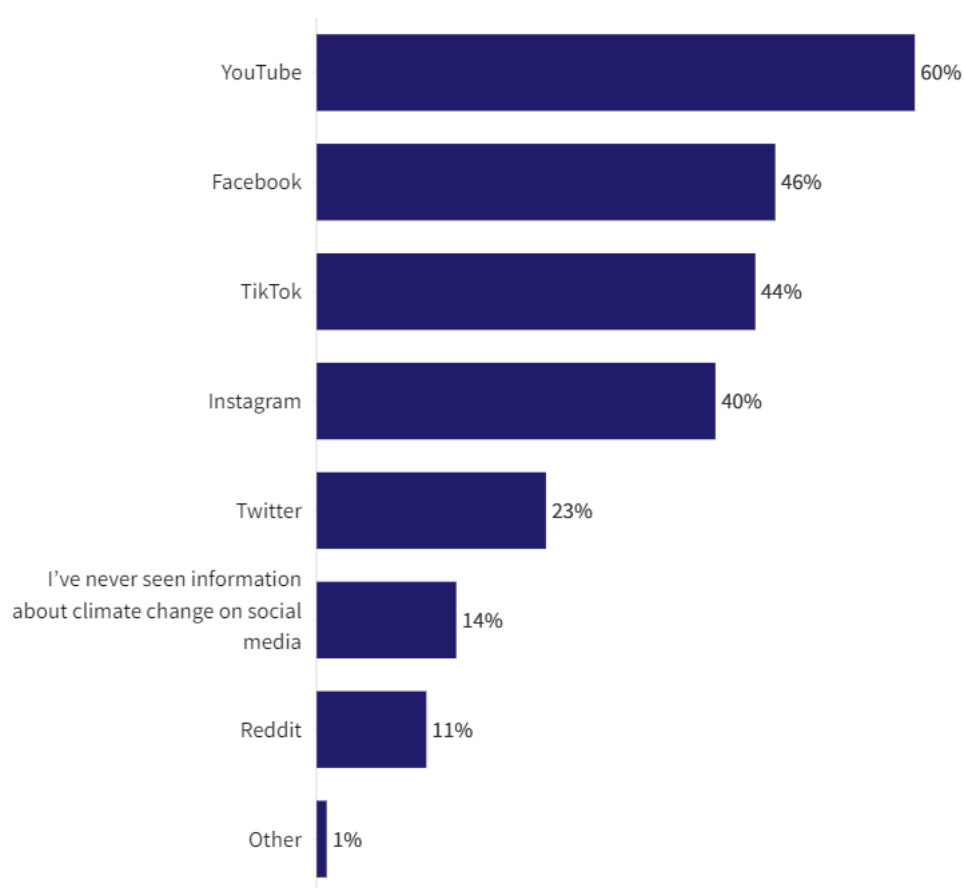
### **3.4.1 Introduction to Climate Change via News & Social Media**

Climate change in early education is necessary due to the decreasing age at which young people start to hear about the subject. Most people hear about climate change as

frequently as once per month via news and social media (Leiserowitz et al., 2022, 17). Many young people learn about climate change and sustainability from social media sites such as TikTok, Youtube, Facebook, and Instagram (Prothero & Page, 2023), as shown in Figure 3f. Some climate change and sustainability content young people find comes from official news sources, while broader discourse on climate change happens on social media platforms (Prothero & Page, 2023). However, media discourse can be inaccurate and misleading ("Deconstructing Climate Science Denial," 2020, 62-64). Currently, 50% of children have social media accounts before the age of 12 (by middle school), and this age has been getting lower (Bozzola et al., 2022, 1).

**Figure 3f**

*Where Young People See Climate Change Information on Social Media*



Note: From *Most Teens Learn About Climate Change From Social Media. Why Schools Should Care*, by Prothero, A. and Page, D., 2023, Education Week (<https://www.edweek.org/technology/most-teens-learn-about-climate-change-from-social-media-why-schools-should-care/2023/01>).



Social media discourse on climate change is important because much of the current news on climate change is negative, and can be polarizing (Feldman & Hart, 2021, 1; Bolsen & Shapiro, 2018, 149). Much of what is shared from influencers on social media is designed to evoke an emotional or polarizing response, rather than be informative (Prothero & Page, 2023). This leads to stress, anxiety, and trauma referenced in Section 3.2. In order to give young people the language, tools, and knowledge to effectively understand and critique what they are seeing and hearing on social media platforms, climate change and sustainability education needs to happen before and during these exposure points.

### **3.4.2 Habit & Mindset Development**

Although our perspective on the world evolves with age, research shows that many of our habits develop in early childhood, below the age of 9 (Pressman et al., 2014, 347). While the study was limited to basic habits, the physical and mental habits young people form affect their development and learning experiences (Darling-Hammond et al., 2019, 97-98). As children develop, all of the information they observe feeds into their mental model of how the world works and how they are contextualized within it (Darling-Hammond et al., 2019, 97-98). This is relevant to climate change and sustainability because what young people learn about and do in the world informs their mental model of how the world works.

As a simple example, imagine a young person who learns about recycling and reuse as soon as they become responsible for disposing of their own trash. Their recycling and reuse habits may be reinforced by parent or caregiver intervention, so their habit solidifies. The earlier this habit is introduced, the more likely it will last - so as the young person grows up, they will continue to recycle and reuse a variety of materials that would otherwise go to landfill.

As a more complex example of a mental habit, if the actions and behaviors a parent instills in their child reinforce a “linear mindset” in which everything is produced, used, and disposed of, then their child will be more likely to act with that mindset moving forward. Instead, to reinforce sustainability mental models, the parent might encourage their child to establish a “circular mindset,” in which they consider what they need, where it might come from, and what to do when they are done with it to prevent sending the waste to a landfill. The earlier the parent can introduce and reinforce these concepts, the more likely a young person will develop a circular mode of thinking.

Beyond teaching in a school setting, helping young people at home and in their communities adopt the habits and perspectives of sustainable thinking is important in order to equip them with sustainability-focused mindsets later in life. Parents, caregivers, and other community members have a large influence on childhood development. As a result, climate

change education is not just about what we teach in schools, but what we do in our homes and communities.

### **3.5 Climate Change Discourse in Social and Family Settings**

While the majority of teachers support climate change education, the fact that 80% of parents support climate change education as well highlights that parents are also looking to teach their children about environmental issues (Kamenetz, 2019). Children's perspectives on climate change are informed by their immediate environment and interactions, including their community and family. As a result, parents' and families' perspectives on climate change, and how they teach it to their children, is relevant in shaping young people's perspectives on and feelings toward climate change.

#### **Parents & Community Member Sentiment Influences the Sentiment of their Children**

The way parents and community members help young people cope with their feelings around climate change shape young people's perspectives on the topic (Ojala & Bengtsson, 2018, 912-913). Children whose parents routinely discuss climate change as a family in supportive, informative ways tend to both have less anxiety about the topic and tend to take more actions toward environmental stewardship (Lawson et al., 2019, 458). Children of parents with negative, "doom-and-gloom", or dismissive outlooks on climate change tended to have a more negative or dismissive attitude toward climate change (Ojala & Bengtsson, 2018, 925-927). This may extend to other members in a young person's community as well, including friends and extended family (Ojala & Bengtsson, 2018, 912).

#### **Communities Can Normalize Pro-Environmental Behaviors**

Another finding of Ojala and Bengtsson is that the community and environment surrounding a young person's growth can normalize discourse and actions about the environment (Ojala & Bengtsson, 2018, 912). Young people feel more empowered to take action on environmental issues if they see and hear examples of their peers or community members taking action as well. When those actions are taken together, as a family or a community, it validates the feelings that other family or community members may have, and leads to more cohesion within the group (Ojala & Bengtsson, 2018, 925-928; Clayton et al., 2021, 67). This helps people feel more comfortable engaging in climate change discourse, and reduces their anxieties because they see that others care and are willing to listen (Clayton et al., 2021, 67).

#### **Parents Feel Guilty, Disempowered, and Uninformed**

Young people asking their parents about how our behaviors contribute to climate change can be a major point of friction in family discourse on the topic. This happens because

children will point out actions or behaviors that their family takes part in which might contradict prior discussions they had about sustainability (Gaziulusoy, 2020, 5). This creates anxiety and hopelessness for parents, who feel like their integrity is compromised and that they aren't being responsible global citizens, while also acknowledging that their individual actions are a "tiny drop in the ocean" (Gaziulusoy, 2020, 6). Parents feel that they need to be experts in climate change to explain the complexities of the issue, and to prepare their children for a world that is difficult to imagine (Gaziulusoy, 2020, 6). The interconnected web of science, policy, news, and family behaviors can make parents feel overwhelmed, disempowered, and uninformed when their children ask about climate change (Gaziulusoy, 2020, 6-7).

### **Discovery- and Learning-Focused Mindsets Help**

Part of what can address parental guilt and lack of knowledge is creating experiences where parents can learn alongside their children. This tends to reduce anxiety for both parents and children, and leads to more environmental stewardship within the family as a result (Lawson et al., 2019, 461). A discovery- and learning-focused mindset helps because it reduces feelings of powerlessness and gives both parents and children agency (Ojala & Bengtsson, 2018, 913). These mindsets help reframe the climate change issue from pessimism to optimism, because the child's learning process, guided by parents, helps to uncover actions that are already being taken, and actions that do make an impact from an individual and community level (Ojala & Bengtsson, 2018, 913). Discovering what has been done and what can be done helps to feel like the burden is not solely on the parent or the child to solve climate change (Ojala & Bengtsson, 2018, 913).

### **Children's Learning Affects Parents Views on Climate Change**

One of the most important aspects of climate change integration into home and community discourse is that children's interest for climate action can foster climate change concerns in their parents (Lawson et al., 2019, 459-461). In Lawson et al.'s study, parents who identified as conservative and exhibited minimal concern toward climate change experienced the largest shift in their perspectives after their children learned about it in school (Lawson et al., 2019, 460). This study shows that effective climate change education plays a pivotal role in shifting the perspectives of both children and their parents, thus presenting intergenerational learning as an opportunity for affecting public sentiment on climate change. Creating intergenerational learning experiences in which parents and children can learn together can empower both younger and older generations to take action on climate change (Lawson et al., 2019, 461).

### 3.6 Secondary Research Review: What is Working, and Where Are the Gaps?

At broad scales researchers and educators have recognized a need for better education and communication on environmental issues in school and home settings. Our secondary research review indicates a few core gaps and common themes that are worth focusing on as we develop our framework:

1. Climate change and sustainability education is needed for elementary-school age children.
2. Existing climate change education lacks interdisciplinarity.
3. Teachers and parents feel disempowered and uninformed on climate change and sustainability.
4. Project-based learning in community settings reduces anxiety and facilitates an action-oriented mindset.
5. Families, communities, and collaboration play an important role in normalizing climate discourse and action.
6. Climate change learning is effective if holistic to young people's lives and communities.
7. children can change parent perspectives on climate change.

In order to understand how these high-level trends actualized in situations with adults teaching or discussing climate change with kids, we conducted primary research through interviews with teachers, parents, and climate communication experts. These interviews allowed us to drill down into exactly what teachers, parents, and other adults are feeling when they try to talk about climate change and sustainability with young people, and what they have tried that has helped mitigate some of the issues that our secondary research uncovered. Alongside our secondary and primary research, we also explored existing solutions that demonstrate different ways that climate change education has been implemented to-date.

# 4

## The Spiral of Silence

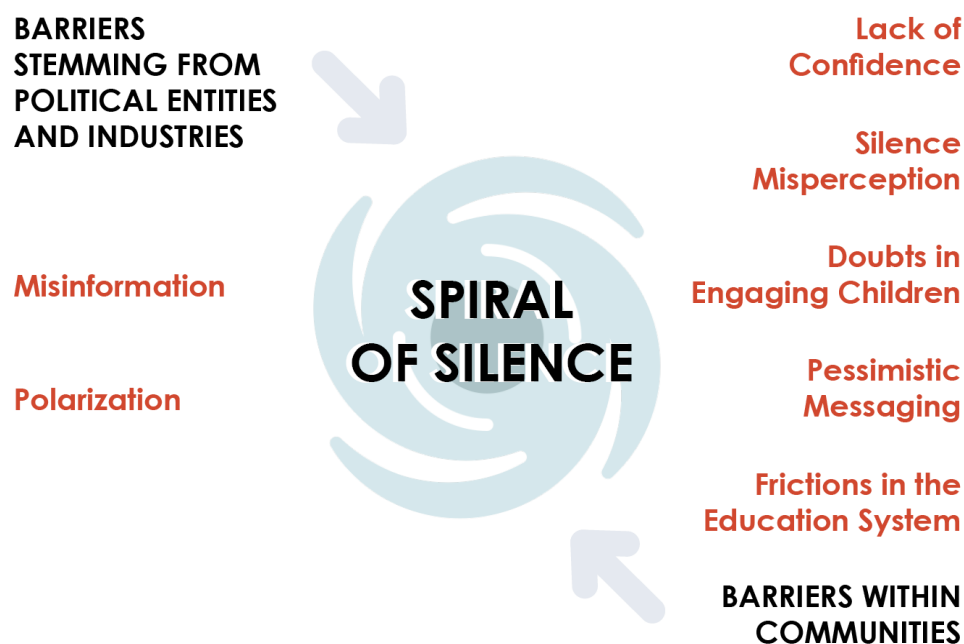
### 4.1 Overview

***A Spiral of Silence surrounding sustainability is fueled by barriers to communication and action.***

Many adults are interested in climate change and sustainability and want to do better: 64% of Americans say climate change is extremely, very, or somewhat important to them (Leiserowitz et al., 2022, 18). However, there are multiple barriers to communication and action at the systemic level. We talked to climate and communication experts, educators, and parents to verify these barriers. Through primary research, we have confirmed that on-the-ground sentiment of climate change and sustainability learning is consistent with what we found from secondary research. The problem at large can be depicted as a “Spiral of Silence,” as named by Participant 3, a climate communications researcher, surrounding the topic of climate change and sustainability. It includes numerous elements which together, continue to fuel and exacerbate silence.

Barriers within the Spiral of Silence can be segmented into two parts, including those stemming from large entities such as industries and political bodies, and others existing within the community level. We decided to take a bottom-up approach and focused our research on barriers that exist within communities.

**Figure 4a**  
*The Spiral of Silence*



## 4.2 Barriers Stemming From Political Entities and Industries

Many political entities and industries do not prioritize sustainability, some to the extent of propagating misinformation to their own benefit, according to Participant 3, a climate communications researcher. As an example, there have been instances where political influence through donations from the fossil fuel industry undermined climate education, and campaigns were launched to incite doubts about climate change (Cho, 2023). Misinformation, on a systemic level, is extremely hard to overcome. Consequently, misinformation leads to polarization of society surrounding climate change and sustainability. Participant 3 further explains that “in the US, political viewpoint is the strongest indicator of climate belief.”

Consequently, polarization can render negotiations and conversations difficult and undesirable. Participant 14, a parent, mentioned that polarization has caused her to avoid conflict by not discussing sustainability with friends and family altogether.

**There is a lot of funding going into getting people to believe that climate change is not real.** (Participant 6, environmental educator, psychologist)

## 4.3 Barriers Within Communities

### 4.3.1 Lack of Confidence

**95% of teachers want to teach climate education, but less than 40% feel confident to do so... There is a lack of confidence, resources, time, and capacity. (UNESCO, 2021, 2-4, as cited in Lamba, 2022)**

Adults are unable to confidently discuss the complex topic of sustainability for two main reasons: lack of precedent and lack of resources. Firstly, adults we talked to expressed that they lack precedent for how sustainability should be discussed. They mentioned that they have seldom been exposed to sustainability education in their lives and in the classroom. In the case that they have been, messages they are familiar with are negative and anxiety inducing. As a result, they do not have a good relationship with discussions surrounding climate change or sustainability, and sometimes would rather choose avoidance.

Secondly, they feel that they are not equipped with the right resources to initiate conversation with children. They do not have guidance regarding what they should talk about, how they should go about conversations, and when it is best to begin discussions. Since sustainability is not a conventional topic taught in classrooms, there have been limited educational resources developed for educators and parents.

**We don't really find any resources... There are resources we use for math, there are resources we use for reading. For science and especially sustainability, we would love to hear where to go. We have not found any natural place to go for that. (Participant 23, parent)**

Subsequently, this lack of confidence causes adults to feel like they are not qualified to initiate conversations with each other, let alone with children.

### 4.3.2 Silence Misperception

As discussed in Section 3.2.2, individuals perceive the number of people concerned about climate change to be lower than it actually is (Buttel et al., 2020, 2). Consequently, they feel isolated on their journey towards sustainability, and are discouraged to begin conversations, take action, or reach out for support. Participant 14, a parent, expresses how she wishes for a better support system:

**I'm unsure what would help me do it better. I don't know! I don't really have anyone else who tries around me... I wish there were more people around me who are supportive of these things.** (Participant 14, parent)

### 4.3.3 Doubts in Engaging Children

Some adults have doubts in engaging children in climate change conversations. Firstly, they may be protective of their children and are fearful of informing them of negative information. They are afraid of making children feel uncomfortable if they bring up topics that may provoke negative or contradicting feelings.

**Folks don't want their kids to feel bad. They want their kids to feel happy.** (Participant 14, parent)

According to Participant 14, a parent, there is also an element of "laziness" in not wanting to answer children's questions regarding contradicting ideas.

Meanwhile, some adults do not believe that children can make a meaningful impact, and that small actions accessible to most young people, such as recycling or small-scale advocacy, feel inadequate.

**There is a choice point in what we're going to engage kids with. For 6 to 10 year olds, it's a relatively high bar for them to do anything meaningful.** (Participant 11, education researcher)

Given the lack of motivation to engage children in sustainable action, sustainability becomes less of a priority in terms of conversations with children.

### 4.3.4 Pessimistic Messaging

As discussed in Section 3.2.3, the majority of messaging surrounding climate change, particularly through mass media, is negative, anxiety inducing, and problem-oriented. As a result, this spurs pessimism around sustainability and reinforces silence around the topic.

**A lot of what we're hearing today is very scary and anxiety inducing** (Lamba, 2022)



### 4.3.5 Frictions in the Education System

As made clear by many educators, making change within the education system is extremely difficult. While some educators are able to innovate in the classroom on an individual level, it is hard for changes to scale to the communal level. There are numerous ways in which the status quo serves to fuel the Spiral of Silence.

#### **Traditional Education Standards Do Not Prioritize Climate And Sustainability Content**

As described by Participant 6, an environmental educator, “adhering to the standards set by schools are big constraints.” Educators are busy preparing lessons to abide by standard curriculum, and are discouraged from innovating and including sustainability in the classroom.

Sustainability education is intangible to both students and teachers, making the subject difficult to evaluate. Because educators are evaluated on a regular basis, they are discouraged from teaching about sustainability because, as explained by Participant 2, an education researcher, “people don’t want to spend time on things that can’t be measured.”

All in all, as discussed further in Section 3.3, in the US, teachers may dedicate only 1-2 hours of climate change content over the course of a year (Plutzer et al., 2016, 664-665).

#### **Traditional Climate Education Is Taught In Science Class**

Today, climate change as a topic is not only sparsely covered in classrooms, but also mostly contained in science classes, as discussed in Section 5.1. Furthermore, “[climate science] is taught as a subject, as a set of facts that you get tested on,” as described by Participant 7, an environmental educator. Consequently, climate education is isolated from other subjects and disciplines, discouraging extension and application beyond the classroom. This limitation prevents certain individuals from connecting to climate change and sustainability because not every child is inclined to understand the topic through the sciences.

In Section 3.3.2, we elaborate in more detail why learning about sustainability and climate change in an interdisciplinary context is important and possible ways in which it could be done (Lozano et al., 2017, 4; UNESCO, 2020, 28).

**The best strategy is weaving it throughout the curriculum. This topic, if we’re going to isolate it, you really limit the profoundness of it. (Participant 26, 3rd Grade Teacher)**

### **Traditional Education Provides Limited Exposure To Nature**

There is minimal infrastructure to support learning outdoors. Because of that, children, especially those who live in urban areas, have limited connection to the natural world. Participant 5, an educator, describes how “it was surprising to [him] how little students seem to connect or care about the environment.” This disconnect distances children from the most important source of knowledge, inspiration, and motivation, that is nature.

**Ideally, schools would just spend more time outside. It should be more possible to spend more of the day outside... Nothing is set up to support outdoor learning...** (Participant 10, parent, environmental advocate)

### **Traditional Learning Lacks Reflection**

**One of the problems with traditional schooling is a lot of people come out with the inability to reflect because it's just task, task, task...** (Participant 2, education researcher)

Education researchers we talked to revealed the importance of reflection in learning and how typical classrooms do not leave space and time for students to reflect. They believe that without reflection, it can be difficult for children to connect to ideas in ways that are meaningful to them, nor conceptualize new knowledge such that it becomes applicable to future problems. Without the opportunity to reflect, children are unable to connect to these new problems simply by applying previously learned ideas.

### **Traditional Learning Is Abstract**

“Unlike adolescents, elementary age students are less capable of abstract thought,” according to Participant 6, an environmental educator. In classrooms, children are often tasked with imagining scenarios or solving problems that are difficult for them to connect with. There is a lack of hands-on learning that is necessary for children to be able to come to terms with new knowledge in their own way. Participant 7, an environmental educator, describes how abstraction and complexity cause difficulty in sustainability education:

**Children's imagination are powerful, but it made everything they were doing feel abstract because they knew it was pretend.** (Participant 5, environmental justice educator)

**Things felt remote and abstract because they were acting as lawyers, and not as children.** (Participant 5, environmental justice educator)

# 5

## Existing Solutions for Climate Education and Communication

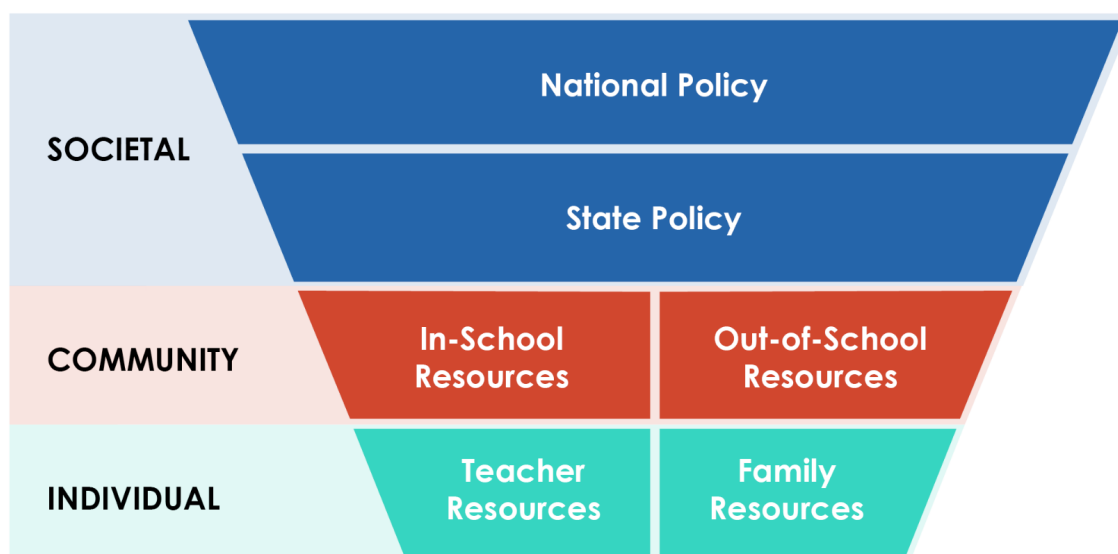
### 5.1 Overview

There is a broad spectrum of climate change and sustainability education solutions that influence how and where young people learn at different scales and in different settings.

At the highest level, national policy dictates what young people are expected to learn at what age range. Individual states may choose to expand upon those requirements with their own policies or programs. At a community level, programs and other resources exist to support exposure and education on climate change and sustainability both in and out of school. As the scope of solutions narrows to the individual level, tools and resources exist to support parents and educators in teaching their children about sustainability. These scales are mapped in Figure 5a below.

**Figure 5a**

*Different Scales of Existing Solutions for Climate Change and Sustainability Education*



Various education solutions also address different aspects of climate change and sustainability. Each solution typically falls into one of three broad categories:

- **Making Sustainability Meaningful:** Building an awareness of what climate change and sustainability problems exist, and why we should care about solving them.
- **Making Sustainability Tangible:** How to think about climate change and sustainability problems in effective, constructive ways.
- **Making Sustainability Actionable:** Identifying what actions can be taken to address climate change and sustainability problems, and taking them.

Below is a review of different solutions at different scales of climate change and sustainability education. We used our review of existing solutions to map out gaps, insights, and implications of the existing solution space in climate change and sustainability education.

## 5.2 Climate Change Education Standards at the National Level

The two leading frameworks on K-12 science education in the United States are the Next Generation Science Standards (NGSS) and the National Research Council Framework for K-12 Education (NRC). These two frameworks clarify student learning expectations at different grade levels in science curricula. These science teaching standards are implemented in 44 states, representing about 71% of all students. The NGSS is adopted by 20 states and Washington D.C., and the NRC is adopted by 24 states (National Science Teaching Association, 2018). Tables 5a and 5b shows what explicit climate change and sustainability lessons are covered in each framework.

As we explore in Section 5.2.1 and 5.2.2 below, the majority of the standards focus on problem understanding through a scientific lens. The standards suggest that students explore the effect of human activity on the climate and on natural ecosystems, including natural resource destruction, biodiversity loss, and energy resources. A majority of the standards emphasize why sustainability is meaningful, because they help young people build an understanding of the problem and why it is important. Some explicit and implicit standards build an understanding of tangibility, i.e. ways to think about the problem. However, there is minimal emphasis on what actions can be taken to mitigate these effects.

Additionally, these standards are only applied within science curricula. Climate change and sustainability themes are not present in other subject standards. As mentioned in Section 3.3.2, teaching sustainability in a holistic context adds meaning and depth beyond the scientific perspective, because it integrates important lessons from history, urban planning, social equity, and engineering. These standards also primarily involve middle school and high school curricula, and do not include as much content for elementary school students.

While both standards include curricula and assessments on climate change and sustainability, these frameworks only influence state choices on climate change education. States can make their own decisions about what to include or exclude, and teachers can choose to teach the content in these standards in their own ways (National Science Teaching Association, 2018). Research shared in Section 3.3 highlights that 75% of US public school science teachers include climate change content in their teaching. Since 71% of US students reside in states influenced by these standards, it is likely that the content from these standards is being applied. However, most teachers may only dedicate 1-2 hours of climate change content over the course of a year (Plutzer et al., 2016, 664-665). So while it may be applied, it is not necessarily well-integrated.

### **5.2.1 Climate Change Themes in the Next Generation Science Standards**

The Next Generation Science Standards (NGSS) framework primarily integrates climate change learning at the high school level. Explicit themes on climate change and sustainability are listed in Table 5a. The explicit themes focus mostly on understanding the impact of human activity on the environment, and include some topics addressing how to think about the problem, and actions we might take to mitigate human impact on the environment. These themes are mostly taught within the context of Earth and Space Sciences, with some categorized as Life Sciences topics (Next Generation Science Standards, 2014).

Other aspects of the standard incorporate themes of climate change and sustainability, but they are inexplicit. These can include standards such as standard HS-LS2-6, which asks that students be able to “Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem” (Next Generation Science Standards, 2014). In this example, population dynamics helps young people build a baseline understanding of ecosystem structure and the implications to an ecosystem if something changes, but it does not explicitly teach how human impact on the environment can affect the ecosystem. Only by helping students make connections across different standards would human impact on ecosystems become apparent. For example, HS-LS2-6 in conjunction with MS-ESS3-4 would connect how human consumption affects earth’s systems with how those ecosystems would change and adapt. Helping students make these connections is up to how the teachers frame the material. If teachers are only putting 1-2 hours per year into teaching this material, then those connections and learnings may not be very strong.

The extent to which “problems” and “solutions” to climate change are framed increases with grade level, as does the depth to which each concept is explored. It is important to note that there are no direct references to climate change in any NGSS curriculum below middle

school. In some earth and life science classes below the 6th grade, the NGSS states “Assessment does not include climate change” (Next Generation Science Standards, 2013). However, some themes of human impact on climate appear before middle school, and are expanded upon to include climate change later. For example, standard 4-ESS3-1 identifies how energy use affects the environment, and introduces air pollution and fossil fuels. In middle school, students investigate evidence of the factors that cause global temperature rise in standard MS-ESS3-5, which includes fossil fuels. In high school, students may analyze data to forecast global temperature rise and environmental impact in HS-ESS3-5. The topics go more in-depth as students get older, starting with simple problem understanding and expanding to include how humans affect the problem, how to quantify it, and the short- and long-term consequences of climate change.

**Table 5a**

*Climate change topics covered in the Next Generation Science Standards (NGSS)*

<b>NGSS Code</b>	<b>Grade Levels</b>	<b>Excerpts from NGSS Learning Goals</b>
K-ESS3-3	Kindergarten	Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
4-ESS3-1	4th Grade	Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
5-ESS3-1	5th Grade	Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
MS-ESS3-5	Middle School	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
MS-LS2-5	Middle School	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
MS-ESS3-4	Middle School	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

<b>NGSS Code</b>	<b>Grade Levels</b>	<b>Excerpts from NGSS Learning Goals</b>
MS-ESS3-5	Middle School	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ETS1-1	Middle School	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
HS-ESS3-1	High School	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
HS-ESS2-4	High School	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
HS-ESS3-4	High School	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ESS3-5	High School	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 systems.
HS-ETS1-1	High School	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-3	High School	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Note: Information collected from a search of the NGSS Standards for terms related to climate change and sustainability (Next Generation Science Standards, 2014).

## 5.2.2 Climate Change Themes in the National Research Council Science Education Standards

The National Research Council (NRC) Standards for K-12 Science Education introduce climate change and sustainability in a similar fashion to the NGSS. While the NGSS is structured around different competencies recommended at specific grade levels, the NRC is structured around “Core Ideas” that transcend across grade levels, with specific competencies that become more in-depth with each grade. Some basic concepts and problems related to climate change and sustainability are taught in elementary school. Like the NGSS, the depth to which the problems and solutions are explored expands as students enter middle school and high school. The NRC standards relevant to climate change and sustainability are reviewed in Table 5b.

**Table 5b**

*Climate Change Topics Covered in the National Research Council (NRC) Framework for K-12 Science Education*

<b>NRC Code</b>	<b>Grade Levels</b>	<b>Excerpts From Disciplinary Core Ideas</b>
LS2.C - Life Sciences: Ecosystem Dynamics, Functioning, and Resilience	9-12	Anthropogenic changes...can disrupt an ecosystem and threaten the survival of some species. (National Research Council et al., 2012, 156)
LS4.D - Life Sciences: Biodiversity and Humans	3-5	Populations of organisms live in a variety of habitats, and change in those habitats affects the organisms living there. Humans...obtain living and nonliving resources from their environments. (National Research Council et al., 2012, 167)
	6-8	Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on. (National Research Council et al., 2012, 167)
	9-12	Human activity is...having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. These problems have the potential to cause a major wave of biological extinction. Thus sustaining biodiversity so that ecosystem functioning and



NRC Code	Grade Levels	Excerpts From Disciplinary Core Ideas
		productivity are maintained is essential to supporting and enhancing life on Earth. (National Research Council et al., 2012, 167)
ESS3.A - Earth & Space Sciences: Natural Resources	K-2	Humans use natural resources for everything they do: for example, they use soil and water to grow food, wood to burn to provide heat or to build shelters, and materials such as iron or copper extracted from Earth to make cooking pans. (National Research Council et al., 2012, 192)
	3-5	All materials, energy, and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. (National Research Council et al., 2012, 192)
	6-8	Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geological processes (link to ESS2.B). Renewable energy resources, and the technologies to exploit them, are being rapidly developed. (National Research Council et al., 2012, 192)
	9-12	Resource availability has guided the development of human society. All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks, as well as benefits. New technologies and regulations can change the balance of these factors. (National Research Council et al., 2012, 192)
ESS3.C - Earth & Space Sciences: Human Impacts on Earth Systems	K-2	Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things—for example, by reducing trash through reuse and recycling. (National Research Council et al., 2012, 195)

NRC Code	Grade Levels	Excerpts From Disciplinary Core Ideas
	3-5	Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (National Research Council et al., 2012, 196)
	6-8	Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of many other species...Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (National Research Council et al., 2012, 196)
	9-12	The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. When the source of an environmental problem is understood and international agreement can be reached, human activities can be regulated to mitigate global impacts. (National Research Council et al., 2012, 196)
ESS3.D - Earth & Space Sciences: Global Climate Change	3-5	If Earth's global mean temperature continues to rise, the lives of humans and other organisms will be affected in many different ways. (National Research Council et al., 2012, 198)
	6-8	Human activities, such as the release of greenhouse gasses from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing human vulnerability to whatever climate changes do occur depends on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (National Research Council et al., 2012, 198)
	9-12	Global climate models are often used to understand the process of climate change because these changes are

NRC Code	Grade Levels	Excerpts From Disciplinary Core Ideas
		<p>complex and can occur slowly over Earth's history. Though the magnitudes of humans' impacts are greater than they have ever been, so too are humans' abilities to model, predict, and manage current and future impacts...Science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences—for humanity as well as for the rest of the planet.</p> <p>(National Research Council et al., 2012, 198)</p>

Note: Information collection from a search of the standards for terms related to climate change and sustainability (National Research Council et al., 2012, 156-198).

### 5.2.3 Implications of Climate Change Themes in the NGSS and NRC Frameworks

One of the interesting insights upon reviewing the themes in both the NRC and NGSS standards is where different aspects of climate change and sustainability communication appear. Typically, causes of climate change and some solutions that mitigate climate change are discussed earlier on, but practical ways to think about the issue that tie the problems to the solutions are not explicit until middle school and above. Additionally, while students gain an awareness of what actions can be taken at a global or societal level, it is not clear that students learn what they can do as individuals. Further, the standards cover what should be learned, but not always how to teach it. As a result, students will not necessarily gain experience taking action themselves.

The NRC Framework's Core Idea of ESS3.A: Natural Resources is a relevant example of this, which can be referenced in Table 5b. The content covers how humans use natural resources, and the associated costs, risks, and benefits of renewable and non-renewable resources. In this example, the consequences of human use of natural resources are not discussed until middle school, where students explore the limits and the distribution of different resources and how this affects human consumption. Solutions to minimize resource extraction, such as renewable energy resources and new technologies, are discussed in middle school, and broader management of resources via regulation alongside technological development is not covered until high school. Because of this, learners do not get the systems level perspective of resource extraction until middle school, which informs how they might think about natural resource consumption. The solutions presented are abstracted to someone else's responsibility -

in middle and high school, the takeaway is that it is up to engineers to invent new technologies, and international governing bodies to manage resources responsibly.

Although teachers may choose to present this information in different ways, both the NRC and NGSS do not sufficiently prioritize showing students, especially young students, how they can leverage their systems understanding to identify promising solutions, nor how they can take action themselves, as individuals or as communities. The solutions-focused content is explanatory, rather than action-oriented.

## **5.3 State-Level Involvement of Climate Change and Sustainability Education**

States can adopt the NGSS or NRC as their standards, but can modify them as they see fit by state, district, or even school decision makers. Some states have chosen to go beyond the standards by integrating climate change more fully into their curriculum. However, only two states have successfully passed this legislation, but support for these policies in other states is growing.

New Jersey and Connecticut have both passed legislation requiring that climate change and sustainability be taught at all grade levels, with New Jersey specifically requiring climate change be taught in all disciplines as well. With these pieces of legislation have come additional support and resources for both states in order to help schools and teachers implement new curriculum. This section explores how these policies have played out in each state, and what is happening in Massachusetts, where legislation on climate change education has been introduced but not yet passed.

### **5.3.1 New Jersey Climate Change Education Standards**

New Jersey was the first state to require climate change content be integrated into all subjects and K-12 grade levels. With this policy also came funding and structure dedicated to climate change education. New Jersey Governor Phil Murphy created an Office for Climate Change Education within New Jersey's Department of Education, and allocated \$5 million in funding for climate change curriculum development. (New Jersey School Boards Association, 2022)

The strength in New Jersey's approach comes from the way it has executed upon the new standards. Their approach is teacher-empowering, interdisciplinary, action-oriented, and locally relevant. New Jersey created its own set of climate change learning standards, and launched the New Jersey Climate Change Education Hub with resources supporting the standards. The Education Hub provides schools and teachers with lesson plans, teacher

resources, professional learning opportunities, and school administrator guidance to help schools adopt and implement the standards. (New Jersey Climate Change Education Initiative, 2022)

New Jersey has adapted the NGSS to make their climate change and sustainability education more expansive, and they have created lesson plans and resources to help teachers comply with their additional standards. From a high level, they provide the lesson plan framework in Figure 5b to guide their curriculum (New Jersey Climate Change Education Initiative, 2022). Curriculum needs to span the following three areas:

- **Inspire:** Expose students to scientific curriculum in compelling ways that tap into their curiosity and wonder. Make themes and ideas personally relevant to the students.
- **Inquire:** Encourage students to ask questions or pose challenges that are interesting and personally relevant, and determine what they need to do in order to resolve them.
- **Investigate:** Motivate students to create their own experiments and investigations to understand how to answer their questions or solve the challenges they posed.

**Figure 5b**

*A Framework for Climate Change Education by the New Jersey Climate Change Education Hub*



*Note: From New Jersey Climate Education Hub, by New Jersey Climate Education Hub, 2022 (<http://njclimateeducation.org>).*

The New Jersey curriculum standards heavily emphasize community-based and action-based learning in order to help students put climate change and sustainability in the context of their communities and their own lives. Throughout the Report on K-12 Climate Change Education Needs in New Jersey, a few key areas of focus are highlighted and addressed by their Climate Change Education Hub:

### **Professional Learning Opportunities**

When New Jersey established the Climate Change Education Hub, they recognized that a lack of knowledge around climate change education was a barrier for many teachers, who typically held misconceptions related to climate change and lacked the knowledge to teach it effectively. To respond to this need, the NJ Education Hub established a resource for teachers to participate in professional development programs and certifications on teaching climate change (New Jersey Climate Change Education Initiative, 2022). The Education Hub provides online and in-person courses and workshops to help NJ teachers uplevel their climate education skills, especially for non-science teachers who may not have been familiar with teaching climate subjects before (New Jersey Climate Change Education Initiative, 2022). The courses cover anything from broad strategies for creating climate change curriculum, teaching pedagogies that are specifically beneficial to climate change education such as culturally-relevant teaching and place-based teaching, and specific topics such as environmental justice and climate adaptation (New Jersey Climate Change Education Initiative, 2022). The state of New Jersey has also built out benchmarks for teachers and staff to address professional development needs around climate change education, with a proposed 5 year plan for training and engagement (Madden, 2022, 19) . As part of these efforts, they also acknowledged the need-based nature of funding and resources for climate change education, suggesting that "an equity-driven approach, in which those schools or districts with higher needs are prioritized to receive support...should drive decision making in distributing resources, with an emphasis on providing the most support to urban schools." (Madden, 2022, 18)

### **Easy Access to Tested Curricula**

In addition to training teachers, the New Jersey Climate Change Education Hub also published research-backed curricula to accelerate adoption of climate change and sustainability education. The hub has 141 specific lesson plans available and over 2,000 additional resources for teachers, all developed and tested by education professionals around the country . Many of the lesson plans are designed to be contextualized within New Jersey environments and ecosystems, while others can be adapted to other states and contexts to extend beyond the scope of just New Jersey. Each lesson plan follows the three-part framework

of Inquire-Investigate-Inspire, and includes tips for teachers on how to implement them effectively. (New Jersey Climate Change Education Initiative, 2022)

Not only was it important to develop these curricula, but also to make it easy to find. By centralizing many different lessons and educator resources on climate change and sustainability, New Jersey teachers know exactly where they can look for validated curricula that they can adapt to their classroom contexts. Lessons can be sorted by grade level, disciplinary areas, learning standards, and more so that teachers can easily filter to their specific needs. (Madden, 2022, 22-23)

### **Community- and Place-based Learning**

One of the cornerstones of New Jersey's climate change education program is the contextualization of global issues within local communities. The learning methodologies heavily prioritize "place-based learning," in which students can learn about and act upon specific sustainability topics within the places in their community, such as their school, home, city, or local natural environment. (Madden, 2022, 26)

Place-based learning methods make the lessons far more tangible than what would be considered "traditional" approaches to climate change education: "These direct effects add salience and a sense of place in a way that discussing polar bears that live on melting icebergs, for example, do not. Exposure and connection to local community issues helps young children make sense of broader global effects." (Madden, 2022, 26)

Community-based learning gives young people the experience and understanding of their influence within their communities. The report recommends that within classes, students collaborate with community stakeholders such as businesses, school administrators, local leaders, and residents to understand the local effects of climate change from multiple perspectives, and implement strategies to address them. Project-based learning in this way allows for students to explore climate change from an interdisciplinary lens, considering the social, political, historical, scientific, and financial lens of the many decisions that could contribute to a more sustainable future. (Madden, 2022, 26-27)

Contextualized learning deepens the connection between the seemingly abstract concepts introduced in the classroom and real actions that can be taken. As a result, contextualized learning has multiple benefits, because it both teaches students about climate change and sustainability while also tangibly making sustainability improvements at the same time: "Efforts to mitigate climate change within schools should be part of efforts related to teaching and learning. For example, school-based waste reduction initiatives should be included in curricular and professional development efforts to connect the physical place of a

school to the learning activities going on within that space" (Madden, 2022, 27). When students' ideas are implemented in the community, they recognize their role as change-makers in their communities, and can see tangible differences they've made as a result. Community- and place-based learning nurtures an action-oriented mindset toward climate change, while also boosting their agency and confidence that they can make an impact in solving a global problem. (Madden, 2022, 26-27)

### **Interdisciplinary and Diverse Forms of Learning**

New Jersey's climate change education policies acknowledge that environmental issues should be taught in more than just a scientific context, and also in more than just a traditional setting. Interdisciplinarity is important to climate change and sustainability education because of its complex nature - different disciplines provide different lenses upon which climate change can be viewed, to help students build a more holistic understanding of why human activity has accelerated climate change, who it affects the most, and what we can do about it. Climate change and sustainability are complex topics spanning many different subjects, meaning that it should be taught in such a way too. (Madden, 2022, 6, 14-17)

Beyond interdisciplinary learning, diversity in education methods is important to New Jersey's climate education plan as well. Provided resources and lesson plans span from scripted lectures to open-ended field trips in which students can direct their own learning by exploring and inquiring about natural systems they encounter. These varied learning experiences cover many different modes of thinking and learning in order to maximize retention and build connections between the classroom and the real world. (Madden, 2022, 23)

### **School Administrator Resources**

By providing resources for school administrators, the NJ Climate Change Education Hub helps schools not just teach climate change and sustainability, but also model sustainable behaviors at the school level. In addition to resources that review the standards schools must comply to, they also provide resources for schools and districts to participate in and build sustainability plans. This reinforces the community-based approach that New Jersey is taking to climate education. Through these resources, New Jersey is empowering students, teachers, and schools to strengthen their communities' sustainability efforts. (New Jersey Climate Change Education Initiative, 2022)

Overall, New Jersey has established effective resources and support for educators to teach climate change and sustainability, and can serve as a model for other states to do the same.



### **5.3.2 Connecticut Climate Change Education Standards**

Connecticut will also require climate change be taught in all public schools at all grade levels starting in the summer of 2023, but has kept the focus on science classes. While 90% of Connecticut schools teach and test on climate change at the 5th, 8th, and 11th grade, the policy will require all schools to teach it and will include the development of K-8 climate change education. Unlike New Jersey's approach, the new policy did not come with additional funding for schools to build out their climate change curriculum. A lack of funding has caused tension between the government and the Connecticut Association of Public School Superintendents. (Monk, 2022)

Currently, Connecticut schools and teachers either build their own curriculum, or leverage resources developed by DEEP, Connecticut's Department of Energy and Environmental Protection. DEEP has consolidated a collection of data sources, environmental non-profits, teacher resources, and some specific lessons that teachers can leverage. However, it is not nearly as extensive as New Jersey's Climate Change Education Hub. For example, only nine lesson plans are listed in DEEP's page on climate resources for educators, and teachers do not get additional support in contextualizing these lessons within their own communities like New Jersey teachers do. Therefore, it is still up to teachers to create curricula that resonate with their students, and it is up to schools and school districts to establish policies and source funding for climate change curriculum development. (Connecticut Department of Energy & Environmental Protection, 2019)

A lack of additional funding and support for schools has the potential to make climate change education inequitable in Connecticut, because schools in underserved communities with less social and economic capital will not have as much time or resources to build climate change curriculum, while schools in communities with more wealth likely have the resources to spare. This could propagate a knowledge and wealth gap between different socio-economic classes, which is especially important in the context of climate change because impoverished communities will experience greater effects of climate change and other environmental issues. Climate change and sustainability education need to be equitable so that all students have perspective on how the changing environment will affect their lives, and what they can do to support both their own communities and those of others.

### **5.3.3 Massachusetts Climate Change Education Proposals**

Massachusetts may be the third state to pass climate change education bills into law. In 2023, Massachusetts House Bills 470, 496, and 576 were introduced in 2023 to propose deeper integration of climate change and sustainability curriculum into K-12 public education, and

dedicated funding to support climate education buildout. The bills propose revising standards in history, social science, and civics, as well as in the sciences to help young people form a deeper understanding of why climate change is happening and how it will affect people around the world. Like with New Jersey's approach, they propose helping students connect insights across disciplines to understand the complexities of environmental justice, climate policy, and more. (Branch, 2023)

Currently, teachers in Massachusetts have been taking measures into their own hands by building relationships with local non-profits such as CitySprouts, and collaborating to build shared resources such as the Massachusetts Environmental Education Society (MEES). Some of these resources are explored in Sections 5.4 - 5.5.

### **5.3.4 Insights From State-Level Policies**

Although only two states have adopted statewide climate education policies (with one more likely on the way), their differences in approach serve as lessons for how climate change education should be implemented elsewhere. New Jersey's success in implementing climate change and sustainability education across the state hinges on the system they funded and built to support teachers. After recognizing the skills gap as the biggest barrier toward adopting climate education standards, they built a cohesive and expansive set of teacher training materials, lesson plans, and other resources in the New Jersey Climate Change Education Hub. This drastically lowered the barriers to adoption of the state standards, and did so in an accessible, equitable way so that educators in low-resource schools and communities could access and leverage content just as easily as any of the other educators in the state. Widespread standardization and education equity is a hurdle that Connecticut has been unable to crest because of lack of funding.

New Jersey's approach also highlights the importance and effectiveness of interdisciplinary, locally relevant, and action-oriented learning. Teaching climate change and sustainability across different disciplines helps students build a more contextualized understanding of all of the interconnected issues that have caused and are impacted by climate change and other environmental issues. Connecting these issues back to the context of the local community that a student lives in helps to build stronger values for sustainability. An interdisciplinary mindset is critical to navigating these issues and identifying key leverage points for action. By giving students the opportunity to take what they've learned and apply it in the real world, all of the interdisciplinary and locally relevant learning experiences can be leveraged to design effective solutions for climate change mitigation at the community level. These learning methodologies combined all boost student confidence and hope, and make them more likely to take further actions toward a sustainable future as they age.

## 5.4 Climate Change and Sustainability Themes at the School Level

At the school level there are many factors that influence the adoption of sustainability education, including teachers, school boards, school budgets, and parents. Schools typically adopt climate change and sustainability curriculum in one of three ways:

- 1. Top-Down Policy Driven Approach:** State or national policies are implemented, prompting schools to adapt to meet the new curriculum standards. These standards may be met by training teachers and providing them with resources (such as in the case of NJ), partnering with external programs, or creating curriculum from scratch. This is explored in Section 5.2 - 5.3.
- 2. Bottom-Up Teacher Driven Approach:** Teachers express interest in integrating climate change into their curriculum, so they search for resources and programs to support them. If enough support from teachers, parents, and school staff is garnered, then the school may choose to integrate the program holistically.
- 3. School Established With Environmental Themes:** Schools from the start are designed with environmental themes in mind, so sustainability and climate change education are a natural, core part of the curriculum. This is more common in private schools, because they are not held to the same standards as public schools are.

Both the top-down and bottom-up drivers for integration of sustainability into schools prompt educators and school officials for resources so that they do not have to build curriculum from scratch. This often means building partnerships with local non-profits and environmental groups who serve as subject matter experts on teaching young people about climate change and sustainability. Schools established with environmental themes tend to have school staff and teachers with the resources and knowledge to create curricula themselves.

### 5.4.1 Educational Program Partnerships with Schools

Instead of relying on teachers who may not have the bandwidth or expertise to teach climate change education, some schools build partnerships with local non-profits and programs to offer climate change curriculum. These partnerships are typically piloted at the teacher- or class-level and then expanded to the school level if appropriate. Educational partnership programs can vary widely, and can take one of a few formats. Some programs are based around a specific location, such as a farm or nature preserve. Schools may partner with the programs to run experiments or go on field trips, where an on-site representative may teach the students about the area and why it is important. Others focus on teaching specific content - for example, Action for the Climate Emergency (ACE) is a non-profit that partners with schools to teach students about climate change and incentivize young people to take action (Action for

the Climate Emergency, 2015). As part of their “Our Climate Our Future Live” programming, they host school-wide assemblies to teach students about climate change and then discuss what actions can be taken (Action for the Climate Emergency, 2020). These are examples of “acute” programming with schools, in which a program might engage with a school for a specific occasion but not over the course of the year. On the other end of the spectrum are “integrated” programs, in which a school partners with a program to offer regular learning engagements within the context of the program. The partnering program would typically have a specific representative that works with the schools to plan activities and tie them into what students are learning elsewhere in their curricula.

CitySprouts is an example of one such program; a Cambridge and Boston-based organization that teaches sustainable urban gardening and outdoor science learning for K-5 classrooms. They create outdoor, hands-on learning experiences that help students build a strong connection with nature, while also integrating lessons from earth and life science in accordance with Massachusetts science standards (Massachusetts uses NGSS). CitySprouts has a dedicated educator that works with each school, serving as essentially a subject matter expert who collaborates with school teachers to integrate CitySprouts' lesson planning into their curriculum. Their representative typically spends half an hour per week with each classroom, in which students learn science in the context of the garden they are helping to curate. (CitySprouts, 2018) Participant 25 described some of the benefits of partnering with CitySprouts:

**The educator that comes to my school will collaborate with us and ask what we're doing in the classroom, and connect it to how the kids can spend more time being outside...a program like that makes something click in our brains, that we should be doing this. The fact that she is here and offers it makes a lot of teachers say “oh wait, I should make time for this. (Participant 25, 1st grade teacher)**

Programs like CitySprouts offload a lot of the teaching about sustainability to experts who are well versed in the field, making it very helpful for teachers who do not have the bandwidth for creating new lessons (CitySprouts, 2018). Similar to themes that have been explored in our secondary research, educational program partnerships focus on building value for nature in their local community, which connects young people more deeply to issues of climate change and sustainability.

#### **5.4.2 Sustainability Themes in School Design**

Another approach to integrating sustainability into schools has been through school design. For example, the Martin Luther King Jr. School in Cambridge, MA is the second-highest scoring LEED Certified public school building in the country (Eastman & Benson, 2018). Features

such as its solar panels, its rainwater catchment systems, the materials it uses for insulation and lighting, and the piping for water, heat, and sewage are emphasized in the school's design. All of the features that contribute to the school's reduced environmental footprint include displays, demos, and placards that teach students about what each of the features are doing.

**Figure 5c**

*Examples of Sustainability Themes and Interactive Displays in School Design*



Note: Vertical sunshades (left and center) and heat-sensitive insulation tiles (right) at the Martin Luther King Jr. School in Cambridge, MA.

However, from an interview with a teacher in this school, we found that they didn't integrate any of these aspects of the school design into their curriculum or classroom activities. There aren't any intentional opportunities for students to explore the school's sustainability features, so the connection between class concepts and building design isn't nurtured for the students in the school.

### 5.4.3 Outdoor & Alternative Schools

The COVID-19 pandemic led to growth of outdoors schools and outdoor classes as an alternative to traditional classroom environments. While relatively new to the U.S., Outdoor schools are more common in Europe. They embrace nature-immersed learning, all while still meeting national curriculum standards for their respective grade levels. Activities are heavily project-based, typically involving real-world, self-directed science experiments in their local environment. Young people tend to develop a strong systems-thinking mindset because they spend so much time exploring and investigating the natural ecosystem around them. In addition, outdoor schools facilitate deep socio-emotional development since students build connections with others by exploring and learning naturally. Outdoor schools can make learning, especially about the environment, very concrete and tangible because the curriculum

happens in context, rather than in an abstract setting. (*What Is Outdoor School?* — *Friends of Outdoor School*, 2018)

Other schools have a specific environmental focus even if they are not considered to be outdoor schools. An example of such a school is the MUSE School, in Calabasas, CA. The MUSE school has a specific focus on environmentalism, teaching young people to be responsible stewards of the environment. In the school, teachers are viewed as facilitators, observing what the students are interested in, what questions they have, and creating learning experiences for students to explore and answer those questions together (Harrington, 2010). As the school has developed over the past two decades, it has become more intentional about environmental stewardship in order to model environmentally responsible behaviors. For example, MUSE shifted the school to an all-vegan meal plan (Kirkova, 2015). Students and teachers grow food for the school, learning about gardening, plant cultivation, and meal preparation along the way (Kirkova, 2015). By tying these activities into the curriculum, students understand how their actions contribute to a sustainable lifestyle, and gain concrete experience within the school that establishes sustainability-oriented habits and mindsets.

Access to outdoor and alternative schools is very limited, and they are typically private or only accessible to upper- or middle-class families due to their location. Of about 130,000 K-12 schools in the US, 600 of them are outdoor schools (Fox, 2021; Vlasova, 2023). While these schools are taking great strides in environmental education, their location and private funding typically means they are only accessible to upper-middle-class families. Children from families with less social and monetary capital do not have equitable access to these types of schools, and typically rely on public education in poorly funded neighborhoods. Although these schools are making great strides in environmental education, broader access is limited, so the majority of young people are excluded from these opportunities.

#### **5.4.4 Insights from School-Level Climate Change Education**

Although the ways that schools influence climate change and sustainability education for their students can vary broadly, there is a connecting theme of contextual learning that spans all of the examples presented. In each example, climate change and sustainability are taught in atypical ways outside of a traditional classroom structure. CitySprouts and other educational programs, outdoor schools, and even schools with sustainability features all encourage students to learn about how sustainability is put into practice in the real world, whether that be through nature, such as with garden cultivation, or through the elements of a school's design. This speaks to the importance of real-world learning and problem-solving especially in the context of sustainability. As we have explored through previous examples and research, going beyond abstract science and teaching young people how to create

sustainable lifestyles for themselves and in their communities creates very tangible, practical lessons for young people.

## 5.5 Teacher Resources

Although there isn't much state legislation that requires climate change or sustainability education in the US, districts and teachers may choose to leverage their own resources when introducing climate change and sustainability concepts. This represents the "bottom-up" approach described at the beginning of Section 5.4, in which teachers are becoming more aware of their influence in helping young people adopt sustainability-focused mindsets. However, many teachers do not feel confident in teaching climate change and sustainability on their own, so they start by looking at what other teachers have done. This bottom-up interest in climate change and sustainability education in conjunction with the "top-down" levers due to policy has created increasing demand for teacher tools and resources.

In response to this need, many environmental education groups have formed or expanded to provide teachers with resources focused on climate change and sustainability education. While in New Jersey, there is a centralized hub for teachers to find resources on climate change and sustainability education, other states are not as organized. Many of the resources are found via word-of-mouth or through internet searches, and there are so many resources and so much noise that it can be overwhelming to know where to start. A few organizations offer teacher trainings and certifications that are more high-level and holistic to climate change education, while other organizations may share specific techniques or lessons relevant to very specific topics.

### 5.5.1 Teacher Trainings & Curriculum Tracks

According to Participant 27, an educator with Take Action Global (TAG), many teachers who want to start with climate change education have minimal knowledge of what should be taught, or how to teach it. To address this skills gap, programs such as TAG and Earth Warriors offer training on both the content and the pedagogies for climate change for teachers to uplevel their competencies. These are two of the only teacher certification programs for teaching climate change and sustainability. Earth Warriors focuses more on nursery and elementary school teaching, while TAG focuses on high school teaching. (Take Action Global, 2021; Earth Warriors Global, 2021)

Throughout their teaching certifications, both TAG and Earth Warriors walk teachers through how to teach climate change in a positive, solution-focused way. Both programs introduce strategies to empower young people via "their own interests and ambitions," by

making lessons meaningful and relevant to the lives of the students (Take Action Global, 2021). Both programs heavily emphasize action-oriented learning that is age-appropriate and empowering for young people (Earth Warriors Global, 2021). These tactics include creating projects with students that make a difference in their communities.

In addition to teacher trainings, TAG and Earth Warriors both recognize how much work it takes to develop new curricula. Both include annual curriculum and other resources that teachers can leverage to implement climate change curriculum in their classrooms to “reduce the burden on teachers who already spend on average 14 hours a week planning lessons” (Earth Warriors Global, 2022). By providing both training and lesson plans, TAG and Earth Warriors reduce the burden on teachers to create their own curriculum, and they empower teachers with the knowledge and confidence to teach climate change and sustainability effectively (Take Action Global, 2021; Earth Warriors Global, 2021). The Earth Warriors Teacher Trainings helped 80% of teachers feel more confident teaching climate change (Earth Warriors Global, 2022).

As part of their curriculum, Earth Warriors connects its classrooms around the world via the Earth Warriors Community. This addresses a critical need described in Section 3.2.2 - that many young people feel alone in their thoughts about the climate crisis. Classrooms around the world are given the opportunity to interact with one another through pen pal programs and online calls, learn about how climate change affects each region differently, and collaborate with each other to create solutions. In building an international community of young people all learning about climate change, Earth Warriors helps young people feel like they are part of a larger community of change-makers “united in a common mission” (Earth Warriors Global, 2021). This creates a sense of collective action and hope in the community, reducing the likelihood of climate anxiety as discussed in Section 3.2.4.

## **5.5.2 Teacher Lesson Planning Materials**

While progress on teacher training and development is just beginning, traditional resources teachers would use for curriculum are lagging. For example, the amount of climate change content in science textbooks has decreased in the last two decades, going from an average of 52 sentences about climate change per textbook to 45 between 2000 and 2010. Only 3% of this content is dedicated to solutions for climate change, and these sections are typically added to the end of textbooks, which typically maps to the end of a curriculum. (Cho, 2023)

Beyond textbooks, there are a wide array of online resources designed for teachers to bring climate change and sustainability into the classroom. These resources range from specific



lesson plans and tools developed by NASA, to blog posts with tips and tricks for teachers interested in integrating climate change into their curricula (Kamenetz, 2019). Other sites share a conglomeration of many different resources for teachers to use, such as the Massachusetts Environmental Education Society (Massachusetts Environmental Education Society, 2018). Because of this vast array of resources and organizations, it can feel overwhelming to teachers who are not sure where to start. As Participant 29, a climate change communicator, put it: "climate education is a complete mess...how do we undo it?" This is compounded by the subjects of climate change and sustainability being so large and interconnected that they are hard to understand even for teachers. Resources often point to examples and insights from New Jersey's climate education initiatives as a model for what works effectively (Kwauk & Winthrop, 2021).

Recently, there have been some efforts to converge and connect many of the disparate climate change education resources into something more cohesive. This typically takes concerted effort on behalf of teachers and organizations to unify under a specific purpose or activity. For example, many schools around the world now participate in Earth Day. Although the activities, lessons, and partners that schools work with on Earth Day vary widely, thousands of schools around the world participate. EarthDay.org provides a hub of information, events, and activities that classrooms and organizations can leverage to participate. Earth Day is a reminder that everybody can participate in building a better future, and by creating a specific day to celebrate the earth, it activates interconnected communities of students, teachers, and schools around the world to participate. (EarthDay.Org, 2022)

## **5.6 Out-of-School Community Resources**

Outside of school, families may choose to partake (or have their kids partake) in a variety of programs to learn more about their local environment and climate change. From a broad perspective, many of these programs do not call out climate change specifically as their teaching intent. Rather, themes of climate change and sustainability are interwoven within content on a specific topic. For example, an after-school gardening program might not appear to directly teach climate change, but important lessons on ecosystems, biodiversity, soil quality, and sustainable living may emerge as themes that students learn within the context of gardening. Some of these types of programs are explored in this section.

### **5.6.1 Museum Exhibits**

Museums are another place in which young people can be exposed to climate change and sustainability themes. Typically science and children's museums include a mix of exploratory, explanatory, and facilitated activity-based content for young people to learn from.

As an example, Boston's Museum of Science has several exhibits and programs to teach climate change and sustainability to young people in engaging ways.

Rather than having a single explicit exhibit about our changing climate, themes of climate change and sustainability are contextualized within the topics that each exhibit explores. One such exhibit is the "Arctic Adventure: Exploring with Technology" exhibit, which puts visitors in the shoes of an arctic explorer (Museum of Science, 2021). Exhibit-goers can explore the different ecosystems of the arctic, learn how to use scientific tools to take readings, and see how arctic ice records historical climate data (Museum of Science, 2021). The exhibit interweaves themes of climate change and how ecosystems are changing in response (Museum of Science, 2021). While the Arctic Adventure exhibit has explicit tie-ins to climate change, other exhibits, such as "New England Habitats," include inexplicit themes that build value for nature (Museum of Science, 2012). They do so by introducing young people to different animals and showing the environment they live in (Museum of Science, 2012). Further opportunities for children to learn about climate change exist in the museum's online resource library, and the museum works with community partners to highlight how Boston is building a resilience plan for climate change (Boston Museum of Science, 2022; *ActionPact Boston*, 2021).

**I took my son to the science museum and that was probably the first and only time he asked me anything about climate change.** (Parent at Framework Feedback Workshop)

## **5.6.2 Action-Learning After School and Summer Programs**

Programs that partner with schools, such as those referenced in Section 5.4.1, typically also have after-school or summer opportunities for students to expand their learning outside of class. These types of programs allow for a deeper engagement with the program content, extend learning beyond the limits of the classroom sessions, and typically also provide further reinforcement for young people to feel comfortable taking action in their communities. CitySprouts, an organization discussed in Section 5.4.1, also works with schools, runs a "Young Leaders" program for middle school students after school and during the summer (CitySprouts, 2020). Through this program, students become active members of their community by exploring Boston's natural environments, and participating in projects that make Boston communities safer and more sustainable (CitySprouts, 2020). Just like with many of the leading school programs and state standards, contextualizing sustainability learning within the local community helps students connect to and act upon climate change issues at a personal level, and creates opportunities for them to build confidence and hope that these issues can be overcome.

### 5.6.3 Outdoor Programs

A broad group of outdoor programming that helps build value for nature includes visiting farms, exploring nature parks and sanctuaries, or attending outdoor camps. These differ from after school or summer programs which are explored in Section 5.6.2 because they have much less structured learning opportunities. The primary benefit that these types of programs give to young people is extended outdoor experiences through activities and exploration. Some spaces, such as farms or national parks, may host talks or have exhibits about the local environment in which themes of sustainability and climate change may come up. For example, the National Parks Service (NPS) developed a Climate Change Communication Toolkit to help park staff integrate climate change learning into the park experiences (National Parks Service, 2021).

As we have explored in Section 3.2.4, spending time in nature provides young people with a deeper connection to the outdoors. The NPS leverages place-based learning experiences to help visitors build connections with nature, and through its communication strategy shows how those areas may be affected by climate change. While not all outdoor programs are as intentional about their role in affecting climate change mindsets, just spending time in the outdoors helps young people build a connection with nature. If there is no dedicated climate change content, it may take further nurturing or facilitation on behalf of parents or other adults to show young people how to make these connections.

### 5.6.4 Implications of Community Resources

Community-level opportunities for young people to learn about climate change and sustainability vary widely depending on the location a family may reside in, which presents an equity and access issue. Communities with less support for climate change or nature-based programming will not have equal access to these opportunities, and socioeconomic status makes access to these resources more challenging (Transportation Planning & Capacity Building, 2020). For example, most farms are in rural areas and require a car to get to. Families living in underserved inner city neighborhoods may not have access to a car and may not be able to afford the time to take public transportation. Similarly, the cost of nature-based summer camps may be out of reach for some families, so their children may not be able to access the same experiences. Some of these equity issues are resolved via public education, since students may learn about this content in other ways, and may be able to access museums, farms, and other opportunities via school trips or discounts. To contribute toward sustainability education equity, CitySprouts offers its after school and summer programs for free to any Boston or Cambridge students (CitySprouts, 2018).

Another relevant insight on community-based opportunities for climate change and sustainability learning is how the different experiences frame the connection to environmental issues. Instead of there being a climate change focused exhibit at Boston's Museum of Science, for example, they chose to contextualize it within another topic, such as in their Arctic Adventure exhibit (Museum of Science, 2021). Action-learning programs also appear to do the same thing, such as with CitySprouts using gardening to teach sustainability (CitySprouts, 2018). While the reasoning behind creating the programs is unknown, it is likely that the contextualization of climate change within other learning experiences makes the subject matter more approachable for both parents and children, and better connected to topics that young people are interested in learning about. A parent might be more interested in sending their children to an after school gardening program, which they may perceive as a fun, skill-building activity, than they would in sending their children to a climate change camp.

## 5.7 Family Resources

There are plenty of resources online for parents interested in helping build sustainability values with their kids. These resources are typically dependent on the parent to translate the messages or themes from these books, games, or activities into actions or learnings that can be applied to the real world. The most common recommendation to parents in blogs, guides, books, and other resources, is to build young people's value and appreciation for nature by spending time outdoors with them. Especially in early childhood, this helps young people connect to and value the earth and its natural ecosystems. As we discussed in Section 3.2.4, spending time outdoors not only builds value for nature, but also positively contributes to a young person's mental health. While our secondary research into parent resources was not all-inclusive, they fell into the following categories:

### 5.7.1 Guides for Parents

One of the only books specifically on parenting and climate change is "*How to Talk to your Kids about Climate Change: Turning Angst into Action*" (Shugarman, 2020). However, there are many other online resources such as websites, blogs, parenting groups, and influencer pages that share tips for parents on discussing climate change and sustainability with children of all ages. A surge of these informal resources have appeared in recent years, potentially catalyzed by the pandemic and the rise of video-based social media platforms such as TikTok. These resources typically highlight the following themes to help parents build childrens' values for sustainability and have effective discussions with them:

### **Exposure & Empathy**

The simplest step parents can take in raising children who care about climate change and sustainability is to regularly spend time in nature with them. Immersion in nature can foster a sense of caring and compassion for the environment (Suttie & Nogales, 2016). While just regularly spending time outside where and when possible is a start, various sites recommend encouraging children to explore, question, and investigate in nature. Some of these activities can involve planting seeds, observing how trees change with the season, or observing the patterns of local wildlife (Shinn, 2019). These actions give children an opportunity to form compassion with natural ecosystems.

### **Small Actions of Respect**

Encouraging and rewarding young people when they respect nature will help incentivize them to care for the world around them. These actions can be as small as turning off the lights, not disturbing natural wildlife, or disposing of litter properly. Rewarding these kinds of activities will remind children that they are doing something positive when they take action. (Shinn, 2019)

### **Explain and Contextualize the Science**

The science of climate change can be explained relatively simply for a wide age range. However, if it feels irrelevant to a young person's life, it may be abstract to them. Parents can help their children understand climate change by explaining the science in age appropriate ways, and then going further to show how it can affect their community or lives (UNICEF, 2022). Parents who don't feel confident in explaining these concepts can explore them together with their children. For example, if the family learns that climate change causes more severe weather, they might explore what new weather patterns their neighborhood might experience as a result (UNICEF, 2022). Science-related organizations such as NASA and the Museum of Natural History typically have easily digestible climate change content that parents can leverage to help explain what is going on (NASA Climate Kids, 2023; American Museum of Natural History, 2012).

### **Encourage Climate Change Questions**

Parents can foster continued interest in climate change and sustainability by encouraging their children to ask questions about the environment and how their actions affect it. Establishing a culture of curiosity and exploration in the home helps encourage children to dive deeper into topics that are interesting or relevant to them. When parents don't have the answers, discussing and investigating the question can be a learning experience for all parties.

Within the context of climate change, a culture of continuous learning can normalize discussions about climate change and sustainability in the home. (Shinn, 2019)

### **Discuss Actions at Small and Large Scales**

Climate change can be anxiety-inducing to children because it can make them feel powerless to stop it. Children can help lead change too, and doing so both does good for the planet and reinforces an action-oriented mindset. Parents can show children small, measurable ways they can make a difference, such as composting, saving water, or reducing single-use items. Actions can also be taken in communities, where young people can participate in events or programs to make their communities more resilient and sustainable. Advocacy-based actions, such as writing to local officials or spreading awareness in their communities, are some of the easiest for young people to participate in. (Cranmer, 2017)

At the same time, it is important that young people feel they are not alone in their concerns. Parents can give young people hope by providing examples of others, especially peers, who have taken action on climate change (Cranmer, 2017). Doing so helps young people see that they are not alone, because others their age are also worried about climate change and doing something about it (Cranmer, 2017). This can help give young people the confidence and motivation to take action as well. A few sites, such as National Geographic Kids, reference Greta Thurnberg as an influential role model to introduce children to, because she is someone many young people can empathize with (National Geographic Kids, 2019).

Going even further, parents can show children what work is being done at even broader scales, such as discussing the renewable energy transition, or the electrification of transportation due to a rise in electric cars. Having these kinds of conversations can help young people contextualize what actions are happening where, and which ones have the largest impacts. Most importantly, it shows how adults around the world are taking action to mitigate climate change at large scales, because they recognize it is a problem too. These conversations can provide further hope that the climate crisis can be mitigated, and that it isn't all on them to reduce climate change. (Shinn, 2019)

### **Discuss Emotions and Create Coping Strategies**

Climate change can be a scary topic for young people. As a result, it is important for families to share their feelings honestly while also helping each other manage their emotions (Shinn, 2019). Sharing feelings about climate change as a family can help remind children that there is nothing wrong with feeling scared, angry, or upset about climate change, and can show them that they are not alone in their thoughts (Weeden, 2019).

Creating coping strategies in the family for when these feelings arise is important to helping children work through their emotions in productive ways (Shinn, 2019). When young people get upset about climate change, discussing some of the actions that adults, peers, or governments are taking to mitigate it can help rekindle hope that climate change can be managed (Shinn, 2019). By ending these conversations with inspiration and encouragement, parents can help their children turn their anxieties into meaningful actions (Weeden, 2019).

Despite the vast amount of resources on climate change communication available for parents, it is important to recognize that every child and every conversation is different, so “preparation” for these conversations can only go so far. Many of these resources give broad-strokes recommendations for navigating climate change conversations, but they may not be helpful if a parent is caught in-the-moment by their children asking about climate change. It is up to the parent to interpret and adapt these conversations to the context of their relationship and home.

### **5.7.2 Children's Books**

There are a range of children's books that directly or indirectly introduce climate change and sustainability to children in approachable ways. Many of these books highlight a specific problem in an engaging, tangible way. They are frequently told from the perspective of young people or animals, focused on building empathy with readers, highlighting a problem, and then in some cases, showing how to take action.

Books such as *Just A Dream*, by Chris Van Allsburg or *The Lorax*, by Dr. Seuss are told from the perspective of a young person who experiences a world stripped of its natural resources. They reinforce themes of overconsumption and the destruction of resources, and tie these themes into why we should value and respect our natural resources. (Van Allsburg, 1990; Seuss, 1971)

Books such as *The Magic School Bus and the Climate Challenge* focus on explaining the climate change problem clearly for young people, while those such as *The Tantrum that Saved the World* and *Why Should I Recycle?* are likewise informational but with more of an emphasis on actions young people can take, such as speaking up, or recycling. (Cole, 2010; Herbert & Mann, 2022; Meredith, 2010)

Others, such as *The Lonely Polar Bear*, *Can we Save the Tiger?* or *The Pout-Pout Fish Cleans up the Ocean* are used to build empathy with creatures and help young people understand the problems they go through as a result of climate change. They typically connect some of these messages to small actions young people can take, such as turning the lights off or disposing of waste properly. (Le, 2018; Jenkins, 2014; Diesen, 2021)

All of these examples effectively build empathy with the reader, and then highlight a problem and why we should care about it. In some cases, these books recommend specific actions we can take to prevent the outcome of the story, while others just emphasize the value of the things that are lost or damaged in the stories. While these stories often introduce the importance of valuing nature, and occasionally identify actions to preserve the environment, they do not always emphasize how the actions meaningfully help solve the problem.

Parents play a key role in helping young people connect specific actions to these stories. For example, Participant 13, a parent, shared how he connected activities to lessons from some of these books: “my youngest son...we’re talking about if he consumes too much resources, the polar bears will have no home.... there’s going to be some consequences. There’s no direct connection, but it’s related to some story books he’s read before.” The messages these stories tell can be used as tools to help young people act in more sustainable ways, but rely on the parent or caregiver to continuously tie actions and habits to these books.

### 5.7.3 Outdoor Activities & Toys

Typical “outdoor activities”, such as sports, nature walks, camping, or just playing in the playground are useful in building a value for nature overall. They contribute to young people spending more time outdoors. But what young people take away from the activities is very dependent upon the context of their actions, and which of their actions are reinforced by those around them.

As an example, Participant 15, a parent, shared a story of an interaction with another family while their children were playing:

**It was raining and worms were on the ground. All the kids were curious, crouching to stare at them. One kid just started smushing them, and then came and showed them to us and asked for praise. Just because we want to see it doesn’t mean we should destroy it. [Our daughter] told the kid that they shouldn’t smush them. Their parent got upset because their kid got corrected.** (Participant 15, parent)

If unregulated, children build a mental model that humans are “above” or “separate from” nature, rather than a player in natural ecosystems. This places the responsibility on the parent or caregiver to help deepen their children’s value of and respect for nature. Specific outdoor activities can help young people build more of a symbiotic relationship with nature. Activities such as nature scavenger hunts, or challenges such as “100 Days of Outdoors Play” reinforce specific habits and a respect for nature (Aadland, 2022; Barahona, 2020). Toys such as magnifying glasses, binoculars, or outdoor science kits enhance young people’s abilities to observe the natural world, and can be used in tandem with nature activities (A Mighty Girl,



2019). Both toys and activities still require some nurturing from parents to use the tools in respectful, rather than harmful, ways - such as using a magnifying glass to concentrate sunlight and burn ants, versus using it to study an anthill and observe its behaviors. Outdoor activities and toys require intentionality from parents to effectively build respect for nature.

#### 5.7.4 Games

Although our research on games was high-level, we did find some themes of sustainability in video games and board games. In largely popular games, sustainability themes are either inexplicit or a small part of a much larger game. Minecraft and Roblox, for example, incorporate some themes related to recycling (Microsoft Education Team, 2021; Roblox, 2014). Other games incorporate beautiful, natural in-game art, scenery, or creatures that may help build value for nature, such as *Animal Crossing* or *Legend of Zelda: Breath of the Wild* (Cope, 2022). But the focus is not on these messages, and the “fun” sometimes overtakes the learning. However, these may somewhat contribute to children’s values of nature and environmentally-conscious behaviors.

Pokémon Go is a unique example of a popular game that can have a direct influence on valuing nature. Because its gameplay incentivizes regular outdoor exploration, Pokémon Go helps players build a regular habit of going outside, which has been linked to reduced stress and increased appreciation for nature, as explored in Section 3.2.4. (Woolington, 2017)

Some video games are explicitly focused on sustainability and climate change, and help build a good problem-solving mindset for environmental issues. However, explicit climate-focused video games are single-player, and often not expansive enough for children to maintain interest in them. As a result, they are often used as teaching tools in the classroom, rather than being used to play for fun. (United Nations News, 2022)

Explicit sustainability board games fill a similar niche to explicit sustainability-focused video games. They often are inspired by real-world ecosystems or challenges and lead players through gameplay that forces a series of decisions with short- and long-term systemic consequences (Carlin, 2022). Games such as *Wingspan*, *Meadow*, and *Oceans* have players build hypothetical sustainable ecosystems resilient to different disruptions. Others such as *Dilemma* and *ClimeOut* are discussion and negotiation games, more connected to existing global sustainability discussions that are currently happening (Snowflake Education, 2017). These types of board games are typically used by educators to help learners understand and partake in contemporary discussions about climate change and the environment (Snowflake Education, 2017). Both types of board games provide an amount of “practice” thinking about the

interconnected nature of systemic problems, and discussing them with peers (Snowflake Education, 2017).

Sustainability-focused video games and board games do provide effective ways to think about these issues. However, in order to activate and apply the systems mindsets you can practice in these games to the real world, some nurturing or structure may be needed. Without having a parent or teacher to provide some facilitation to translate the lessons learned into the real world, then the learning opportunity might not translate into something actionable.

### **5.7.5 Online Resources for Kids**

As mentioned in Section 3.4.1, many young people learn about climate change and sustainability via social media sites such as TikTok, YouTube, and Instagram (Prothero & Page, 2023). Resources such as the TED ED Earth School provide videos that teach young people about climate change and sustainability, and news agencies such as the New York Times share easily digestible information online about climate change and its effects (TED-Ed, 2020; Rosen, 2021). Other news or educational organizations with online learning also have videos and resources to teach climate change to kids. However, there is a lot of noise about climate change in social media as well (Prothero & Page, 2023). Videos or photos from influencers may focus more on garnering emotional response, so they can be uninformative, polarizing, and anxiety inducing (Prothero & Page, 2023). Most of this content focuses on a combination of empathy-building to get viewers to care about the environmental issues, and explanations of what is happening and why, without offering solutions. Online resources must be supplemented with media literacy to help young people critique what they are encountering, find trustworthy resources that share accurate information, and understand how what they are learning applies to them.

## **5.8 Implications of Existing Solutions for Climate Change Education**

Broadly, there are many different resources for climate change education and communication that fill niches at different scales and in different environments, creating a conglomeration of resources that can be difficult for parents and teachers to navigate.

In school settings, national standards do cover climate change and sustainability, but they mostly focus on problem understanding, while actions that can be taken to mitigate climate change are somewhat abstracted and high-level. At the state level, New Jersey leads the way in effective structure and implementation of statewide climate change education, but very few other states come close to their level of execution. Climate change and sustainability

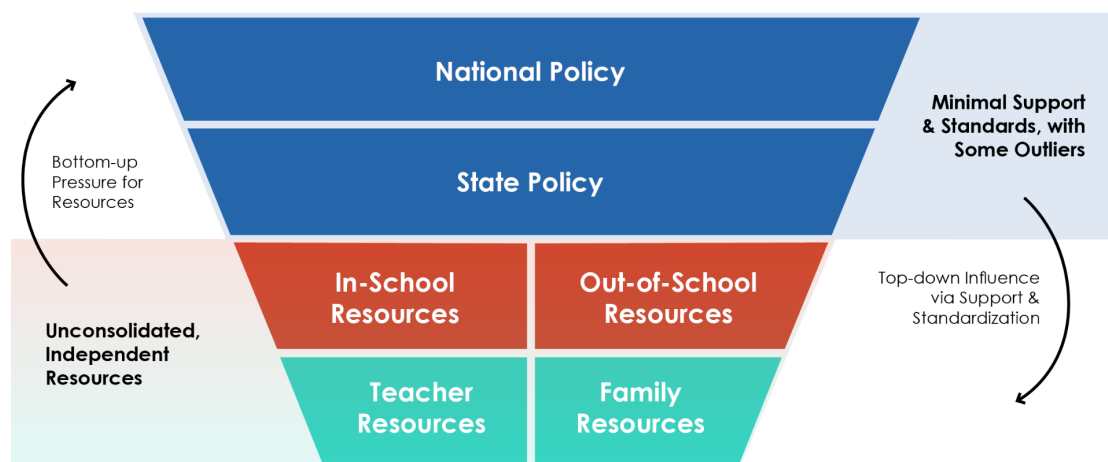
education happens mostly at the middle school and high school science level, and does not connect problems to solutions that can be taken within a young person's community.

Providing funding, teacher trainings, and consolidated resources were three key elements crucial to New Jersey's adoption strategy. Outside of New Jersey, these resources are less present. It is harder for teachers to access funding, there are very few organizations that offer climate change education training, and most of the resources available are unconsolidated because of many different players in the climate change education space. This makes it challenging for teachers to find validated resources and lesson plans that they can easily adapt to suit the needs of their classroom. Even when they can, a lack of knowledge about climate change itself, and how to teach it effectively, leads to a lack of confidence and disempowerment in teaching. This supports our primary research, as detailed in section 4.3, in which educators shared with us that they were aware of the resources, they wanted to do something, but not knowing the best pedagogies to teach climate change, not having the funding or time, or not knowing which resources were the most effective got in the way.

The current standards and solutions explored show what actions are being taken from top-down and from bottom-up. Much of the pressure for climate change and sustainability education stems from parents and educators. There are a wide array of informal resources to support adults at this scale, but they are unconsolidated. As top-down policies get implemented, more structure gets built out to support teachers and formalize resources. As more resources, research, and support becomes available, teachers, parents, and communities can get access to tools and training materials to enhance their ability to teach climate change, and further normalize conversations about it in the community.

**Figure 5d**

*The State of Existing Solutions and Their Relationships*



Another key recurring theme, present in New Jersey's approach as well as in the community- and school- level solution spaces, is the contextualization of sustainability and climate change into interdisciplinary projects for the local community. Contextualization is critical to helping young people understand how climate change has an impact on the spaces and communities they care about locally, making climate action more meaningful. Interdisciplinary learning adds lenses of different subjects through which problems can be identified and solved, making the learning more holistic. Finally, an action-learning approach both gives young people the encouragement and confidence to build a more sustainable future, and makes real, visible change in the communities students learn in.

While a contextual, hands-on approach is the leading strategy for teaching climate change, it is very rare for that to actually happen, since the examples we explored were exemplary outliers. At a high level, many traditional educational resources skew toward problem understanding, and out-of-school resources focus on helping children build compassion and respect for nature. These two aspects of climate change education are important, but only represent one step in effective climate change education. Helping parents and teachers bridge different elements of climate change education as their children learn about it is an important and unaddressed gap. Young people need to be able to go from problem understanding and value, to systematic, empathetic ways of thinking about the solution space, to actually implementing solutions in local communities.

We mapped out how different solutions for sustainability education fulfill different learning themes observed throughout our existing solutions research. To do so, we identified several key learning themes present in our existing solutions research, and mapped them out in Table 5c. The identified themes include:

- **Meaningful:**
  - **Problem Understanding:** Young people develop an understanding of what climate change and other environmental issues are, and how they affect the planet at large.
  - **Problem Empathy:** Young people develop a connection to the environment or population that climate change issues affect. Spending time outdoors with young people or leveraging place-based learning can build a value for nature, and foster this connection.
- **Tangible:**
  - **Problem Context:** Climate change issues are contextualized so that young people are taught the context of the problem, including why it exists and who or what it affects.

- **Systems Thinking:** Young people are taught how to think about small- and large-scale causes and effects, what leverage points there are to make effective change, and how different solutions in a system will contribute to sustainability.
- **Actionable:**
  - **High-Level Awareness:** Young people are introduced to various existing solutions that will mitigate climate change, such as learning about renewable energy or carbon capture technologies.
  - **Action-Learning:** Young people actively participate in creating or influencing solutions during their learning. This can include small actions like planting trees or gardening, or larger actions like advocating for community solar or building a waste reduction strategy for their school.

We mapped out how different solutions for sustainability education fulfill different learning themes observed throughout our existing solutions research. Although climate change communication lessons and activities can vary broadly depending on individuals, communities, schools, and states, each solution type typically tends to fill certain niches. It is also important to acknowledge that these solutions operate at different scales - so the solutions at bigger scales have broader impact, but potentially higher variability. Outdoor activities, for example, tend to be specific to family-child settings and only help to build empathy with nature. Meanwhile, New Jersey's state policy affects millions of students and addresses many different aspects of sustainability education, but it is the only state that has such a sweeping coverage of different aspects of teaching climate change and sustainability. As a result, a direct comparison of the impact and effectiveness of different solutions is challenging. Table 5c highlights the different learning themes that these solutions focus on.

**Table 5c**

*Existing Solutions Categorized into Learning Themes*

	Meaningful		Tangible		Actionable	
	Problem Understanding	Problem Empathy	Problem Context	Systems Thinking	High-Level Awareness	Action-Learning
NGSS	✓		✓		✓	
NRC	✓		✓		✓	
New Jersey State Policy	✓	✓	✓	✓	✓	✓
CT State Policy	✓		✓		✓	

	Meaningful		Tangible		Actionable	
	Problem Understanding	Problem Empathy	Problem Context	Systems Thinking	High-Level Awareness	Action-Learning
School Partnerships		✓	✓			✓
Sustainability Themes in School Design			✓		✓	
Outdoor & Alternative Schools	✓	✓	✓	✓	✓	✓
Teacher Trainings	✓	✓	✓	✓	✓	✓
Teacher Lesson Planning Tools	✓	✓	✓	✓	✓	✓
Museum Exhibits	✓	✓	✓		✓	
After School & Summer Programs		✓	✓			✓
Outdoor Programs	✓	✓				
Guides for Parents	✓	✓	✓		✓	✓
Children's Books	✓	✓			✓	
Outdoor Activities & Toys		✓				
Games		✓		✓		
Online Resources for Kids	✓		✓	✓	✓	

Mapping out various sustainability communication solutions highlights the disarray of quality, scale, and theme coverage of the many different solutions in existence. Although some solutions, such as New Jersey's policies, outdoor schools, and teacher trainings have a wide coverage, they are rarely implemented, so they are not the status quo for sustainability communication. Additionally, just because a specific solution includes the six themes identified, it does not mean that it is taught well. For example, there are teacher lesson planning tools and guides for parents that include many of the sustainability themes, but they are all disconnected resources. So although it appears that they are good solutions, teacher tools and guides for

parents both include a wide range of specific solutions that only target individual learning themes.

This implies that while various solutions cover various themes, there is minimal formalized structure that pulls all of these themes together cohesively. Currently, communicators have to connect the dots between different solutions on their own, and therefore struggle to teach sustainability in a holistic way. Additionally, many of these solutions are very reliant on adults to facilitate young people into forming these connections, yet they may not be aware that these connections should be made, or how to explain the connections in approachable ways. Our solution must facilitate better learning and discussion to connect the dots between values, actions, and impact.

# 6

## Normalizing Sustainability Through Education: An Introduction to the Framework

### 6.1 Opportunities in Sustainability Education

As outlined in Section 4, barriers within the Spiral of Silence prevent climate and sustainability conversations from becoming a part of everyday life. At the same time, as described in Section 5, there is minimal infrastructure to effectively educate children, not to mention adults, about climate change and sustainability. These barriers and gaps present to us opportunities to reinvent the way we talk about and engage in sustainability in our day-to-day life.

#### 6.1.1 Creating Effective Learning Experiences for Children

As mentioned in Section 4.3.5, there are many frictions within the education system that hinder the development of climate and sustainability education. Existing solutions, illustrated in Table 5c, educate children about different aspects of sustainability, focusing on making sustainability either meaningful, tangible, or actionable. However, addressing each of these aspects independently is insufficient. According to the experiences shared by many adults we talked to, inciting value-based behavioral changes surrounding sustainability calls for including and connecting all three elements.

Therefore, to create more effective learning experiences surrounding sustainability for children, we explore the following research question:

***How might we make sustainability meaningful, tangible, and actionable for children?***



### 6.1.2 Supporting Adults with the Means and Methods for Communication

While many adults are not motivated to care about climate change in the first place, those who do care feel like they do not have the means and methods to take action. As mentioned in Section 5.5 and 5.7, existing resources for parents and educators are scattered and difficult to implement. Adults need an approachable, adaptable, and empowering way to communicate sustainability to young people. More specifically, in order for children to effectively embrace sustainability thinking, adults around them must be able to curate or create a coherent set of resources and activities, building up to a holistic learning experience.

Therefore, to support adults with the means and methods for communicating sustainability with children, we explore the following research question:

***How might we provide adults with an approachable, adaptable, and empowering resource for educating children about sustainability?***

## 6.2 Framework Introduction

A child's worldview is influenced by adults around them and what they observe from and interact with in their environments. Accordingly, there is a need for adults and institutions who care and are able to communicate about sustainability.

We have designed the Sustainability Communication Framework to help adults improve the way they communicate about climate change and sustainability with young people by making sustainability meaningful, tangible, and actionable. The framework is a tool that can be used as a guiding principle to curate or create a series of activities to help children embrace and engage in sustainable thinking and action. Curation includes leveraging existing resources, while creation consists of building up new experiences or building upon existing ones.

### 6.2.1 Designed for Sustainability Communicators

The framework is designed for sustainability communicators, as defined in Section 1.5: Glossary of Terms. All adults, including but not limited to educators, parents, community leaders, can learn to become effective communicators. Communication goes beyond just conversations. It extends from how we react to questions from children to what kinds of activities we invite our children to partake in. There are countless ways in which communicators can engage children through communication, and numerous opportunities to build meaningful learning experiences.

## 6.2.2 Targeted for 6-10 Year Olds

For reasons discussed in Section 3.4, the Sustainability Communication Framework is designed to facilitate communication with young children ages 6 to 10. Within that age range, children develop their mental model of the world and a sense of self in relation to others and their environment. Habits and values begin to form and exposure to climate discourse through various media increases. Our responsibility as adults is to prepare children to engage in climate discourse as critical thinkers and active problem solvers. Furthermore, the skills we equip them with must be applicable for solving unknown problems of the future.

## 6.2.3 Learning Happens Everywhere

**People are always learning, every day. They're learning all the time. From my reactions, from every interaction with a tool or machine, when they walk down the street, they learn values in the grocery store...** (Participant 10, parent, environmental advocate)

Teaching typically happens in classrooms, but learning happens everywhere. Communicators should aim to integrate learning into the day-to-day to increase a child's exposure to elements of the framework in different settings. Influencing touch points throughout a child's daily interactions, be they at home, at school, or elsewhere, can help children develop and sustain new habits and values. Participant 22, a parent, discusses how she engages her child in conversations in multiple settings:

**We bring [our children] with us to do activities, we bring them to the store with us. When we go on long trips we talk about the gas that we're using. We invite the kids to participate in planting around the house. Watching things grow, and thinking about what was here before our house.** (Participant 22, parent)

## 6.2.4 Sustainability is Interdisciplinary

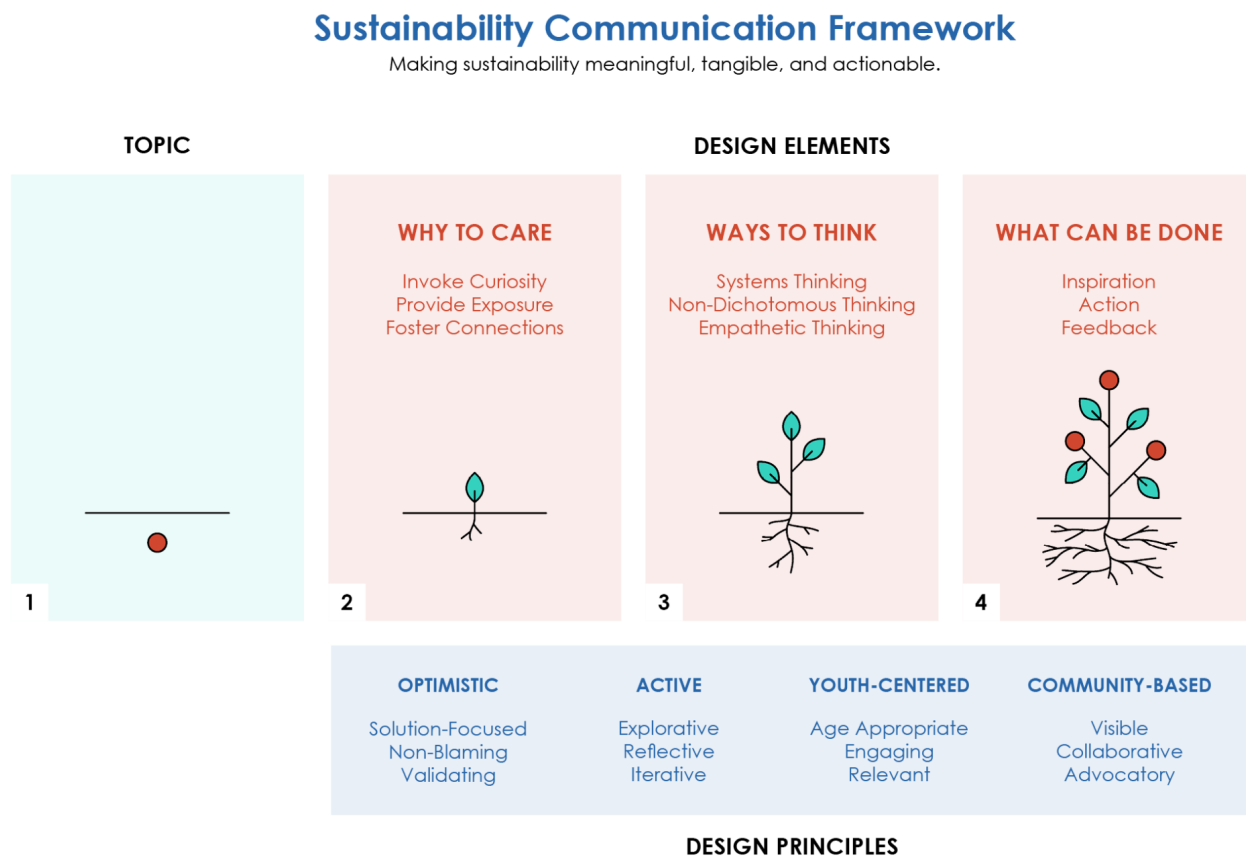
Traditionally, climate change and sustainability is taught in schools during Science class. However, science alone is not enough to communicate sustainability, and sustainability is interdisciplinary by nature. As explained by Keya Lamba, a climate educator, "climate change can be integrated in not just science but other core subject areas, removing the stress from the topic and having it become a part of everyday life" (Lamba, 2022). For example, these activities can include collaborations between multiple educators within a school. Different subject teachers may choose to coordinate their curricula to expose students to the same problems from different perspectives.

## 6.3 Framework Overview

The Sustainability Communication Framework, illustrated in Figure 6a, consists of three main components:

- A **Topic** that communicators want to explore surrounding climate change and sustainability. Examples of topics include, but are not limited to, deforestation, environmental justice, pollution, water quality, local ecosystems, pollinators, etc.
- **Design Elements** that communicators should include to effectively engage children in sustainable thinking and action through the lens of the topic. The Design Elements include “Why to Care,” “Ways to Think,” and “What Can Be Done,” which contribute to making sustainability meaningful, tangible, and actionable, respectively. It is recommended that the communicator covers the elements in the order mentioned. Each Design Element also includes three Sub-elements.
- **Design Principles** that communicators should consider to make communication more effective. The Design Principles include “Optimistic,” “Active,” “Youth-Centered,” and “Community-Based,” which serve as inspiration during the design process. Each Design Principle also includes three Sub-principles.

**Figure 6a**  
*The Sustainability Communication Framework*



## 6.4 Applying the Framework: An Example on Community Waste

In this section, we explain how the framework could be applied through an example. Assume that an educator is designing a curriculum for her classroom. Figure 6b shows an example curriculum plan.

- 1. Pick a Topic:** Let's say an educator was interested in teaching a unit on waste management. Specifically, she would like to focus on where waste goes in the community.
- 2. Define Learning Goals for Each Design Element:** The educator would split her curriculum design into the three Design Elements, as per the framework, and define high-level learning goals for each element.
- 3. Design Activities and Integrate Design Principles:** Next, the educator would design activities within each curriculum element to address the learning goals. The length and number of activities are dependent on the timing and structure of the curriculum. These activities will be designed based on the four Design Principles. Not all Design Principles are necessary for every activity; they provide inspiration for how the activities could be made more effective.
- 4. Iterate:** The design process is cyclical and iterative. At any point, the educator can identify which Design Principles, Sub-design principles, or Sub-elements she has not yet leveraged, and brainstorm how they could be incorporated.

**Figure 6b**

*Example Curriculum Plan for Teaching About Community Waste*

<h2 style="text-align: center;">Sustainability Communication Framework</h2> <p style="text-align: center;">Making sustainability meaningful, tangible, and actionable.</p>				
<b>TOPIC</b> Where waste goes in our community				
	DESIGN ELEMENTS	LEARNING GOALS	ACTIVITY	DESIGN PRINCIPLES
<b>WHY TO CARE</b>	<b>Invoke Curiosity</b> <b>Provide Exposure</b>	Students will identify major waste sources in their local community.	Take a field trip to the local waste treatment plant, where students will see where the largest sources of waste come from, and how waste is managed.	<b>Non-Blaming</b> <b>Explorative</b> <b>Age Appropriate</b> <b>Visible</b>
	<b>Provide Exposure</b> <b>Foster Connections</b>	Students will be able to articulate the impact waste has on their local community.	Ask students to identify where they find litter in their neighborhood, talk to locals, and reflect on how they think litter affects the environment and their community.	<b>Reflective</b> <b>Engaging</b> <b>Relevant</b> <b>Visible</b>
<b>WAYS TO THINK</b>	<b>Systems Thinking</b>	Students will be able to explain where different kinds of waste go when they are disposed of.	Students will work together to draw out a map of how different common materials are supposed to be disposed of.	<b>Solution-Focused</b> <b>Age Appropriate</b> <b>Collaborative</b>
	<b>Systems Thinking</b> <b>Empathetic Thinking</b>	Students will be able to explain how different kinds of waste affect the environment and their local community.	Students will form groups and investigate how different materials impact the environment and community members if disposed of improperly.	<b>Explorative</b> <b>Collaborative</b>
<b>WHAT CAN BE DONE</b>	<b>Inspiration</b>	Students will learn ways in which waste could be reduced in the community.	Students meet leaders from a local non-profit working to improve the efficiency of recycling processes in the town.	<b>Solution-Focused</b> <b>Engaging</b> <b>Relevant</b>
	<b>Action Feedback</b>	Students will design a method for reducing waste at the individual level.	Students track how much waste they produce in their homes over the course of a week, and reduce the amount of waste they produce over the course of a month.	<b>Solution-Focused</b> <b>Validating</b> <b>Iterative</b>
	<b>Action Feedback</b>	Students will design a method for reducing waste at the community level.	Students work as a class to find a key leverage point to reduce waste in the school, and work with teachers and school staff to create and implement a plan.	<b>Solution-Focused</b> <b>Validating</b> <b>Relevant</b> <b>Visible</b> <b>Collaborative</b> <b>Advocatory</b>

## 6.5 Conclusion

The Sustainability Communication Framework has been introduced as a solution to opportunities in sustainability education presented in Section 6.1. We have outlined a method in which the framework could be applied, and specified whom the framework is designed to be used by and targeted for. Furthermore, we suggested that the framework can and should be implemented in multiple settings and in an interdisciplinary way. By integrating learning into various touch points throughout a child's life, sustainability can be reinforced and normalized, and value-based habits can be formed. The upcoming section, Section 7, delineates the framework in detail, while Section 8 provides case studies that can shed light on how the framework could be effectively implemented.

# 7

## The Sustainability Communication Framework

The Sustainability Communication Framework was introduced from a high-level in Section 6, and a depiction of the framework was shown in Figure 6a. In this section, we describe in detail each Design Element and Design Principle within the framework.

### 7.1 Design Elements

#### 7.1.1 Why to Care

*Understanding why to care about sustainability makes it meaningful.*

##### 7.1.1.1 Invoke Curiosity

Children are innately curious, and communicators can leverage this curiosity to get children excited to learn more about their surroundings. By creating a sense of wonder around objects, processes, and natural phenomena, communicators can encourage children to ask more questions. Participant 22, a parent, reveals the difficulty she faces in answering seemingly simple questions raised by her children:

**It would be inaccurate for me to say that the college students only ask harder questions than the kids do. The kids often ask much more difficult questions than college students do. When the younger kids ask a question, they are not asking for a clarification of something they already understand. They are asking us to explain how the world fundamentally works. It's hard for me to explain why a seed turns into a plant. But they will ask that question because they are still forming that concept of things. The "Why are plants green?" question was really hard! One of them asked why the sun follows us when we're driving along the road... (Participant 22, parent)**

Communicators can also engage children's curiosity by asking questions. For example, in our Materials Workshop, which we talk about in more detail in Section 8.1, we asked students how they think plastic is made. While the students are familiar with the material due to its prevalence in everyday objects, they are unable to easily provide answers to this question.



However, driven by curiosity, students enthusiastically searched for answers as they discussed possibilities with their peers.

Participant 23, a philosopher and father of six, says that sustaining concentration is the essence of learning, and to have that, there must be immersion. He believes that curiosity in natural phenomena, such as a desire to understand why we are experiencing a blizzard in March, can get children absorbed into a valuable learning experience. Meanwhile, Participant 25, a 1st grade teacher, describes a sense of wonder as the key to meaningful learning experiences:

**A really important piece to start with is to get kids to ask the questions. If you can provoke them with something they wonder about and develop a question from that, that is where they get that drive, and that curiosity can take them to go into all these other pieces. Especially when we move into an era of education where things are student directed... It is harder with younger kids but they are curious enough to know how to ask questions and smart enough to know what to ask.** (Participant 25, 1st grade teacher)

#### **7.1.1.2 Provide Exposure**

By exposing children to new environments and ways of life, many of which may feel unfamiliar to them, communicators can help children build awareness and appreciation for diversity within the world's different ecosystems. In addition, providing exposure to different natural settings and cultures drives children's curiosity.

Moreover, exposure is not limited to the real world, and communicators can leverage storytelling through books, videos, and other media. Participant 16, a parent, talks about how her daughter gets exposed to the natural world through reading and engaging her imagination:

**The most interesting books are the books that maybe are less about sustainability itself as more about animals and nature and plants. To show not so much what the problem is, but what a thriving ecosystem can be. [My daughter] really likes, for example, one book called [Otters Love to Play] It's about otters and how playful they are. That's not a book about sustainability in itself, but by being insightful about the life of an otter and the environment that the otter needs to thrive, it tells the story of how we should make sure that these ecosystems exist and are preserved.** (Participant 16, parent)

**We live in the city, and a lot of the things we read about are not the things that she sees in day-to-day life. So it helps her to imagine these worlds. It makes it a little more concrete for her because the reality here is that there's not that many animals we see on the way to school.** (Participant 16, parent)

Additionally, by providing exposure to environments and communities affected by climate change, communicators can help children gain better awareness of the effects of human activity. Instead of telling children about the drastic consequences of human action, it is helpful for children to experience it themselves. That way, they are able to make a tangible connection between cause and effect, as well as visualize ways in which they could make change within that context.

### **7.1.1.3 Foster Connections**

Appreciation and empathy for the natural world help children understand the value of sustainability. By facilitating children in developing personal connections with nature, living things, and communities affected by climate change, communicators help give meaning to children's learning experience. Participant 16 believes that human's relationship with our surroundings shape the way we view and interact with the world. She explains:

**I think it's important to develop a healthy relationship with the living things around us. That's something that's just easily taken down to the level of 'I'm a superior human and things around me bother me, and I'm just gonna either ignore them or destroy them if they keep bothering me, when it's really just a change of lens. (Participant 16, parent)**

Communicators can help children form a positive relationship with their environment by providing ways for children to connect with nature and supporting learning through nature. Multiple parents and educators have attested that for young children, the easiest entry point to sustainability is through their connection with plants and animals. Communicators can leverage children's innate need to connect with living things to build a long-lasting appreciation and empathy for the natural world. Participant 16 recounts:

**[My daughter is] very sensitive with her relationships with animals and living things in general. She cares about trees and plants. She will make these associations that I never pointed out to her: 'When we eat animals it's really sad because they end up in the toilet.' She really absorbs things that we discuss in ways that are personal to her interests. (Participant 16, parent)**

Building a healthy relationship with nature involves working in and with nature. As described by Participant 10, a parent and an environmental advocate, learning in nature is the "follow your nose" kind of learning. Children ages 6 to 10 are in the process of making sense of the world around them. As a result, they are innately curious about their surroundings. Communicators can invoke children's innate curiosity and love for nature to change the way they see and interact with the world. And for children to be invested in sustainability efforts, they need to think of nature as a place we live in, not a place we visit.

When children form a strong connection with nature and other beings, they naturally grow into advocates. The deeper the connection, the greater the investment in sustainable action. When asked what motivates her to take action, the child of Participant 14, said:

**I really like animals and I like to help animals a lot. That's why I clean up trash.** (Child of Participant 14, age 6)

## 7.1.2 Ways to Think

**Understanding ways to think about sustainability makes it tangible.**

### 7.1.2.1 Systems Thinking

Systems thinking is a growing field of study. To aid problem solving within a complex system, researchers are utilizing systems thinking as a tool to think about sustainability. John Sterman, author of *Business Dynamics: Systems Thinking and Modeling for a Complex World*, defines systems thinking as follows:

**...Systems thinking – the ability to see the world as a complex system, in which we understand that ‘you can’t just do one thing’ and that ‘everything is connected to everything else.’ If people had a holistic world view, it is argued, they would then act in consonance with the long-term best interests of the system as a whole, identify the high leverage points in systems, and avoid policy resistance. Indeed, for some, the development of systems thinking is crucial for the survival of humanity.** (Sterman, 2000, 4)

We argue that systems thinking can be made accessible outside of academia, to educators and parents, and even children. By engaging young people in conversations and activities that involve thinking across systems, scales, and processes, communicators can facilitate children in their growing understanding of their place within the world's different ecosystems. Additionally, communicators are not limited to discussing the climate and environment when engaging children in systems thinking. For example, a conversation about students borrowing and returning books from the library can effectively teach a child about system balance.

We break down systems thinking further into four components to make it digestible for communicators: challenging boundaries, understanding equilibrium, thinking across scales, and analyzing processes.

### 7.1.2.1.1 Challenging Boundaries

**Most people don't know what happens when you turn on the light.** (Participant 10 , parent, environmental advocate)

To most people, adults and children alike, energy is an abstract and intangible concept. According to Participant 2, an education researcher, "in the western world, people just think of a plug as an infinite river of energy." Most children living in a modern home are very confined in the way that they view the world.

Participant 18 is an environmental educator for a conservation center in Long Island, NY. In the program, one activity includes having children from either side of the Long Island Sound explore the shore and investigate the water quality. Then, they are asked to compare data with peers across from the Sound. Participant 18 explains that the goal for the activity is to get across the idea of interconnection: because something is not physically visible does not mean that it is not connected to us.

**Even though I can't see you, and you are somewhere far away... we are connected.** (Participant 18, environmental educator, conservationist)

Therefore, what are some ways in which we can encourage children to expand the horizons of their worldview and venture beyond the boundaries of their immediate environments? How might we help them wonder about and draw connections with new people, places, and things?

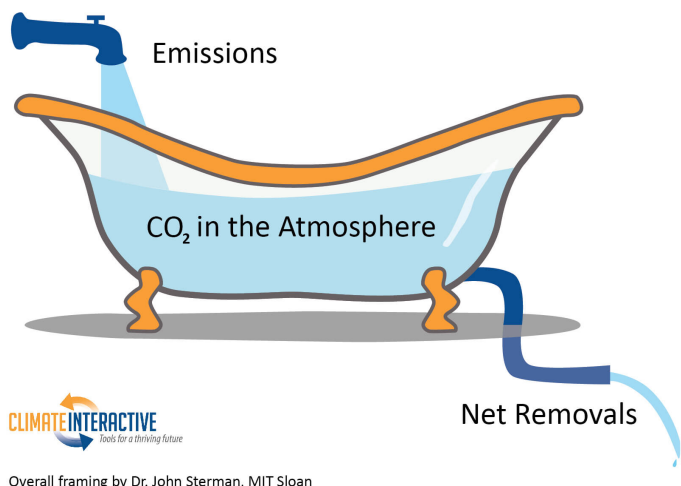
### 7.1.2.1.2 Understanding Equilibrium

The concept of equilibrium is key to understanding sustainability. In order for humans as a species to live sustainably, rates of use should be in equilibrium with rates of production across all scales. Hence, it is critical for children to understand what it means for processes to be in equilibrium. It is easier for children to digest the concept of equilibrium through a metaphor or another lived experience, and communicators can explore different ways to convey this idea such that it is relevant to and appropriate for each individual. Following are some examples:

Climate Interactive uses imagery of a bathtub to illustrate the dynamics of the carbon cycle (Climate Interactive, 2009). The CO<sub>2</sub> level in the atmosphere is represented as a "stock" of water in the bathtub, while CO<sub>2</sub> emissions and net removals are represented as inflow and outflow, respectively. When the rate of emissions exceeds net removals, the CO<sub>2</sub> level increases, and vice versa.

**Figure 7a**

*Bathtub Diagram Illustrating the Dynamics of Equilibrium*



Note: From *Climate Bathtub Simulation*, by Climate Interactive, 2009 (<https://www.climateinteractive.org/ourwork/climate-bathtub-simulation/>).

Meanwhile, Participant 13, a parent of three, tells two stories of how he prompted his children to think about equilibrium through limited resources in the home:

**We started giving them weekly allowances, so they start to get the concept of finite things, like numbers. If they use it, it will be reduced... They started to be aware of how much they have, and how quickly that can be resupplied, and how much they can spend.** (Participant 13, parent)

**With toys, they also know that the amount of energy is similar to what they have in the allowance savings... They start to get this idea of limited things, like the energy content in the battery... They start to get the idea that it's not sustainable to use something without attention to how much you still have.** (Participant 13, parent)

While being immersed in the outdoors, children can naturally learn about equilibrium as they observe the interconnectedness of living things and interact with the flow of organic materials. For example, what happens if a new species is introduced into an ecosystem? What if one is removed? Or how do nutrients flow through different plant and animal species?

**Kids learn a lot from observing what is happening in the natural world... There are so many things in balance in nature. How does an animal build its home and where does it go when it's done?** (Participant 10, parent, environmental advocate)

Lastly, once children understand what it means for a system to be in equilibrium, they will naturally start thinking about what it means to disrupt that ecosystem.

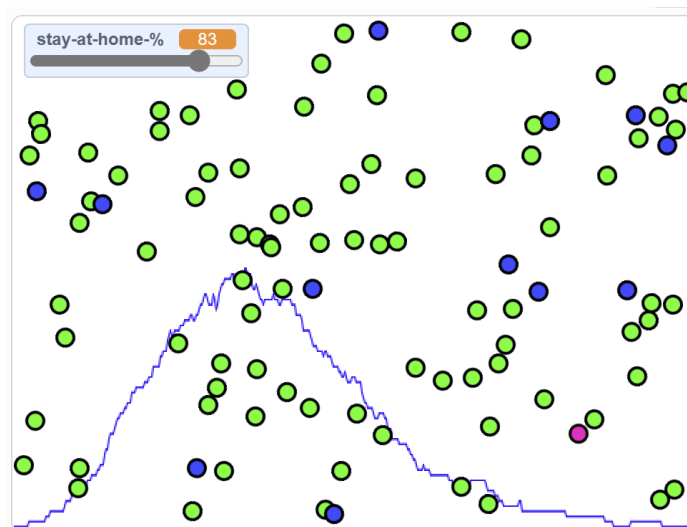
### 7.1.2.1.3 Thinking Across Scales

For most children, thinking across scales in both space and time can be difficult, especially when we traverse different magnitudes. Being able to grasp a sense of scales is critical towards understanding sustainability because action and effect often happen across scales.

Participant 11, an educator and researcher, says that “time scales is also something that most kids aren’t very good at.” He talks about a simulation on Scratch that demonstrates the spread of an epidemic, as shown in Figure 7b. In the simulation, when the percentage of people who stay at home (represented by the “stay-at-home-%” variable) increases, the number of sick people decreases, and vice versa. By playing around with the “stay-at-home-%” variable, scratch programmers can explore how the stock of sick people changes over time. The interactiveness and simplicity of this visualization not only help children wrap their heads around a complex system, but also get them excited to make sense of systems thinking. Participant 11 further invites scratch programmers to modify the code to see how recovery speed, population size, and infection rates affect the dynamics of the spread.

**Figure 7b**

“Epidemic Simulation” Scratch Program



Note: From *Epidemic Simulation*, by user mres, 2020, Scratch (<https://scratch.mit.edu/projects/376656449/>).

#### 7.1.2.1.4 Analyzing Processes

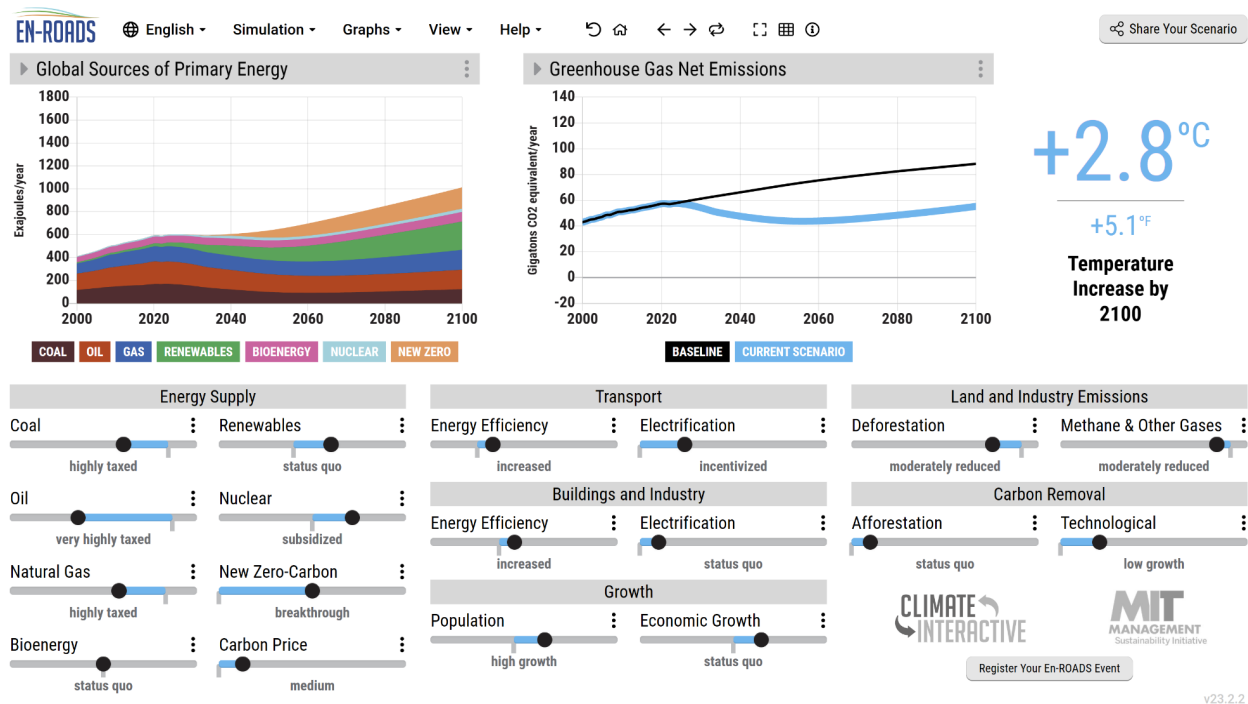
Participant 11 argues that “in most traditional education approaches, you're looking at facts. You don't learn about process so much.” Because processes are not emphasized, children often lack the awareness of where things come from, how they are made, and how they are disposed of. Providing exposure to processes can help children gain a better understanding of the flow of resources, while challenging them to expand system boundaries in their mental models. Participant 14, a parent, provides an example of how engaging her child in gardening builds appreciation for food while giving her a better sense of time scales:

**She knows the work it takes to get a plant to grow. I used to have a garden. Everything takes work. Everything has a lot of value. When you waste, you're really wasting! It took this long to grow this thing! You also cooked it. It took a lot of time.** (Participant 14 , parent)

Associated with the idea of processes is that of cause and effect. When a process is in place, changes to one element within a system potentially affects other parts of the system. By helping children connect action to consequences, communicators can help children understand the interconnectedness of members within a system, and accordingly nurture their view of the world as an ecosystem.

The En-ROADS Simulator, developed by Climate Interactive, is a program that helps users understand the impact of policy changes on the climate, as quantified by temperature increase by the year 2100 (Climate Interactive, 2015). Although not designed for the younger population, the En-ROADS simulator is an example of a tool that successfully engages users in systems thinking by connecting action to consequence and exploring changes across scales.

**Figure 7c**  
En-ROADS Simulator



Note: From *En-ROADS Climate Solutions Simulator*, by Climate Interactive, 2015 (<https://www.climateinteractive.org/en-roads/>).

### 7.1.2.2 Non-Dichotomous Thinking

Discourse surrounding climate change and sustainability is often non-dichotomous. There may not be one single correct answer to problems, and the problem could possibly be viewed from different perspectives; this is unlike what children are typically presented with in school. Therefore, it is critical for children to be able to engage in conversations that are nuanced, to understand that problems may not have a singular “right” or “wrong” answer. For example, Participant 14, a parent, recounts her experience discussing CO<sub>2</sub> levels with her daughter: “I’ve been liking how we’ve been getting to a lot of nuance. Too much can be bad, but not enough can be bad too.”

As described by Participant 8, a communications expert, “kids’ sense of right and wrong, and boundaries, is very strong, because that is how they learn. It is very binary.” Communicators can help children practice non-dichotomous thinking by encouraging them to approach problems with an open mind and explore solutions from multiple perspectives. Moreover,



engaging children in empathetic thinking can help them learn to respect others and understand that there may be different ways of thinking.

**Climate issues are not black & white. There might be opportunities to engage kids in real world issues where there is not a single 'right' thing to do.** (Participant 6, environmental educator, psychologist)

### 7.1.2.3 Empathetic Thinking

When we put ourselves in the shoes of others, we are challenged to think more critically about how our actions can cause a wider impact on different environments and ecosystems. Communicators can help encourage children to empathize by asking questions or invoking their curiosity. Following are examples of how communicators have successfully engaged children in empathetic thinking:

**I put up pictures of different houses and ask them to look at it with the eyes of a bee or a bird. What will you eat in this space? Where will you sleep? Where will you hide from your enemies? They look at the landscape with the eyes of not a human, but of other creatures.** (Participant 7, environmental educator, conservationist)

**If she's using a stick to bang on plants and trees. I take her close to me and we look closely at the plant. What is the plant trying to do by growing leaves, what the bark does. Trying to understand, to empathize... To try to see the world not through this super anthropomorphic lens like everything needs to be humanized. Trying to look at it from the very level of the plant or the insect.** (Participant 16, parent)

Communicators can also support children by promoting empathy as a tool for problem solving. By facilitating conversations and interactions between children and stakeholders involved, communicators can help children tackle problems more deeply, critically, and holistically. Examples include creating opportunities for children to observe wildlife, and setting up meetings with members from communities affected by climate change.

## 7.1.3 What Can Be Done

***Understanding what can be done about sustainability makes it actionable.***

### 7.1.3.1 Inspiration

**[We] need more access to success stories. Being hopeful is not foolish.** (Participant 18, environmental educator, conservationist)

To incite action, children need to see what is possible. Showing what other peers and role models have done can inspire children to take action. By observing others succeed, children will feel empowered to reflect on how they might be able to make change in their own way. Additionally, solutions that work should be shared to demonstrate the diversity of ways to take action. Participant 18, both a parent and an environmental educator, recounts how her daughter became inspired to take climate action:

**I told [my daughter] about an autistic girl who went on a mission. She responded with “Can I do that?”** (Participant 18, environmental educator, conservationist)

Most importantly, it is critical that communicators practice what they preach. Children learn by watching and mimicking adults around them. When they observe behaviors over time, they will naturally adopt them as their own.

### **7.1.3.2 Action**

Because classroom learning is often abstract, learning can be reinforced and made concrete through specific actions taken after school, at home, and in communities. Educators have attested to the effectiveness of hands-on learning. Communicators can participate by providing children with the means and methods to take action. Participant 14, a parent, explains how she engages her daughter in small, but regular, sustainability conversations and actions:

**[My daughter] helps with the maintenance of the house. She helps us buy groceries. She helps me choose significant amounts of veggies and fruits and we eat a bit of meat. She gets to be an integral part of our consumption.** (Participant 14, parent)

Communicators can help motivate children by partaking in activities together. However, if communicators are too hands on, children may decide to take the back seat. Participant 20, a parent and an environmental advocate, explains how her son “feels like he doesn’t need to be [taking action] because [she] is.” Hence, while acting as role models, communicators should also take care to involve children as active participants.

The communicator’s goal is to nurture an active experience where children take ownership and pride in their actions. Actions can be big or small, local or global. Impact is measured not by the consequences of that single action, but by how much that action can empower the child so they can continue to see themselves as an active changemaker in the world. Participant 24, a grandparent and a climate action educator, emphasizes that small actions can go a long way to empower children:

**Both of the children are empowered to [take] action because they feel that that is really making a difference, that they are doing something positive... For example, at school, my grandson read the giving tree and connected that to the acorn he has planted and how he's seen it grow.... But also he has been extremely picky about where that tree is going to grow. He wants to also plant it in an area where it will provide tree equity in the city. So, the ideas are huge, the actions are small... All of those connections – who knows where they are going to lead. They are just being awakened. And the fact that we keep on talking and doing activities around that area is what keeps the interest alive and keeps him trying to create new things.** (Participant 24, grandparent, climate action educator)

We dive into her success story in more detail in Section 8.2: The Role of the Red Oak in New England's Natural Ecosystem.

### 7.1.3.3 Feedback

Participant 10, a parent and an environmental advocate, explains how she empowers her children:

**I love presenting my kids with how the world could be rather than the way it is.**  
(Participant 10, parent, environmental advocate)

It is important for children to understand that the world as they experience has the potential to change based on their actions. By providing opportunities for children to see how their actions can make a measurable difference, communicators can foster children to grow into changemakers.

Communicators should strive to provide feedback in a timely manner. The faster the feedback loop is closed, the easier it becomes for children to connect action to reaction, cause to effect. Furthermore, a tight feedback loop allows children to iterate quickly on their actions, as they reflect on what they can do better next time. Participant 2, an education researcher, explains the importance of timely feedback:

**It doesn't prepare you to think about the problem if the only feedback you get about your energy comes a month later in the form of this electricity bill... That kind of feedback is not going to give you an understanding of what you did and why that bill was so high.**  
(Participant 2, education researcher)

Last but not least, communicators should not be afraid to show children how their actions may have negatively impacted their environment. Asked to give advice to other parents, Participant 14 said, "it doesn't hurt your kid to see how their actions can affect others. Even if

they cause others pain or discomfort.” Positive feedback is empowering, while negative feedback is a valuable learning experience.

## 7.2 Design Principles

### 7.2.1 Optimistic

#### *Optimistic communication builds comfort and confidence.*

Communicators can help children navigate their emotions by communicating optimistically, which empowers them to overcome fear and anxiety and puts them in the right state of mind to problem-solve and take action. As alluded to previously, climate anxiety is prevalent among young children today. To avoid adding fuel to the fire, communicators can convey ideas in a non anxiety-inducing manner by calling attention to solutions, communicating in a non-blaming manner, and making connections with what children are already doing well.

#### 7.2.1.1 Solution-Focused

When discussing climate change, to express the urgency of the problem at hand, communicators often resort to illustrating the dire problems we face as a society. Intense imagery of a post-apocalyptic world gets triggered: dying polar bears, oceans flooded with plastic, mass extinction, the list goes on. However, what this does is spawn fear and despair. For children, the large scale at which these problems are presented overwhelms them, leading to inaction because they perceive the problems as insurmountable.

Communicators should focus not on just problems, but also on solutions. What are some steps that can be taken to address these issues? What actions are already being taken? While communicators should explain the problem truthfully, it is critical to also show that there is a way out. Additionally, communicators can invite children to discuss ways in which they can play a part in the solution. Ultimately, a communicator’s goal is to put power in children’s hands.

**Give them positive control over the situation.** (Participant 19, parent, psychologist)

One way problems can be framed is in the context of consequences to our actions. That way, a connection can be made between the problem and what actions can be taken to prevent the problem from worsening.

#### 7.2.1.2 Non-Blaming

Participant 19, a parent and psychologist, explains how “kids tend to over blame themselves,” and that “it can be overwhelming for them in terms of internalizing blame.” This

sense of guilt adds to their anxiety. Hence, it is important that communicators convey information without reprimanding. Instead, they can provide children with guidance on how to improve and do better the next time.

**Try to speak to them without it feeling like we're reprimanding them, like 'you're doing it wrong.'** (Participant 16, parent)

### 7.2.1.3 Validating

In order to take action, children need to first feel confident that they can indeed make a difference. Most children are already thinking about or taking actions towards sustainability. Communicators can empower children by highlighting the connection between what they are already doing and how that action creates a positive (or non-negative) impact on the world. For example, communicators can talk about how walking to the grocery store has a smaller environmental footprint than driving.

Participant 26, a 3rd grade teacher, explains how she utilizes empowerment as a tool to help children navigate their anxiety:

**As much as I know that it is beyond our own individual power, I do believe that our actions can make a difference. And so I teach them, I do teach them that. You have agency, you have this power. You can write - one of the fourth graders did a mini-capstone and they wrote to the mayor. I do think we need to empower. Empowering does ease a bit of the hardness of it and the anxiety around it.** (Participant 26, 3rd grade teacher)

## 7.2.2 Active

**Active communication helps individuals connect to sustainability in ways most meaningful to them.**

Communicators should strive to create an active learning experience for young children that involves the three key elements of exploration, reflection, and iteration. Engaging learning experiences go beyond facts and figures. By crafting experiences that help learners come to their own conclusions and feel involved in the process, communicators can nurture within children a self-motivated love for learning, while fostering a culture of curiosity and question-asking.

**Don't communicate to kids by telling them, but by engaging with them.** (Participant 7, environmental educator, conservationist)

### 7.2.2.1 Explorative

Each learner brings with them a different set of knowledge, opinions, and beliefs about the world. Learning through exploration allows learners to build meaningful connections unique to them. Additionally, by providing learners with agency to connect with concepts in their own way, communicators can engage with a diverse audience. Participant 3, a climate communications researcher, explains how “different people can support the same solution for different reasons.” Therefore, communicators should provide the space for learners to carve out their own path towards sustainable thinking.

Participant 18, an environmental educator, leads a group of young children to explore the ecosystems of the Long Island Sound. According to her, outdoor activities are engaging for children because they love freedom. As the group walks along the shoreline, each child has the opportunity to discover and interact with what they find most intriguing, whether it be a bird's nest or a horseshoe crab. She explains:

**Nature does the teaching for us. They just want to explore.** (Participant 18, environmental educator, conservationist)

Meanwhile, hands-on learning, where learners engage in problem solving and learn through doing, is explorative by nature. When given the agency to explore, children decide on their own journey, take ownership of their successes and failures, and learn from their experience. Hands-on learning is enjoyable and engaging for children because exploration creates room for self discovery, while creation serves as a platform for self expression.

**Kids love making things. It's not to convince someone, it's just whatever is on their mind...** (Participant 11, education researcher)

When communicators task children with a problem where boundaries and constraints are loosely defined, they effectively create a “microworld,” an imaginary space where children can let their creativity roam free. Participants 22 and 23, parents of six, give challenges to their children and encourage them to use their imagination to solve different open-ended problems. By engaging their children in microworlds, they are able to involve multiple individuals with different ages, genders, and interests, exemplifying the benefits of learning through exploration.

**It would be interesting to set up a problem, ask kids to set up a sustainable community. Give them certain parameters and have them try to build a little world with them. My kids like that kind of game. They already do that. That impulse would work out very well. A little toy universe or toy community, a thought experiment or farm they set up, making rules for the community, looking at different climates... I think the kids could actually**

**enjoy that and be good at it even without having a sophisticated knowledge of all the concepts. They can use their intuitive understanding of how ecosystems and sustainability work. They really like to be in charge of the decision making process, and being able to make choices really appeals to them.** (Participant 22, parent)

### 7.2.2.2 Reflective

Reflection is a critical element of the learning process, especially when it comes to experiential learning. It is important to provide learners with the opportunity to reflect upon an activity so that they can make sense of the learning in their own terms. Furthermore, reflection enables learners to conceptualize ideas and skills in ways that make them accessible for and adaptable to future scenarios. Reflection can take on many forms, such as time and space for learners to write down key takeaways, ask lingering questions, or discuss potential applications to their learnings. Participant 12, an education researcher, explains how reflection can be weaved into learning experiences:

**Allow them to process what they experienced, apply it to parts of their lives, and then weave it back into what they can do, or how to think differently.** (Participant 12, education researcher)

### 7.2.2.3 Iterative

Sustainability should be portrayed not as something to be perfected, but as something we can continuously strive to do better at. Being sustainable is not a goal, but a process.

**Sustainability is not a 'once and done' thing. It's something you practice and learn... It's not about being perfect or being a purist, it's about being better than you were the last day.** (Participant 7, environmental educator, conservationist)

When asked what advice she would give to other parents who want to teach their children about sustainability, Participant 14 highlights the importance of not striving for perfection and moving gradually towards a sustainable lifestyle – one step at a time.

**Just be bold, take the leap. You don't have to be perfect. You don't have to walk outside barefoot and live in a cabin. There's a good in between. Having some awareness is better than nothing.** (Participant 14, parent)

Communicators may encourage this way of thinking by promoting an iterative mindset. Generically, this means nurturing an environment in which children can exercise their creativity and generate ideas without feeling judged, feel safe to experiment and fail, and ask questions and receive constructive feedback from mentors and peers. Specific to sustainability,

communicators can support children in taking small sustainable actions that lead to moments of exploration and reflection. Consequently, children can continue to iterate in cycles and build up towards bigger actions that create bigger impact. Timely feedback, as outlined in Section 7.3.3.3, also helps to facilitate iterative thinking.

### 7.2.3 Youth-Centered

#### ***Youth-Centered communication makes sustainability relevant and engaging.***

In order to connect with each individual learner, communicators must meet them where they are in their lives and communities. Communicators should convey ideas in ways that are not only age appropriate, but also engaging and individually relevant.

According to Participant 6, an environmental educator and psychologist, the key to connecting with individuals is in finding common ground. Communicators should start where learners are, observe the connections they make, and identify how those connections fit with the broader space. Effective communication is relatable and personalized. The stronger the connections children make, the stronger their investment in the cause. Participant 22, a parent, provides advice to other parents:

**What I would say to someone who is just starting with their kids around sustainability is to use the situation at hand as an opportunity for teaching. Everything interesting for teaching is right in front of you, and that is what you have to live and contend with.**

(Participant 22, parent)

#### **7.2.3.1 Age Appropriate**

Communication should be age appropriate, including both the content and the language used. Content should comfortably and gradually build off from the learner's existing knowledge. For example, communicators can consider what children are learning in school in different subjects, what kinds of environments they play in, and what toys they interact with. For instance, are there windmills or solar panels nearby that children may have encountered?

Additionally, the way in which ideas are conveyed make a big difference for children. Participant 25, a 1st grade teacher, points out that "what [doesn't] work [is] being too scientific, too focused on the process, not making it grounded in something they can see or touch." Especially for younger children, "teaching" should be kept short and concise, leaving room for self discovery. Communicators should keep in mind that lessons do not need to be comprehensive, for a communicator's role is to plant the seed of curiosity for children to explore ideas further on their own. Participant 25 provides further advice:



**There needs to be a one sentence thing you are trying to get the kids to take away, rather than explaining the full process. If we are talking about photosynthesis, maybe the focus isn't the whole process of photosynthesis. Maybe it's 'plants use the sun to get energy.' If you can get kids to take that away and see that plants get their energy from the sun, they can walk away with something they can say to a family member or something.** (Participant 25, 1st grade teacher)

Communicators can consider creative ways to engage learners. For example, Keya Lamba, a climate educator, advocates for using characters to engage children in social-emotional learning (Lamba, 2022), while Participant 6, an environmental educator, attests to the effectiveness of storytelling as a means of communication. Communicators should stay attuned to the needs of each child to see what might work best for them.

Participant 25, a 1st grade teacher in special education, narrates the difficulty she faces in concurrently connecting to all six students in her class. What she has found to work is creating a theme that students can relate to, in addition to room for each student to explore and build their own connections within that theme.

**For my kids, there are six kids in my classroom and they are all in pretty different places with skills and knowledge and development. I struggle with how to design things for all of them to work together. What we've figured out is making a theme, and then activities that are important to connect to that theme.** (Participant 25, 1st grade teacher)

### **7.2.3.2 Engaging**

One way communicators can make learning experiences personally engaging for children is by leveraging a child's interests. Communicators should seek a common ground in which a connection can be made. By identifying a child's interests, communicators can not only nurture the growth of their interests, but also leverage those interests to help children form meaningful connections with other important ideas.

As an example, we have found that a lot of young children are interested in collecting rocks. Accordingly, this interest can serve as a pathway for the child to connect with nature.

**My daughter is very science driven, so she reads a lot about minerals and rocks... It connects her to something that's natural. She's become quite an expert. She knows the names of gems and stones. My son has gotten into it too. He wants to be a paleontologist.** (Participant 19, parent, psychologist)

Participant 13's son, age 8, explains that he collects rocks because they have cool colors and shapes, and are unique!

**Figure 7d**

*Rock and Mineral Collection Belonging to Participant 13's Son*



Last but not least, a truly engaging learning experience is fun for the learner; a fun experience can mean that children will not even notice that they're doing anything educational at all! For example, Participant 13 talks about his son who makes a discovery that repurposing cardboard is a form of recycling, though his initial motivation was to play with it.

**He starts to associate what he likes to do with the paper box, how he repurposes it as a toy... Because repurposing something is fun, the main drive is the fun part... They have the knowledge, but if it's not fun, it does not fulfill the needs at the moment... they don't have that emotional purpose, or awareness, to convert it to action. (Participant 13, parent)**

**Figure 7e**

*Participant 13's Son Repurposes Cardboard for Play*

**7.2.3.3 Relevant**

Communicators can engage children by tying in problems and stories that are close to them. Closeness is not limited to physical proximity, but also extends to stories about families, friends, and communities of people that children care about.

First of all, communicators should discuss ideas that are locally relevant for children. Conversations about local climate and ecosystems are great ways to get started. Keya Lamba, a climate educator, highlights the importance of building location-specific climate resilience, emphasizing that communicators are responsible for preparing children for extreme climate events in a positive, empowering way (Lamba, 2022). Especially for younger children, in order to be invested in sustainability, it is important for them to be able to make a connection between what they experience day-to-day and the immediate problems they may face. Participant 5, an environmental justice educator, recounts how his students had difficulty caring about the dwindling population of whales because they have never seen them before.

**They all understood the important things, like whales are dying... but there wasn't as much investment in the outcome. Learning about sonar to be able to make a case for whales didn't feel close to them.** (Participant 5, environmental justice educator)

Meanwhile, communicators can also engage children by inviting them to empathize with people close to them. For example, Participant 13, a parent, tells a story of how he helps his son build meaningful connections by nudging him to empathize with his older relatives.

**It's more about family stories. Your grandparents, they're immigrants and had bad economic status sometimes they tell stories about what happened then and [the children] become intrigued and engaged. And I think this kind of topic is almost always related to resource scarcity. The behavior at that time is so much different than now. He can understand it, and I think it's helpful that it's someone he knows... He can still have some relatable feelings.** (Participant 13, parent)

Participant 26, a 3rd grade teacher, shares how she teaches about social and environmental justice by connecting with her students through stories that they can relate to as immigrants:

**I often bring it back to our own communities. I have a lot of latino students, and I am from Puerto Rico, and I talk about Hurricane Maria. There is a personalizing component that supports a deeper layer of understanding. The amount of land loss in Peru, in the Amazon, Venezuela, Central and South America... A lot of families are emigrating because of climate change. I share collective stories that are connected to their own communities.** (Participant 26, 3rd grade teacher)

#### **7.2.4 Community-Based**

##### ***Community-Based communication empowers individuals to take action.***

Making learning community-based extends learning beyond the classroom, makes ideas relatable to contemporary issues, and ties them to action. Furthermore, making sustainability community-based makes sustainability sustainable. Community action helps to establish norms, process, and values, which in turn helps to build community identity. Over time, these values become embedded into the community and reinforce future behavior. Participant 12, an education researcher, describes how values spread within communities: "when anyone enters your space, they are on-boarded into that process and culture." Meanwhile, Participant 3, a climate communications researcher, shares how norms are spread between communities:

**A lot is about telling the stories of the people who are local, as close to you as possible, and say 'hey, just in the next town over, here is what they are doing, and here are the results that they have had. You want to come meet them with me and chat with them so we can figure out how to do that here?'** (Participant 3, climate communications researcher)

When sustainable action becomes part of the identity of not just an individual, but of a community, values can begin to spread organically between communities. Participant 20, an

environmental advocate, explains how “neighbor to neighbor discussions” helps speed up electrification of the neighborhood:

**My goal is for them to share those experiences with the communities they live in because they are powerful and there is evidence and research that neighbor to neighbor discussions have higher effect on prompting real action over and above simple provision of information.** (Participant 20, parent, environmental advocate)

#### **7.2.4.1 Visible**

Lessons and activities should be made visible to others whenever possible. Putting climate action in view helps to break the spiral of silence by mitigating silence misperception. In doing so, climate change and sustainability can become normalized as part of day-to-day conversations, and new members of the community can be invited to join in the effort.

As an example, Participant 20, an environmental advocate, explains how the visibility of solar panels stimulates their adoption, which in turn jumpstarts the electrification of the neighborhood:

**There has to be multiple exposures. You can't develop this idea that it's normal unless you keep seeing it. You need to plant that seed with people to say “what is electrification?”** (Participant 20, parent, environmental advocate)

#### **7.2.4.2 Collaborative**

Giving children the opportunity to collaborate allows them to build off each other's ideas to solve problems while engaging in social-emotional learning. Children benefit from teaching and learning from one another. Additionally, it is important for them to learn to empathize with people who may think differently. Participant 25, a 1st grade teacher, discusses the power of peer to peer collaboration:

**The “kids talking to each other” piece is super important because it builds connections between kids. That can be really powerful because they find similar interests. “This other person cares about the same thing, and makes it fun.”** (Participant 25, 1st grade teacher)

Community gathering gives learners the opportunity to connect with others who have shared interests and goals. Building a community around solving problems allows learners to express their empathy as a group, empowering them to take action.

### 7.2.4.3 Advocatory

Children innately have a strong sense of justice. They are self-driven to take action and represent a cause. Participant 11, an education researcher, talks about how children can be very enthusiastic to become advocates and want to express themselves through creative means: “when kids learn about things they’re worried about in school, they make a Scratch project as somewhat of an advocacy platform.”

Participant 18, an environmental educator, talks about an activity where she asks her students to pick, research, and present on an animal that lives along the shore. They are tasked with explaining, through the lens of the animal, what is impeding their survival. Participant 18 then explains how children’s connection with animals motivates them to become advocates, and how becoming an advocate helps to strengthen that relationship further.

Additionally, sustainability is related to other socio-political issues, which communicators can leverage to connect with learners. It might surprise you to find how knowledgeable and invested young children can be with these causes!

**Kids this age, if you have cake and cut it in half, it has to be exactly half! It’s their property, sometimes they want to share, sometimes they don’t and if they don’t they become more protective about fairness. When we see google images of fair trade, or images of a poor society, I think he will feel pretty surprised or shocked, and sometimes asks questions out of a sense of justice, “Why are they getting treated so badly?” That’s because he’s starting to get a sense of justice or empathy. (Participant 13, parent)**

# 8

## Framework Case Studies

In order to illustrate how the framework could be utilized by sustainability communicators in real-world settings, we tested aspects of the framework in a classroom workshop at a local elementary school, and mapped existing effective curricula generated by our stakeholders into our framework. In the latter case, the stakeholders had not known about the framework prior to creating their curricula, yet they had developed curricula that aligned with our framework after experimenting with different activities and methods. These case studies illustrate real-world examples of the framework in practice, and indicate that the Sustainability Communication Framework formalizes the process for developing curricula on environmental topics.

### 8.1 Sustainability Workshop

From conversations with educators in Section 7.1.2.1 and our existing solutions research in Section 5, one of the pain points that we found educators had in existing climate change and sustainability communication was in “ways to think.” Several educators highlighted this framework element, specifically in regard to systems thinking, as particularly challenging for them to teach, because it is an area that they have the least experience with, and that is the least tangible to young people. To test aspects of our framework and its design principles, we ran a two-part workshop in a first grade classroom at a public school in Cambridge, MA. Our main goal was to design a workshop focused on systems thinking, specifically leveraging exploratory, age appropriate, and collaborative design principles.

In our first session, we facilitated discussions between students on where different materials come from and where they go when we no longer want them, and asked them to draw out process-flow maps for each material. By asking students open-ended questions, we helped connect different aspects of their existing knowledge together to build a model of material production and waste flows. In the second session, we asked students to construct renewable energy systems from craft materials to power their community. With this hands-on activity, we encouraged them to connect to new ideas in ways most meaningful to them. Utilizing our framework, we were able to make learning about sustainability meaningful, tangible, and fun for each individual in the classroom, even with ideas that may feel out of reach for first graders. The students walked away having enjoyed and remembered our discussions and activities, and the teacher asked us to return for another session.



### 8.1.1 Materials Workshop

In the first of two workshops, the “Materials Workshop,” our goal was to teach students how to think about where things come from and where things go. At the beginning of the class, we started by presenting a few questions to the class, one of them being “What did you have for lunch today?”

We selected a fresh food that a student had called out to answer the question, and asked them where they got the strawberries from. After they answered “the refrigerator,” we asked the class where the strawberries were before that. The class agreed they came from the store. We continued to probe by asking how the strawberries got to each “point” before they arrived in the student’s lunch, and drew out a map on a piece of draft paper with each of the points of the process laid out. Once our map was drawn out, we continued to ask students questions about specific “transition points” in the process. For example, we asked at what time of year strawberries grew in this area, and what we need to do to get strawberries if they only grow in the northeast during the summer.

In each of our initial questions, we developed a map as a class of each step in the process of creating, transporting, or disposing of different materials. These maps got the students thinking about how to connect different actions, materials, and operations to build a model of how different materials are made.

Next, students were split into groups of 3-4, and they were each given a piece of raw material. Materials included plastic, cardboard, rubber, glass, and metal. Each group was asked to answer the following questions:

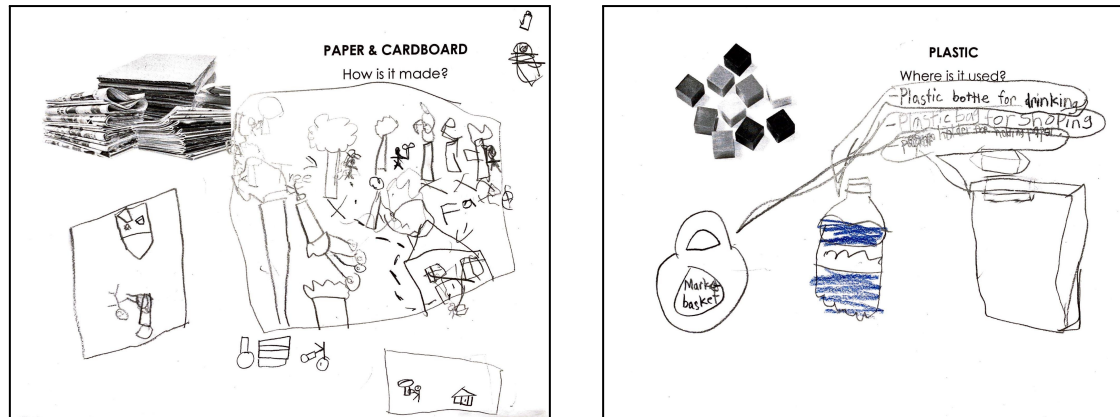
- **Where is the material used?**
- **How is the material made?**
- **What do you do when you don’t want this material anymore?**

For the latter two questions, we asked students to draw out process maps as we had during the examples at the beginning of the class. They spent 30 minutes in groups discussing how the materials were made, and how the materials can be disposed of. Afterwards, we came back to present and discuss our maps as a class. Full materials and prompts from this workshop are in Appendix F.



**Figure 8a**

Example Student Worksheets for the Materials Workshop



Note: Additional Worksheets are included in Appendix F2

### Effectiveness

This activity was effective because it gave students the agency to explore the answers to each question together, and leverage their existing knowledge when doing so. Because we focused our discussion on asking questions for students to explore in groups, rather than explaining answers to them, we were able to leverage their natural curiosity and allow students to discuss their pre-existing knowledge together. Drawing out the process maps helped students visualize the system and its dynamics very clearly, in some cases.

For example, the team focused on cardboard had one student drawing out each step of the process. One student drew out trees being planted and grown, one student drew a person cutting down those trees, and a third student drew the trees being chopped up and turned into cardboard. The student drawing trees saw that all of their trees were being cut down, so he started drawing more trees, which continued to get "cut down" by the other student. The system dynamics became very clear for this group, because the rate at which trees were "grown" (drawn), had to be greater than or equal to the rate at which trees were "cut down" (struck through), in order to continue to make paper.

In the reflection discussion later in the class, the students in the cardboard group also recognized the other benefits that trees provide to the environment - they remove CO<sub>2</sub> from the atmosphere and provide oxygen: "It's impossible! If we keep cutting down trees then we won't be able to breathe!" one student exclaimed. The class exercise helped make material over-extraction more tangible and meaningful, highlighting why it is important to prevent deforestation.

Materials like cardboard, rubber, and glass were straightforward for students to map out based on their existing knowledge. However, some materials, like plastic and metal, were more challenging. Students observed that while there were many different things around them made from plastic, they had no idea how it was made and could not visualize it even when explained - it was not tangible to them.

Similarly, the group focused on metals did not know where metals come from, and wrote down that it came from the moon. When asked why it came from the moon, students in the group said that it was too dirty to collect on earth, and was cleaner on the moon. They were able to make some progress when asked "if it had to come from earth, what would need to be done to make it usable?", and discussed how it needed to be extracted, cleaned, and refined in some way.

Groups that were able to leverage and discuss existing knowledge were able to map out the system of material creation and disposal effectively, while groups with no existing knowledge of how the material was made had trouble getting started. Teaching systems thinking in an exploratory, discussion-based way relies upon an understanding of different pieces of the system, before they can be connected in a clear way. Once that connection is formed, however, students can understand the system dynamics and interrelated behaviors through exploratory, discussion-based activities.

### **8.1.2 Energy Workshop**

The second of two workshops, the "Energy Workshop," focused on a construction activity to design future energy solutions. Prior to the workshop, the teacher had shown the students the solar panels on the roof of the school. To start the workshop, we first discussed where the school got power from, and asked the students to discuss different scenarios that would affect its power. For example, we asked "How does the school get energy when the solar panels are covered in snow?" and students discussed various ways of power generation during snowstorms. We used this to segue into different forms of renewable energy and non-renewable energy, and discussed the benefits and drawbacks of each to set the stage for the activity. We split the students into groups and gave students the following prompt:

**Let's jump on a time machine to 50 years in the future! We have used up all of the non-renewable energy resources. How should we power our homes? Invent a way to power the city of Cambridge using only renewable energy resources! You can draw or build and use whatever you want!**

**You may want to think about:**

- **What kind of renewable power will you build?**

- **Where should it be built?**
- **Why might it stop working? What will you do?**

Groups of students used construction materials such as blocks, play dough, and pipe cleaners to build renewable energy systems to power Cambridge in the future. As they built, students critiqued their own models by asking each other questions. For example, a group of students was building a dam, and one student asked how the fish would swim down the river with the dam in the way, so a separate channel was created for the fish. Students continued to critique their models and iterate on them by creating solutions to some of the questions that were posed. One team created “power lines” to distribute power to the neighborhood, with a cutoff switch in case of an emergency, another built a system for flooding to be relieved via dam gates. The tangibility of the activity, and the setup questions we posed prior to it, created a deeper understanding of the systems they were exploring and what challenges they may encounter when designing them in the real world. Materials and prompts from this workshop are in Appendix G.

**Figure 8b**

*Students Collaborating in the Energy Workshop*



## Effectiveness

- **Learning Through Play:** Because this activity involved construction and creation, students appeared to embrace the playfulness of the activity while learning at the same time. Entering a play-oriented mode of thinking seemed to empower the students to use their imagination to represent different elements of their models. While playing and creating, it was clear that to the students, there were no right or wrong answers. For example, students in the same group had started each building their own dams. The students learned about the features of their groupmate's dams, and decided to merge their two designs into something bigger and better instead of arguing over whose was more effective. Any questions that were asked of the students, or discussions that students had about their models, led to deeper thought and further iterations of their models. Play enabled them to critique, consider, and iterate on their models in positive ways that led to further moments of inspiration as they continued.
- **Tangibility From Prior Knowledge:** One of the observations that we made during this activity was that students were largely building things that were already familiar to them, but taking their own creative liberties in what they looked like. Since we had introduced the class to many different forms of energy generation at the beginning of the activity, groups tended to pick a solution that was interesting to them and build off of it. This appeared to make starting the construction activity easy, because they had something they could easily reference to begin the build. Once they got started building, it was easier for them to integrate in other features, pivot, or critique and iterate upon what they were doing.
- **Distracting Story Elements:** A distracting element of this workshop was the detail about the time machine. This detail prompted a surprising amount of questions from the students. A few students asked how the time machine worked, whether they would be able to return to the present, and whether they would be old in the future once they went through the time machine, or still the same age. What we thought was a simple story detail ended up creating confusion and distraction. While the time jump provided some context for running out of renewable resources, it proved to get in the way of the main point of the activity. Since this was a "pretend" story, finding the right balance and realism of details to kick off the activity is important to getting the students engaged and focused on the right part of the activity.

## 8.2 The Role of the Red Oak in New England's Natural Ecosystem

Participant 24, a grandparent and a climate educator, leveraged her grandson's interest in maple syrup to teach him about the role of trees and plants in their ecosystems. Throughout her design process, she had tested different types of teaching pedagogies and activities and lessons to see what was engaging for her grandchild. The learning pathway that ended up being successful mirrored the design elements of the Sustainability Communication Framework, and leveraged many of its design principles.

### 8.2.1 Why to Care: Endangerment of the Red Oak

Participant 24's 7 year old grandson loved maple syrup, and wanted to find out how it was made: "My family had no clue about maple trees, syrup, leaves, or what trees give syrup. Since he was so interested in that and could not stop talking about it, that is the route we went." (Participant 24, grandparent, climate action educator)

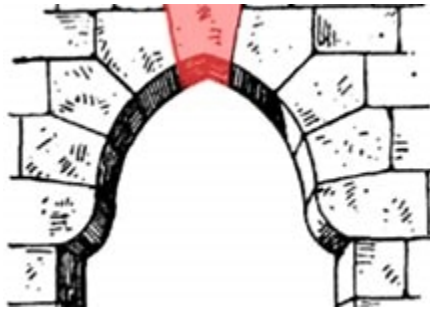
Participant 24 and her grandson started by learning about how to identify different trees: "He started to tell me how the leaves were different - he actually educated me!". Leveraging some resources from Take Action Global (TAG), a training and resource platform for educators looking to teach children about climate change, Participant 24 was able to turn this into a lesson about the different native plant species in the northeast, and they specifically focused on trees. Together, they learned how the Red Oak is native to Massachusetts, and how many different animals use the Red Oak as a home. However, the Red Oak is an endangered species, and faces extinction due to wildfires, invasive species, and development. Participant 24 leveraged her grandson's interest in maple syrup to drive further learning about trees and their value.

### 8.2.2 Ways to Think: Keystone Species

The Red Oak is a keystone species in the Northeast. In order to help her grandchildren understand the significance of a keystone species, Participant 24 created a constructionist activity to make the concept tangible. In her activity, she and her grandchildren collected takeout rice boxes. Each box represented a different species that directly or indirectly rely on the Red Oak to live. They built a keystone bridge out of all of these boxes, with the box representing the Red Oak as the literal "keystone" to the bridge. This activity was based on a lesson plan from TAG's climate education curriculum, which Participant 24 had access to.

**Figure 8c**

Depiction of a Keystone Bridge



Note: The keystone is in red. From *Keystone (architecture)*, by Wikipedia, 2007 ([https://en.wikipedia.org/wiki/Keystone\\_%28architecture%29](https://en.wikipedia.org/wiki/Keystone_%28architecture%29)).

She asked her grandson what would happen if the keystone was removed, and they discussed how the “keystone species” keeps the ecosystem stable because the different species depend on each other to survive. If the Red Oak goes extinct, then it will affect the birds, caterpillars, and other animals that use it for food or shelter.

“If you take away the red oak, thousands of animals and birds that will not be able to exist...we are not going to have what we need to help the animals survive...because all of those will be gone. We are not providing what we need for them.” - Participant 24

This simple construction activity made the concept of an ecosystem much more tangible and easier to grasp for her grandson, and solidified his understanding of its importance in the northeast.

### 8.2.3 What Can Be Done: Planting Trees and Gardening

To connect these ideas to actions, each year they have been planting acorns and seeing how they grow. Participant 24's grandson scouts out areas to plant acorns that ensure tree equity, so that the living things in the area, people included, will have fair access to trees that they can benefit from. Some of the acorns have germinated, and now they are watching it grow.

They have also started gardening as a family, where they can similarly plant seeds and grow vegetables. They have tied this into the learnings from the Red Oak ecosystem as well, because just like how different animals use the Red Oak for food, Participant 24's family now uses what they garden as part of their meals. If they can't grow their garden or they consume too much from it, then they can't depend on it as a resource anymore.



One of the things Participant 24 emphasized about the action-oriented approach is that it continuously reinforces her grandson's affinity for making connections between living things and taking action on them. Now that Participant 24's grandson has an understanding of the importance of trees in the ecosystem, she is going to introduce how trees absorb CO<sub>2</sub> from the atmosphere to teach a lesson on how reforestation will help the earth.

#### 8.2.4 Effectiveness

Participant 24 was able to create activities that grew from her grandson's interests, and as a result unlocked a deeper interest in learning about nature. One of the strongest aspects of this set of activities was how it connected across so many different disciplines all through an interest in trees - from life sciences by introducing the idea of ecosystems, to urban planning via the idea of tree equity, to gardening and cooking. The "How to Take Action" step of this case study is of particular importance, because it provides an example in which even a small action, such as planting an acorn, can make an impact down the line - both in terms of how it will affect their neighborhood, and in how it builds a bias for action on behalf of Participant 24's grandson.

**The impact is huge, the action is small... All these connections keep him alive and creating new things.** (Participant 24, grandparent, climate action educator)

Creating opportunities for real-world actions that make a positive change builds a sense of empowerment in young people: even though they may be young, they can make a difference in ways that are larger than themselves.

Although Participant 24 did not use the Sustainability Communication Framework to design the Red Oak learning activities, having a formalized framework would have accelerated her curriculum design process by eliminating much of the trial and error she faced in creating it.

### 8.3 Salt Marsh Science Program

Participant 18 is an environmental educator for a conservation center in Long Island, NY. She runs programs for young people so that they can learn about their local environment from a scientific perspective. One of the center's programs, the Salt Marsh Science Summer Program, is a week-long program designed for students 6-17, and includes three different "tracks" for different age groups. These three stages map closely to the design elements of our proposed framework.

### 8.3.1 Why to Care: Salt Marsh Explorers

The “Salt Marsh Explorers” track for children aged 6-9 focuses on building a sense of wonder and connection with the Long Island Salt Marshes. The goal of this track is for young people to feel comfortable outside in the marshes. Throughout this track, they explore the marshes to learn about the different animals who live there, and what they do.

This part of the program is very exploratory, open-ended, and unstructured. Each day, students are introduced to a different part of the salt marsh ecosystem, explore the marshes to find these plants and animals in the wild, and observe what they do in the context of the ecosystem. For example, if students were learning about crabs, they would be shown a crab in one of the center’s tanks, learn how to pick it up and hold it without hurting it, and then spend the rest of the day in the marshes finding crabs and observing how they behave in their habitat.

**Nature does the teaching for us. They just want to explore.** (Participant 18, environmental educator, conservationist)

**Figure 8d**

*Young People Exploring the Long Island Wetlands*



Note: From *The Ward Melville Heritage Organization Educational Programs*, by Ward Melville Heritage Organizations, 2017 (<https://wmho.org/educational-programs/>).



### **8.3.2 Ways to think: Salt Marsh Detectives**

Slightly older students in the 10-12 age group focus on learning about the interconnections between species in the salt marsh ecosystem. In “Salt Marsh Detective” activities, students learn about predator-prey relationships, invasive species, and population dynamics. They collect samples from different species to help piece together a model of the ecosystem based on their observations and findings. In addition to building an evidence-based ecosystem model, students put themselves in the shoes of the different creatures in the ecosystem by acting out their behaviors and discussing their implications within the ecosystem.

For example, the education team created a “Salt Marsh Detective Court” in which a “case” would be presented to students and they would have to figure out what happened. “Imagine Gail the Gull came back to her nest to find her egg was stolen. Which predator took her egg?”. The students would make a case for what happened using the evidence they found, and act out these scenarios in the Salt Marsh Detective Court. Activities such as these both help the students build an understanding of the ecosystem, and help the students think empathetically about the different players in the ecosystem.

### **8.3.3 What Can Be Done: Salt Marsh Scientists**

The oldest students in the program, ages 13-17, spend their time in the program as “Salt Marsh Scientists.” They investigate how human activity has affected the salt marsh ecosystem, and participate in activities that prompt them to think about long-term consequences within the salt marsh ecosystem. These activities build their competencies in thinking about real-world problems, identifying the different stakeholders (human and otherwise) in the ecosystem, and advocating in the real world.

For example, the center has a pet horseshoe crab named Nugget. Horseshoe crabs migrate across the Long Island sound each year, but water pollution and ocean acidification has increased the pH levels of the sound. Since horseshoe crabs need to live within a certain pH threshold, elevated pH levels in the sound could drive them from their natural habitats. Through the Salt Marsh Scientist program, students monitored pH levels at different points in the Long Island Sound to confirm whether or not Nugget would be able to migrate across the Sound.

**Figure 8e**

*Nugget, a Horseshoe Crab*



Note: Image obtained from Participant 18.

The students observed how pH levels were higher in areas nearby human infrastructure, and as a result of this discovery, wrote a letter to their governor to pass legislation limiting ocean pollution in the area and protecting horseshoe crabs.

**Legislation might happen in Connecticut to protect horseshoe crabs... they are not just studying the environment, they are part of it.** (Participant 18, environmental educator, conservationist)

Another activity that Participant 18 ran at the Salt Marsh Scientist program focused on futurecasting. Students would select a human impact category, such as overpopulation, pollution, or resource extraction, and then select a wildlife species that they were familiar with from their time in the program. In this activity, they would research how their impact category affected their species of choice, and would give a presentation on the problem, and propose a solution. This exercised their ability to recognize competing forces in the world when it comes to conservation, and raised the bar in terms of them having to think and resolve problems. In exploring and explaining through the lens of the animal they are studying, they build further empathy with the animals, and become an effective advocate as a result.

**The future is like a negotiation between all these different stakeholders in the environment.** (Participant 18, environmental educator, conservationist)

In both of these activities, the primary action that students are learning to take is one of advocacy. Since they build a deep connection with the Salt Marshes as they grow with the program, understand the different players in and effects on the ecosystem, and figure out how they can reduce the effects of human activity on the different marsh species they care about.

This advocacy then turns into actions for students, such as speaking up in their communities and writing to their local governments to create policies that protect wildlife.

### 8.3.4 Effectiveness

Part of the reason why the program starts this young is that it is easy to get children in the 6-9 age range excited about the creatures in the marsh, because the educators can easily tap into their sense of wonder. They found it easier for young people to form connections with the animals in the marsh because the children can empathize with them. Many of the creatures in the marsh are small, and the marsh can be viewed as a sort of nursery. For older students who enter the program for the first time, it is harder for them to connect with the environment:

**Crabs are our most charismatic species. Salt marshes are these enclosed spaces seen as nurseries, so the animals are small. That is why it is hard to get the older kids interested, the small crab is not that impressive unless you met it when you were 6.** (Participant 18, environmental educator, conservationist)

The Salt Marsh Science program is an effective example of place-based learning, a style of education focused on learning within a specific physical environment (Minero, 2016). Because the program creates exploration-based learning experiences, students form a deep connection with the physical location of the marshes. Many of the children who enter the program want to come back after experiencing it:

**Initially when the parents sign them up, it's usually the parents [motivating attendance]. But on the last day, I hear them saying "I want to come back to this"...It's like a subculture that is formed.** (Participant 18, environmental educator, conservationist)

The salt marshes become a place that holds meaning for them, successfully getting students to care about the marshes, and making them more interested in returning in future years. The program structure further reinforces their connection with the local environment each year they return, because students explore and learn more in the context of the marsh, and can observe how it has changed over time.

A challenge that Participant 18 shared was getting past advocacy and toward building real solutions. Participant 18 expressed that there was a lack of understanding of feasible solutions to environmental conservation issues in the program, and was looking to form connections to both engineers and policymakers working on environmental protection that could share success stories about environmental protection, and discuss different solutions in more detail. Participant 18 also expressed how when climate and environmental protection solutions beyond advocacy are discussed, they are still very abstract to the children in the

program - typically just spoken about verbally or with photos. Creating models or activities with different kinds of solutions could make their effects more concrete. Such activities could include chemistry experiments. With a lack of connections to people working on environmental protection in the area, it is difficult to create action-oriented activities to teach solutions.

## 8.4 Case Study Learnings

Our two case studies present two different scales at which the framework is applicable: one, at the individual level between a grandmother and her grandson, and one at the program level, used as the foundation for several groupings of activities across different age ranges. Despite the class size and time scale differences between these two sets of curricula and activities, they both shared a structure that mirrored our framework. These two examples were implemented independently of our framework, but the methods used to create the curricula for each example were not formalized. Through the use of our structured framework, educators can easily create lessons tailored for their specific environments and students. For example, after walking her through the framework, Participant 24 shared how she had tried many different things when creating the Red Oak activities and landed on something that was effective. The framework clarifies the path she created, and would have made it easy for her to develop activities if she were to do it again. More of her feedback is shared in Section 9.

**It makes me feel like somehow somewhere along the lines I am following what you are trying to do, but without a developed path. I'm trying all these roads, and you provide a well-designed and easy to follow path.** (Participant 24, grandparent, climate action educator)

The Salt Marsh Science example highlights a different setting that the framework was used in, with each track in their program matching each design element of the framework. Like the Red Oak case, the method for designing these tracks was not formalized, although the program matched what its educators wanted to teach at different stages, and how they chose to engage with their students.

Overall, the case studies show how the Sustainability Communication Framework is specific enough to guide communicators through creating effective curricula, while also broad enough to be adaptable to different sizes and scales of curricula.

### Starting Younger Is Better

The Red Oak and Salt Marsh Scientist curricula would not have been as meaningful without the participating children developing a connection to the subject of each lesson first. By instilling care for the Red Oak, and care for the salt marshes early on, both sets of learners were

more willing to invest in learning about the ecosystem, and acting upon it later. What Participant 18 observed was that it older students experiencing the program for the first time were not as engaged as those who had grown up with the program:

**That sense of wonder is not there as much, it has to be drawn out...once they become 16 or 17, it is harder. They don't seem as bought in, whereas the other kids [who grew up with the program] are just compelled by it even when they are teenagers.** (Participant 18, environmental educator, conservationist)

The 6-9 age range of the Salt Marsh Explorers program plays a crucial role in getting students excited and engaged in the activities, and getting them to care about the environment they will be learning in. Building a connection with nature appears to be most effective at this age range, because they have a heightened “sense of wonder” when exposed to new experiences. This connects to why the 6-10 age range is important developmentally, since it is when children are forming their mental model of the world, discussed in Section 3.4. By building values for nature and sustainable living in this age range, young people's worldview can more readily be influenced.

This finding also highlights why it is so important to fill the “education gap” of climate change and sustainability in the elementary school age range, which our secondary research and solutions research exposed in Sections 3.3.1 and 5.2. The 6-10 age range is a key leverage point for climate change and sustainability education that is currently underutilized.

Building environmental values at an older age is possible, but more difficult. The process needs to be more drawn out and intentional. However, Participant 18 did emphasize that the way they can get engaged and excited is via their peers: “Kids help other kids see the way.” (Participant 18, environmental educator, conservationist)

### **Tangibility Affects Engagement**

In addition to age range playing a factor in level of engagement, the level of tangibility also affects young people's interest in the subjects. Creating activities that are tangible in the “ways to think” element of the framework is critical to retain learner engagement. For example, Participant 18 shared how it was difficult to get young people excited about plankton, but important for their learning about the ecosystem:

**There are these certain species that are harder to get people to care about b/c they are not as immediately engaging. Like plankton is hard to get them excited about. They do like looking under the microscope, but they struggle with even using a microscope. It's not something you can touch. It's not the same. Plankton are not charismatic. But it's still**

**important that we do it because we have to teach them to stretch themselves. It requires more imagination on behalf of the educators to make those things interesting and relatable.** (Participant 18, environmental educator, conservationist)

This reinforces what was observed in the Red Oak Case Study and in the Energy Workshop. For “intangible” ideas such as keystone species or power generation, activities that include constructionism as a tangible substitute for an intangible concept can help young people build a stronger mental model of the subject material. The keystone bridge activity and the energy solutions activity both allowed learners to create physical things, and think through the broader problem through the lens of the activity. In the energy solutions workshop, after building their models, students continued to critique their models and iterate on them. The tangibility of the activity probed deeper understanding for and appreciation of the systems they were exploring.

Lack of tangibility was a failure mode of the Materials Workshop for specific materials. Students had prior knowledge on materials such as glass, paper, and rubber, making it easier for them to map out how these materials were made. The student group working on plastic in particular observed how many things in their surroundings were made of plastic, but did not have any idea how it was made, and could not complete the workshop activity as a result. Unlike other materials that have a more clear-cut manufacturing process, plastic being made from oil and natural gas was unclear to students even after it was explained to them. Like how plankton is a harder species for students to connect with according to Participant 18, plastic is a more challenging material for students to understand. To make it more tangible, more work will need to be done presenting plastic manufacturing to young people in a clear and age-appropriate way.

### **Pretend vs. Real Actions**

The workshops we ran and the case studies we identified explore a range of different kinds of actions that were key parts of some activities. Some, such as planting acorns in the Red Oak case, were small actions with a real, eventual impact. Others, such as writing to the state legislature to pass a bill protecting horseshoe crabs, were done together as a group. And some, such as the futurecasting activity for the Salt Marsh, or the energy workshop building activity, involved imagining scenarios and actions in a future world.

The value of the “pretend” actions, that involve futurecasting, or acting as a specific stakeholder, is that students can put themselves in alternate personas or scenarios to think about an environmental issue. These playful experiences can involve a lot of creativity and collaboration, and leverage constructionist learning pedagogies. The consequence of “pretend” actions is that they may not feel meaningful to young people because they aren't

real. They may be informative to students' knowledge and perspectives, like how the Energy Workshop informed young people about different energy types and the considerations of different energy solutions. However, students may not feel like they can connect these actions back to things they can do today.

At the same time, taking “real” actions emphasize that young people can make a difference on issues of climate change and sustainability. This is important because in taking repeated, real actions to create a more sustainable future, young people learn that not only can they create change themselves, but they also can end up building action-oriented habits and mindsets when they see opportunities for change in the real world. Planting an acorn, for example, is a very small action that a young person can take, but the learnings and habits that the action fosters has a big impact on the young person's mindset.

However, real-world actions do have limitations in that they need to be age-appropriate and achievable over the course of the curriculum, so scoping is important. For example, one of the drawbacks of the Salt Marsh Scientists program is that since the program is only one week long, there is only so much the students can achieve with the knowledge, time, and resources they have. As a result, most of the actions they take are advocacy-focused. While being an advocate for the environment is still very important, and helps raise awareness in the students' communities, the Salt Marsh Science Program does not currently focus on what they can do beyond advocacy to support the Salt Marsh habitat.

**It is hard to get to meaningful action, but advocacy is a start.** (Participant 18, environmental educator, conservationist)

### **Handling of Negativity**

Another theme present in the workshops we ran and the case studies we identified was how negative or somber topics are discussed. In the case of the Materials Workshop, students effectively made the connection between deforestation, carbon sequestration, and resource extraction for paper, exclaiming “it's impossible!” upon making the realization. In the Salt Marsh Science program, Participant 18 shared a story of how a marine scientist spoke bleakly about the effect of human activity on marine mammals, causing a very somber attitude in the class. These moments are very impactful when teaching young people about environmental issues, because they can convey environmental degradation and climate change in a visceral way. Our existing solutions research in Section 5.7.1 suggests that it is important to be honest about what is happening during these moments, but they should be supported by some discussion of individual actions and larger-scale solutions immediately afterward. This will help young people feel like change is possible, is already happening in some places, and is something they can take part in.

## **Connections Across Environments**

At various points across different workshops and case studies, students leveraged prior knowledge and experiences to understand and engage with the content being taught. For example, in the Energy Workshop, students whose parents had installed solar panels on their rooftop were eager to discuss how solar power worked. In the Materials Workshop, students who had recently read a book on glassblowing were able to use some of what they learned to inform where glass came from. Connected to the Red Oak case study, Participant 24's grandson read "The Giving Tree" in school and connected lessons from the book to the acorn he had planted himself. Creating opportunities for young people to connect what they are being taught to previous experiences they may have had can build stronger connections to the content. Doing so makes the content more interesting for students, because it validates the relevance of their own lived experiences or prior knowledge. This helps young people feel like they have enough knowledge to be active participants in the conversation, and as a result it boosts their confidence.

## **Collaboration**

In the workshops and case studies in which groups of students were working together, they were able to build off of each others' ideas and collaborate on the projects they were working on. For example, in the Materials Workshop, different students brought different pieces of knowledge to the table when working in groups, which helped them piece together different material flows more quickly. In the energy workshop, since students were building energy solutions together, they each initially had different ideas, but had to converge as they started designing and building their structures. During the process, some students assigned different parts of their energy solutions for each groupmate to build, some students created prototypes individually, and then discussed how to merge them. Others worked together to build a cohesive structure, brainstorming as they found components and discussed where to put them. Although the modes of teamwork were all different, working together reinforced how designing sustainability solutions can be a collaborative process, and everyone's ideas can contribute. As investigated in our secondary research in Section 3.5, actions and discourse at the community level help normalize conversations around sustainability, and this extends to smaller team projects as well. Collaborating in groups on sustainability-oriented projects reinforces the idea that everyone is on the same team, working toward a common goal.



## 9

## Initial Feedback from Educators

We presented the latest version of the framework to three educators (Participants 24, 25, 26) and two experts (Participants 27, 19) to receive initial feedback and to understand what aspects do or do not resonate with them or are unclear.

### 9.1 Positive Feedback

#### A Lack of Resources is a Real Problem

Firstly, participants validated that we are addressing a real problem. They expressed the urgency and necessity of an approachable climate and sustainability communication resource.

**First of all, this is a topic that is very close to my heart, I feel like now, the conversation about climate change is inevitable. It's at the forefront, it is very apparent the crisis we are in. One of my values as an educator is to bridge for my students what is happening in the world and how we are all connected.** (Participant 26 , 3rd grade teacher)

**Climate education space is a complete mess and how do we undo it?** (Participant 29, climate communicator)

#### The Framework Resonates with Educators and is Validating

The framework resonated with them, and for some, is validating because they realize that they have already been applying parts of the framework. The framework provides structure to the way they approach sustainability education, helping them understand why certain techniques work, and giving them the ability to reproduce activities that are effective.

**It's systematic - a picture came into my head...Overall it not only makes sense, it makes me feel like somehow somewhere along the lines I am following what you are trying to do, but without a developed path. I'm trying all these roads, and you provide a well-designed and easy to follow path.** (Participant 24, grandparent, climate action educator)

**I feel validated because I feel in some ways that is what I have been trying to do but not knowing I was doing it... That's what I was trying to do, but didn't know where I was heading, and how to figure out if I was being effective or not. My only measure for**

**effectiveness was that they kept wanting to know more. I feel very excited by this.**

(Participant 24, grandparent, climate action educator)

### **The Framework is Approachable and Applicable**

Participant 27, a climate communicator, stated that the open-endedness of the framework makes the framework approachable and applicable to a wide range of communicators, including those who “haven’t had even just the first conversation.” Furthermore, Participant 29, a climate communicator, said that the framework is unlike a lesson plan which “needs to be custom to the community,” and that its open-endedness and “multi-layered aspect” allows communicators and children to draw meaningful connections themselves.

**It’s not cumbersome, it’s not a huge lift. It’s just a conversation. We recognize teachers probably haven’t had even just the first conversation.** (Participant 27, climate communicator)

**I like the multi-layered aspect. Just like there is no one answer for climate change and sustainability, there is no one answer for teaching sustainability. Having a framework to see where I am placing myself in this makes a lot of sense to educators and to parents.** (Participant 29, climate communicator)

**Climate change and other environmental issues affect all aspects of human life. There isn’t something that you can’t make a climate change connection to. If what you’re interested in is on the planet, you can find a connection.** (Participant 29, climate communicator)

### **Systems Thinking is a Valuable Component of the Framework**

A few participants, including Participant 25, a 1st grade teacher, mentioned that systems thinking is new to them when thinking about sustainability, highlighting that they view systems thinking as a compelling way to help children form personalized connections with their surroundings.

**The more you went through it the more I realized the systems thinking is a really integral part of it. It made me realize that the more we can talk about connectivity between things, that is where you can tie in a lot of different reasons for caring. If everything is connected, it is easy to tie in a way to care. It makes it a lot more interesting. Kids can be like “Wow these things are connected! Things are bigger than I realized!”** (Participant 25, 1st grade teacher)

## 9.2 Constructive Feedback

### The Framework Might Foster a False Sense of Optimism

Meanwhile, participants raised concern regarding the possibility of the framework encouraging communicators to be too positive and glossing over the problem. Participant 29, a climate communicator, stated that communicators should strive to “find the balance between urgency and terror.”

**It's all so real, we have to keep it real... I know why you chose positive, because it is a hard and sentimental topic to engage with. But also children need to know the truth...**  
(Participant 26, 3rd grade teacher)

**How do you both have them understand it and not make them feel like they have to fix it... This is a problem, and there are people doing really good work. There are solutions. In your community, what are you seeing that is good? Acknowledge that this is a problem and it's important to fix, but it is not your responsibility to fix it solely.** (Participant 29, climate communicator)

### Pathway to Implementation is Unclear

Additionally, it was still unclear to some participants how they would specifically implement the framework in the classroom and beyond.

**How much do I make it its own thing I'm teaching versus embedding it in other things. Making kids realize it is important and we're talking about climate and that's what we're talking about, versus weaving it into other things. I don't know the balance between those. I think a lot of teachers struggle with that. I want to give it the attention it deserves, but I also don't know if I can always make it the center of attention.** (Participant 25, 1st grade teacher)

**How do we take this learning outside of the classroom? How does it live outside of it?**  
(Participant 26, 3rd grade teacher)

### The Framework Could Be Made More Practical

At the same time, some participants still had doubts regarding the practicality of the framework in a classroom setting. They share the sentiment that it will take a lot of activation energy for teachers to integrate the framework into the classroom given their current resources. Yet, Participant 27, a climate communicator, asserted that the framework will be a perfect resource for teachers who are already on board.

**Just thinking about the practicality of doing these types of things - in one of those sessions, teachers are so limited on time that I think it is super tricky to plan anything, and to find time in the school day to give it the time that it deserves. To not make it seem like we're just throwing something in because you should.** (Participant 25, 1st grade teacher)

**Where does it go after the thesis? I think it can be really helpful. That activation energy of getting a teacher who wants to be doing this - that would be such a key change.**

(Participant 29, climate communicator)

**When teachers are ready to go, this will be a perfect resource for them.** (Participant 27, climate communicator)

# 10

## Conclusion

We started off with secondary research, as detailed in Section 3, in order to better understand our problem space. We looked at the causes of climate anxiety in young children and factors that support and hinder the development of climate change and sustainability education. Additionally, we visited existing research on how climate change and sustainability could be taught effectively.

As mentioned in Section 4, numerous barriers to communication and action creates a Spiral of Silence surrounding sustainability, preventing climate and sustainability from becoming topics discussed in everyday conversations. The barriers exist systemically and across scales, stemming from political and industrial bodies, and locally within communities.

In Section 5, we dove into the state of climate change and sustainability education today at the national, state, community, and individual levels. We learned that there lacks an infrastructure to educate both adults and kids about climate change and sustainability. Specifically, existing infrastructure makes it difficult for children to learn about sustainability in a holistic manner, to engage with sustainability in a meaningful, tangible, and actionable way.

As discussed in Section 6, we have set out to explore the following research questions:

***How might we make sustainability meaningful,  
tangible, and actionable for children?***

***How might we provide adults with an approachable, applicable, and  
empowering resource for educating children about sustainability?***

Our framework serves as a solution that directly addresses these questions. The systemic nature of the Spiral of Silence requires engaging a range of stakeholders. We focused on barriers existing within communities, as shown in the Spiral of Silence in Figure 4a. By facilitating conversations between communicators and children at multiple scales and in various settings, we can help normalize sustainability and contribute towards breaking the Spiral of Silence.

Firstly, the framework makes sustainability meaningful, tangible, and actionable for children. The Design Elements (Why to Care, Ways to Think, What Can Be Done) guide communicators towards building a holistic learning experience for children, integrating all three critical components.

- **Meaningful:** By invoking children's innate curiosity, providing exposure to new environments, and facilitating them in forming connections with the natural world and other living things, communicators can help children understand why to care about sustainability.
- **Tangible:** By providing opportunities for children to engage in systems thinking, non-dichotomous thinking, and empathetic thinking, communicators can equip children with ways to think about sustainability.
- **Actionable:** By inspiring, enabling, and empowering children to take action, communicators can help children understand what can be done about sustainability.

Secondly, the framework serves as an approachable, applicable, and empowering resource for educating young people about sustainability. It provides communicators with a structured way to craft meaningful experiences for children.

- **Approachable:** The framework, concurrently detailed and open-ended, makes it approachable for adults, educators and parents, experts and amateurs, alike.
- **Applicable:** The open-endedness of the framework allows it to be applicable for adults and children across settings and demographics.
- **Empowering:** The framework helps communicators realize how and why certain techniques they currently utilize are effective towards communicating sustainability, allowing them to not only reproduce results but also continue experimenting.

Analysis of case studies (Section 8) and initial feedback (Section 9) indicate that our framework has potential towards normalizing climate change and sustainability conversations. The Red Oak and Salt Marsh Science case studies (as detailed in Sections 8.2 and 8.3, respectively) demonstrate how the framework is concrete enough to provide structure for communicators to build curricula with, and adaptable enough to accommodate different sizes, scales, and styles of communication and education. Our case study analysis showed that communicators can leverage the framework as a formalized tool to help them build effectively structured climate change and sustainability curricula. Meanwhile, the Sustainability Workshop validated that the "Systems Thinking" design element is viable for young children this age, while also piloting the integration of various design principles in the classroom. Last but not least, initial feedback from educators and experts provides us with both validation and constructive feedback, allowing us to embark on our own iterative process to improve the framework.

By helping communicators make sustainability education accessible to children, we hope to create long-term impact by changing the way that children view and interact with the world and nurturing them into critical thinkers and active changemakers.

# 11

## Discussion

### 11.1 Innovation & Significance

Existing solutions to date have been primarily specific and piecemeal: they do not support communicators in fostering connections between why to care, ways to think, and what can be done about climate change and sustainability when they teach young people. The Sustainability Communication Framework synthesizes these three elements into a formalized process for teaching young people about climate change and sustainability. As a result, it makes the topic of sustainability more meaningful, tangible, and actionable for young people. Furthermore, the framework is designed to be an approachable, adaptable, and empowering resource for communicators, making it easier to create effective curricula and activities. It is concrete enough for communicators to leverage when building out lessons, yet flexible enough to be applied to many different topics, contexts, and formats of climate change and sustainability learning.

### 11.2 Intended Impact

Our work will help prepare young people to develop the skills and mindsets necessary to take action in a future heavily affected by climate change. While the scale and complexity of the climate crisis is immense, to effectively mitigate environmental impact, we need to address the problem from two lenses: with technology and with collective behavior shifts. New technological innovations will create sustainable alternatives to environmentally damaging activities, and a collective behavior shift will help reduce footprint by changing the ways we act.

In order to reduce our global environmental impact to less than 1.5°C above pre-industrial levels by 2050, both approaches are necessary to limit further climate change and build communities resilient to its effects. However, these shifts are not possible without proper education and communication. Especially for young people, who will grow up experiencing greater effects of climate change than previous generations, learning how to value, think, and act in an environmentally responsible way is critical.

This shift in collective thinking and action is possible, and it starts with young people. Our framework redefines the way that environmentalism and sustainability can be taught in order to make it more meaningful, tangible, and actionable within the context of young people's lives. Through our research, we have found that environmental issues can and should be taught



earlier in order to tap into children's wonder, curiosity, and enthusiasm for nature, and to leverage a key point in time at which we can best influence their habits, mindsets, and worldview. By connecting values, mindsets, and actions toward a sustainable future holistically, sustainability communicators can show young people that there is a way for them to make meaningful change.

Teaching climate change and sustainability effectively impacts more than just young people. Through effective education, young people can be agents of change by raising awareness of issues that will affect their communities and advocating for action. Young people can help shift the mindsets of the adults in their lives and show adults how they can take action too. Normalizing climate change conversations in families and in communities can create a broader cultural shift that celebrates taking action.

**Children at this age nudge parents' behaviors, not just on climate action, but just about everything.** (Lamba, 2022)

Reinventing environmental education is not only necessary, but also desired by parents and teachers. As shown by our existing solutions research in Section 5, there are plenty of solutions out there that address parts of the problem, and policies are starting to be introduced to standardize climate change and sustainability education. Yet many of these solutions are fragmented, overly specific, and disconnected from one another. The Sustainability Communication Framework emphasizes equal importance of its three design elements, and helps communicators connect the three in their curricula. By expanding our framework and collaborating with climate education groups around the country, we can show communicators how to leverage our framework as a starting point for teaching about sustainability.

## 11.3 Challenges in Framework Development

While we designed our framework to be broadly applicable to different educational settings, we acknowledge that there are gaps in the extent to which the framework can be implemented. These gaps arise from differences in setting and culture, some of which we were not able to test given the participants we had access to.

### 11.3.1 Climate Change Education Inequity

A prescient issue to our framework is the inequity in climate change education. Communities with lower social capital experience education underfunding, have limited access to green spaces, and have higher environmental vulnerability. Communities with more wealth and privilege tend to have better funded schools, meaning that their educators are more likely to have the time, money, and flexibility to create and launch new curriculum. It is important that our framework can be applied equitably within different communities. Doing so will require

additional support for education programs with minimal resources to make curriculum changes on their own.

This is especially important because underserved communities are at higher risk to the effects of climate change. They have not received investment in green spaces or resilience solutions in the ways that communities with higher social and monetary capital have. This means that it is harder for young people in these communities to access safe, natural outdoor environments. Additionally, they experience more extreme local effects of climate change, including air pollution, urban heat islands, and poor water quality. Accordingly, it is important to create educational initiatives within these communities to advocate for change, and also to integrate topics such as environmental justice into climate change education more broadly so that other students can learn about and act on these inequities. (Islam & Winkel, 2017, 1-3)

### **11.3.2 Participant Selection Bias**

Our sourcing methods were selected for parents, educators, and communicators who are already aware of the challenges in speaking with young people about climate change, and often the people who reached out included those currently looking for solutions. This meant that we did not get the perspective of parents or educators who did not care for climate change or sustainability communication. Although this limited potential learnings in our primary research, our secondary research provides evidence that most teachers are in support of climate education, and that educating children about climate change can influence their parents' perspectives. While they would not be interested in our work, their children may change their viewpoints - so they are considered indirect stakeholders of climate change education. It may be useful to expand on research exploring how parents' opinions on climate change evolve as their children receive more environmental education.

### **11.3.3 Infrastructure, Policy & Cultural Hurdles**

Lastly, infrastructure and policy may limit the extent to which action can be taken depending on where young people are living and learning. In some situations, they may face much larger hurdles in making change as a result. For example, let's say a young person learns that walking, biking, or public transportation has a lower environmental impact than driving, and wants to take action. In a well-populated area with sidewalks, safe bike paths, and accessible public transportation, not driving is an easy action to take, and to convince others to take. However, in a rural area with minimal infrastructure for pedestrians or bikes, taking the same action is more difficult and also potentially unsafe. The hurdle that needs to be overcome is far greater, because it requires infrastructure and societal changes. Participant 16, for example, explained how Paris is a city that is well-designed for pedestrians, while cities in the US are largely

designed around the assumption that everybody owns a car. Since their family moved from France, they noticed how the infrastructure and culture has an effect on their behaviors:

**In terms of [our daughter's] relationship with walking for example, she doesn't like to walk. But if we were living in Paris or Marseille, we would be walking everywhere.**

(Participant 16, parent)

Hence, it is important for our framework to be flexible to different contexts: one lesson plan or set of activities cannot be applied across the board to every school or community. At the same time, it is important to acknowledge that actions and change can be easier to execute in some places than in others, so finding ways that young people can do something actionable may be more challenging. This can be affected by the infrastructure, policies, or culture that a learning environment exists within.

## 11.4 Next Steps

### 11.4.1 Further Framework Development for Educators

While we have received positive feedback from stakeholders on the framework, it needs more development in order to be used as a practical tool for creating climate change and sustainability lessons. One of the major pieces of feedback that we received from educators highlighted how it was important to make it as quick and easy as possible for educators to adopt and implement. While the framework helps put different activities and curriculum elements into a broader context, it does not currently help sustainability communicators create specific activities easily: the responsibility of designing and executing upon a creative, well-delivered activity still rests on the educator. Since many educators, especially in traditional classroom settings, are often strapped for resources and time, being able to quickly create effective lesson plans and activities can be an additional burden, especially if it is brand new and untested. Additional development on the framework can help resolve this issue in multiple ways:

1. **Additional specificity on the relationship between design principles and elements:** In some of our case study evaluations and discussions with stakeholders, we found that certain design principles were more suited for specific framework elements, while others were not as relevant. Being more specific as to which principles are the most effective for different elements of the framework, and for different subject matters, can help guide teachers to create the best activities for what they plan to teach.
2. **Develop tools for topic & activity brainstorming:** Brainstorming specific topics or activities to run can be challenging and time-consuming for already overburdened educators.

Creating tools to help educators with topic and activity generation is another way that this framework could be expanded upon to help teachers develop content quickly. This could include specific prompts to facilitate brainstorming and get educators to think about issues relevant to their community, types of activities that work well for different framework elements, or a list of topics and how they could be adapted by teachers.

3. **Provide resources that educators can base their lesson plans on:** Although our framework resonated with the educators we spoke with, some expressed that it may be challenging for some to take the first step toward creating their own lesson plans with different education pedagogies than they are used to. While tested and validated lesson plans will be easiest for educators to pick up, teaching climate change and sustainability in the context of the local neighborhood or community is more effective in making the curricula meaningful for students. Since what works in one educational setting may not work in another, providing lesson plans that educators can use as is, along with ways they can be adapted and improved for different settings, can help teachers feel more comfortable getting started with climate change and sustainability education. To some extent this already exists in some places, but many activities are non-centralized or disconnected between the three design elements of the framework. An effective resource library may recommend pairing different pre-existing activities or resources together to help educators form a broader curriculum on a given topic.

After more development on the framework with these three improvements in mind, we can build out a “Sustainability Curriculum Development Playbook” that serves as a resource for sustainability communicators to design and deliver effective curriculum that teaches young people about climate change and sustainability. In order to evaluate the success of the framework and a playbook, we can measure how long it takes for sustainability communicators to design sustainability-focused curricula, and how confident they feel in teaching the curriculum. This will provide us with measurable metrics and confidence levels to strive for as we continue to iterate on the framework.

### 11.4.2 Further Framework Development for Parents

We have not yet validated our framework with parents, although the high-level framework elements likely to still apply. During our initial user research, we have found that there is a big need and opportunity to provide resources for parents to facilitate conversations and activities in the home. The same framework can still apply from a high level, but the context in which it happens is less formalized and less structured than in a classroom setting. We hope to create an adaptation of the framework that can support parents specifically. This version of the framework likely has to span three “scales” of sustainability and climate change communication:

- **Scale 1 – Supporting parents in climate change conversations:** What can we offer to parents to help them feel more confident, comfortable, and empowered to discuss climate change with their children in-the-moment?
- **Scale 2 – Exposing young people to climate change and sustainability themes:** What experiences can parents facilitate for their children to help their family build an appreciation for and understanding of sustainability?
- **Scale 3 – Influencing growth & development through long-term interventions:** How can we help parents influence the development of their children in the long-term by developing and reinforcing sustainability-oriented habits and mindsets?

Since the context is different, what can be done to apply the framework may differ for a parent than for an educator. There is only so much that can be said in a short conversation between a parent and a child, while educators have a guaranteed block of time in which they can hold students' attention. What is potentially the biggest way to create change is at Scale 3 - to investigate how we can help parents build intentionality around sustainability-focused behavior development into their parenting styles. Addressing the issue at this scale will make it easier for parents to approach the first two scales. We can continue to iterate on our framework for the home context to address these needs at different scales.

## 11.5 Adoption & Scalability

In order for our framework to be adopted, it needs to be sufficiently high-level and easy to interpret for sustainability communicators in any format, and needs to be broadly distributed by credible sources. We have shown that the structure our framework provides can be applied in different settings and scales. It is concrete enough for sustainability communicators to create curriculum with, but flexible enough for them to apply it to a broad variety of climate change and sustainability topics relevant contextualized to their specific education settings.

As explored in Section 5, there are many different resources and initiatives focused on climate change and sustainability education, but many of them are highly specific to what should be taught, without much structure on how it can be taught effectively, or how activities can connect at broad scales to enable young people to think and live sustainably. These tactics are all still applicable within our framework's three main elements, and can be made more meaningful, tangible, and actionable by connecting them to activities in different elements, within the same topic. Our framework does not compete with these alternate approaches. Rather, it adds additional context and structure above them.

To broaden the reach of our framework, we have already started to engage with environmental education groups for framework feedback. By collaborating with groups such as

TAG and CATE, we can help integrate our framework into their climate education methodologies as they continue to build out curriculum. Additionally, we can access speaking opportunities in their educator networks at climate education conferences and meetups to continue to spread the word to sustainability communicators. This broad, top-down strategy can be used to start converging sustainability communication tactics around our framework.

At the same time as this “top-down” approach, we can engage with sustainability communicators interested in teaching young people about climate change and sustainability through a “bottom-up” approach. By creating a website and social media pages to promote our framework, we can build our voice and credibility in the environmental education and parenting space. This will help us reach parents, teachers, and other adults interested in the space and show them what they can do to teach the young people in their lives about climate change and sustainability.

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## Appendix A: Flyer for Participant Recruitment

Have trouble talking with your  
kids about sustainability?

MITidm

LOOKING FOR  
PARENTS, TEACHERS,  
CAREGIVERS OF  
CHILDREN AGED 6-12

We are a group of graduate students at MIT studying the challenges adults face when talking with young people about sustainability. Share your experiences with us via an informal 30-60 minute video call!

To participate, please contact:  
[acrase@mit.edu](mailto:acrase@mit.edu)



## Appendix B: Participants Interviewed

<b>Participant No.</b>	<b>Role</b>	<b>Date(s) Interviewed</b>
1	Urban Designer	09/22/22
2	Education Researcher	09/30/22
3	Climate Communications Researcher	09/30/22
4	Education Researcher	10/03/22
5	Environmental Justice Educator	10/07/22
6	Environmental Educator, Psychologist	10/10/22
7	Environmental Educator, Conservationist	10/17/22
8	Communications Expert	10/19/22
9	Science Educator	10/27/22
10	Parent, Environmental Advocate	11/02/22
11	Education Researcher	11/03/22
12	Education Researcher	11/09/22
13	Parent	11/23/22
14	Parent	12/04/22
15	Parent, Environmental Researcher	12/04/22
16	Parent	12/02/22
17	1st Grade Teacher	12/06/22
18	Environmental Educator, Conservationist	02/24/23
19	Parent, Psychologist	03/01/23
20	Parent, Environmental Advocate	03/03/23
21	Parent	03/13/23

<b>Participant No.</b>	<b>Role</b>	<b>Date(s) Interviewed</b>
22	Parent	03/14/23
23	Parent	03/14/23
24	Grandparent, Climate Action Educator	04/10/23
25	1st Grade Teacher (Special Education)	04/18/23
26	3rd Grade Teacher	04/20/23
27	Climate Communicator	04/27/23
28	Climate Communication Researcher	04/27/23
29	Climate Communicator	04/28/23

## Appendix C: Interview Guides

Our Parent and Educator interviews followed a semi-structured approach with a broad set of open-ended questions in Appendix C1 and C2, with some variation on what questions were asked depending on the length of the interview and how the interviewee was responding to prior questions. Our Climate Communication Experts interviews followed an unstructured approach, with guided conversations about their work initiated by a minimal set of questions in Appendix C3. Our interview process for soliciting feedback on the Sustainability Communications Framework was semi-structured and is described in Appendix C4.

### Appendix C1: Interview Questions for Parents

- How often do you have conversations about climate change or sustainability with your children?
- How does climate change and sustainability come up in your family? Where does it come up?
- What strategies have you found to be effective when talking with your children about climate change and sustainability?
- What strategies have you found to be ineffective when talking with your children about climate change and sustainability?
- What barriers do you encounter when trying to talk to your children about climate change and sustainability?
- How do you feel when you bring up climate change and environmental issues with your children?
- Where do you go to get information on how to speak with your children about climate change and sustainability?
- Do your children have a school curriculum about sustainability?
- What are your childrens' preconceived understanding or beliefs about climate change?
- What reactions or responses do your children typically have when climate change or sustainability does come up?
- Tell me about a time in which you've spoken with your children about climate change or sustainability.
  - What happened?
  - What did you feel?
  - How did your children feel?
  - How did your children respond?
  - What do you think went well during the conversation?
  - What do you think didn't go well during the conversation?

- What did you learn from this conversation?
- What do you wish you had to improve this conversation?
- Are there specific things you do to build values around sustainability, if that is something you want to build with them?
- Have you spoken with other parents about how they talk to their children about climate change or sustainability? How do they respond?
- What advice would you give to other parents wanting to teach their children about sustainability?
- Is there anything else that you would like to share?

## **Appendix C2: Interview Questions for Educators**

- How does climate change and sustainability relate to the work you do? Where does it come up?
- How do you integrate environmental issues into the lessons or activities you run?
- *For out-of-school educators:* What motivates families to sign their children up for this program? What keeps students coming back?
- What strategies have you found to be effective when teaching your students about climate change and sustainability?
- What strategies have you found to be ineffective when talking with your students about climate change and sustainability?
- What barriers do you encounter when trying to talk to your students about climate change and sustainability?
- What do your students enjoy about the lessons or activities? What makes them engaging?
- How do you feel when you bring up climate change and environmental issues with your students?
- What are your students' preconceived understanding or beliefs about climate change and conservation? Where do they get that from?
- What reactions or responses do your students typically have when climate change or sustainability is introduced in your lessons?
- How do you help students process negative emotions about climate change?
- What is your overall strategy for designing lessons about climate change or sustainability?
- What tools or resources do you currently use to create lessons about sustainability and climate change?
- What tools or resources do you wish you had that would help you create lessons?
- Tell me about a time in which you taught a lesson on climate change or sustainability.
  - What was the lesson about?

- How did you create the lesson?
- What resources did you use when creating the lesson?
- What did you feel?
- How did your students feel?
- How did your students respond?
- What do you think went well during the lesson?
- What do you think didn't go well during the lesson?
- What did you learn from this lesson?
- What do you wish you had to improve this lesson?
- Is there anything else that you would like to share?

### **Appendix C3: Questions for Climate Communication Experts**

Conversations with climate communication and education experts were unstructured with few pre-planned questions. We used these conversations to learn more about their work and how it pertained to our research, so the discussions varied widely depending upon the context of their work. Below are the pre-planned questions we used in these discussions.

- How does climate change and sustainability communication relate to the work you do?  
Where does it come up?
- What is important to communicate to children when it comes to climate change and sustainability?
- What strategies have you found to be effective when talking with children about climate change and sustainability?
- What strategies have you found to be ineffective when talking with your children about climate change and sustainability?
- What resources or research on climate change, sustainability, and communication would you recommend we read?

### **Appendix C4: Sustainability Framework Feedback Guide**

For soliciting feedback from stakeholders on the Sustainability Communication Framework, we presented a slide deck to each stakeholder and asked them questions about each aspect of the framework as follows:

1. Present an overview of our project, including:
  - a. Our main research questions
  - b. Initial primary and secondary research



- c. The Spiral of Silence
2. Present an overview of the Sustainability Communications Framework
3. For “Why to Care,” “Ways to Think,” “What can be Done,” and “Design Principles”:
  - a. Present a detailed summary of each design element and design principle
  - b. Pause to solicit feedback:
    - i. What aspects of this section resonate with you?
    - ii. What aspects of this do you have questions about?
4. Solicit overall feedback:
  - a. How do you see this framework being effective?
  - b. How do you see this framework being ineffective?
  - c. Where are the gaps in this framework? What should be elaborated upon?
5. Present Activity Examples from the Materials and Energy Workshops and show how they leveraged the Sustainability Communications Framework
6. Solicit implementation feedback:
  - a. How would you use this framework to design a new lesson or curriculum?
  - b. Walk us through the steps you would use during the design process.

## Appendix D: Framework Feedback Deck


Climate Change Conversations with Children:  
Making Sustainability Meaningful, Tangible, and Actionable



ALEX & BAM  
♥ MITtdm

Anna Engstrom, @aengstrom@mit.edu  
Alex O'Connell, @aconnell14

Climate Change is Top of Mind for Young People



16%	25%	59%
Not/Minimally worried	Moderately worried	Extremely worried

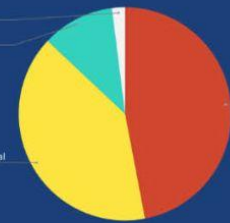
More than 45% of respondents said their feelings about climate change negatively affected their daily life, reporting feelings such as **sadness, anxiety, hopelessness, and fear of the future.**

Climate anxiety in children and young people and their beliefs about government responses to climate change: a national survey (2021)

95% of teachers want to integrate climate change and sustainability into their curriculum, but only **40% feel confident** in doing so.

MITESDD - Putting Every School Climate Ready (2021)

Environmental Issues are Absent from National Education Frameworks



Moderate	2.0%
Minimal	11.0%
Very Minimal	40.0%
No Focus	47.0%

MITESDD - Putting Every School Climate Ready (2021)

"All I know is I want to do something, because I care, **but I don't know what to do.**"

*Cambridge Public School Teacher*

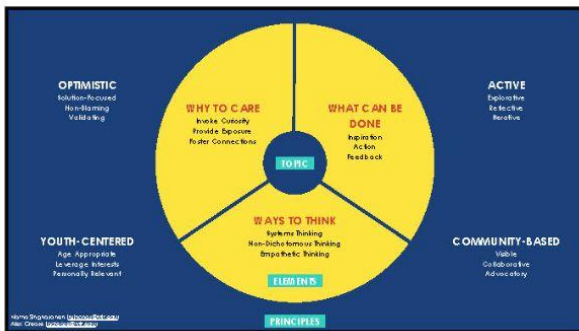
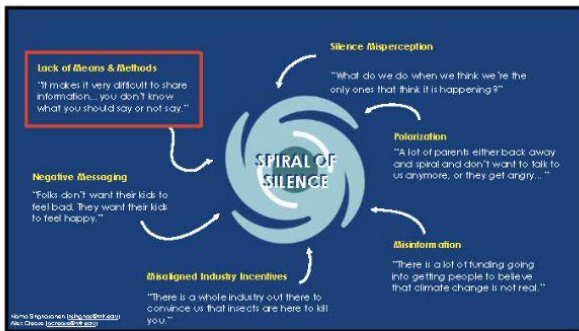
Anna Engstrom, @aengstrom@mit.edu  
Alex O'Connell, @aconnell14

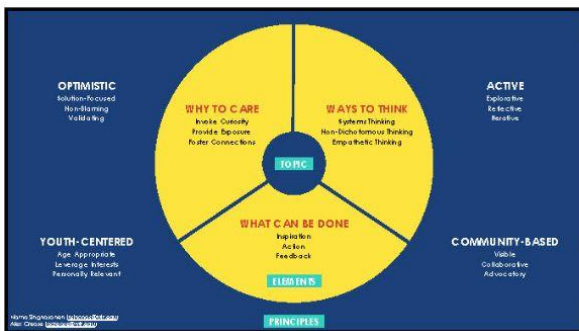
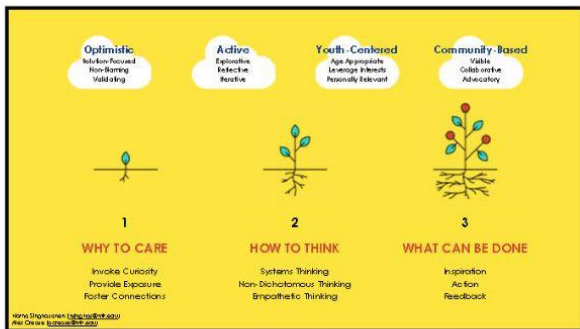
We've talked to...



8	Sustainability & Climate Experts
18	Educators
9	Parents
18	Children

Anna Engstrom, @aengstrom@mit.edu  
Alex O'Connell, @aconnell14





### Example: Workshop on Materials Systems

Engaging young people in conversations that involve thinking in systems.

Harjo Designcenter | harjo@rcat.edu | 408.254.6222



### OUR MISSION:

To normalize conversations around sustainability by making it meaningful, tangible, and actionable for young people.

Why to care	→	Meaningful
Ways to think	→	Tangible
What can be done	→	Actionable

Harjo Designcenter | harjo@rcat.edu | 408.254.6222

## Appendix E: Workshops Hosted

<b>Workshop Name</b>	<b>Location</b>	<b>Date Conducted</b>	<b>Content</b>	<b>Participants</b>
Materials Workshop	First Grade Classroom, Cambridge, MA	11/18/22	Discussion and activity about where different materials come from and where they go.	First graders and Classroom Teacher
Energy Workshop	First Grade Classroom, Cambridge, MA	12/01/22	Discussion and activity about renewable energy sources.	First graders and classroom teacher
Framework Feedback Workshop	MIT Climate & Sustainability Consortium (MSCS)	04/14/23	Presentation of the Sustainability Communication Framework and feedback discussion afterward.	Climate change and sustainability researchers

## Appendix F: Materials Workshop Assets


### Appendix F1: Materials Workshop Slides

Sustainable Thinking  
Workshop Day 1  
by Bam & Alex

We're going to be talking about  
where things come from  
and where things go.



What did you have for lunch today?




What happens when I plug a phone charger into the outlet?

Let's look at different materials.

Where is it used?  
How is it made?  
What happens when we don't want it anymore?



Let's look at COTTON



Where is it used?

Let's look at COTTON



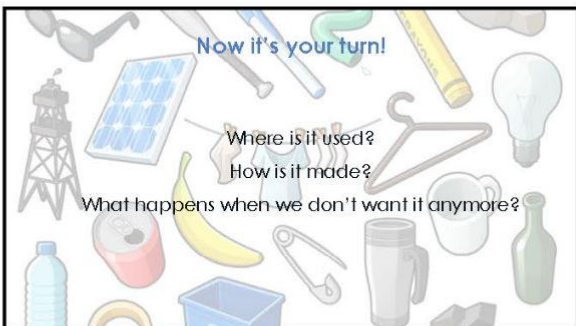
How is it made?

Let's look at COTTON



What happens when we don't want it anymore

Now it's your turn!



Where is it used?

How is it made?

What happens when we don't want it anymore?

What did you draw?



Let's look at a Paper Food Container



Let's look at a Glass Food Container

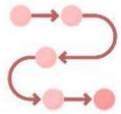




What are some differences between the two?



What did you learn today?



Let's keep talking about where things come from and where things go!




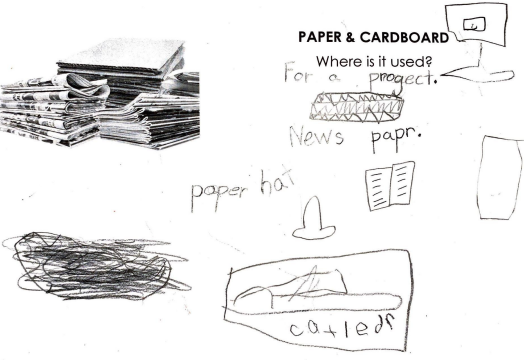


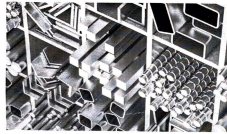
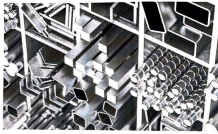
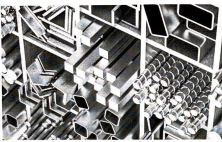


Clean Up Time!




## Appendix F2: Materials Workshop Activity

Worksheets for plastic, cardboard & paper, rubber, glass, and metal were distributed with "Where is it used?", "How is it made?", and "What do we do with it when we don't need it anymore?". Select worksheets are below.


 <p><b>PAPER &amp; CARDBOARD</b> How is it made?</p> 	 <p><b>PAPER &amp; CARDBOARD</b> Where is it used? For a project.</p> 
 <p><b>PAPER &amp; CARDBOARD</b> What happens when we don't want it anymore?</p> <p>I can Resikle</p> 	 <p><b>METAL</b> How is it made?</p> <p>Metal comes from the moon. metal is made from</p>
 <p><b>METAL</b> Where is it used?</p> <p>We see metal on out lines. METAL is used for the botum of a desk in scoot. pawchis have metal rings.</p>	 <p><b>METAL</b> What happens when we don't want it anymore?</p> <p>• used for something else.</p>

**GLASS**  
How is it made?



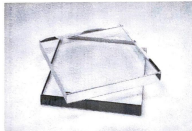
glass is made  
with sand.

**GLASS**  
Where is it used?




Glass containers  
Glass windows  
Sometimes doors  
Glass cups  
Glass clock  
Glass glasses  
Glass plates

**GLASS**  
What happens when we don't want it anymore?

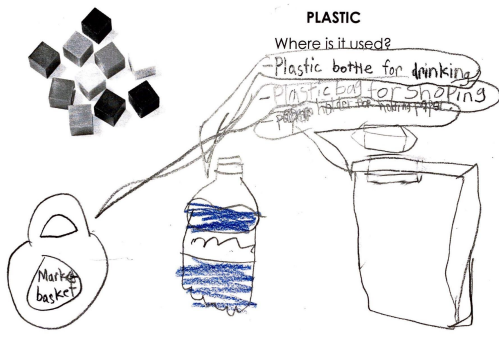


trash  
Sometimes recycle

**PLASTIC**  
How is it made?




**PLASTIC**  
Where is it used?



Plastic bottle for drinking  
Plastic bag for shopping

**PLASTIC**  
What happens when we don't want it anymore?



Recycle it by cutting a plastic bottle. Half and growing plants in it.

## Appendix G: Energy Workshop Assets

### Appendix G1: Energy Workshop Slides

Slides in gray were not presented, they were used as a reminder for class discussions.

Sustainable Thinking  
Workshop Day 2  
by Bam & Alex



Where does the school get power from?

What happens to solar panels when there's snow?



What are some other ways we get power?

Renewable vs. Non-Renewable?



Let's jump on a **TIME MACHINE** to **50 YEARS IN THE FUTURE**

We have used up all of the non-renewable energy resources. How should we power our homes? **Invent a way to power the city of Cambridge using only renewable energy resources!** You can draw or build and use whatever you want!

**You may want to think about:**

- What kind of renewable power will you build?
- Where should it be built?
- Why might it stop working? What will you do?

Reflection

What is the best part about your power plant?  
What was challenging about making your power plant?



**There are many ways  
we can create  
renewable power.**



**Clean Up Time!**

## Appendix G2: Energy Workshop Prompt



## Let's jump on a **TIME MACHINE** to **50 YEARS IN THE FUTURE**

We have used up all of the non-renewable energy resources. How should we power our homes? **Invent a way to power the city of Cambridge using only renewable energy resources! You can draw or build and use whatever you want!**

**You may want to think about:**

- What kind of renewable power will you build?
- Where should it be built?
- Why might it stop working? What will you do?

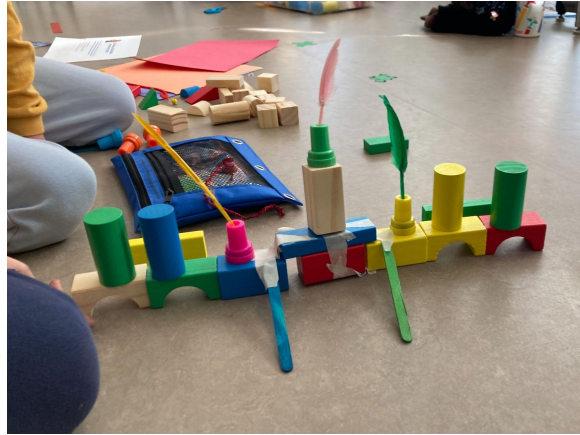


### Appendix G3: Energy Workshop Creations

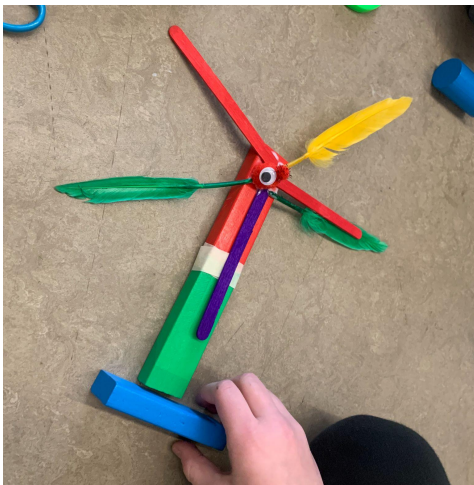
Hydroelectric Dam



Hydroelectric Dam



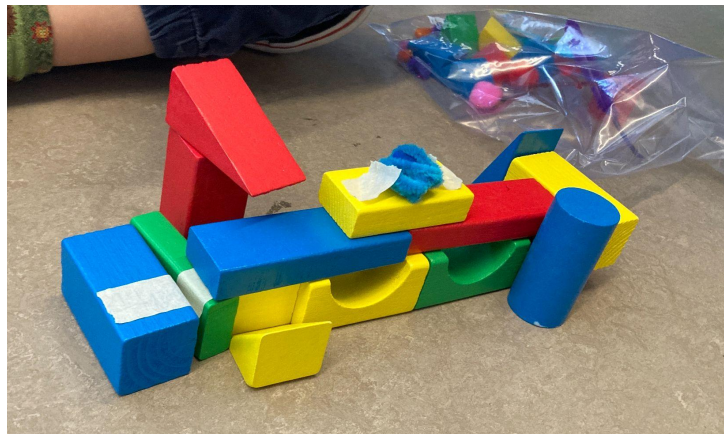
Wind Turbine



Solar Array



Hydroelectric Dam



## Appendix H: Framework Feedback Workshop Assets

### Applying the Framework: Design an Activity

Imagine you are designing a set of activities for a group of 6-7 year olds to teach a sustainability-focused topic. You can choose one of the prompts below, or create your own:

The role of trees in urban communities

Modes of transportation and their emissions

The wildlife ecosystem in a local forest

Resilience to extreme weather events

Where trash goes after you throw it out

Community water quality and how it affects us

How your community gets its energy

Other: \_\_\_\_\_

Leverage the framework to build your lesson plan, and work with your group to brainstorm what activities you will include and how you might structure them to teach your topic. Be prepared to share your work at the end of the session!

### Feedback (Post-Session)

How did you use the framework to build out your lesson plan?

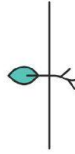
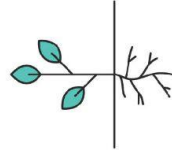
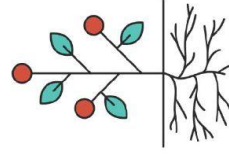
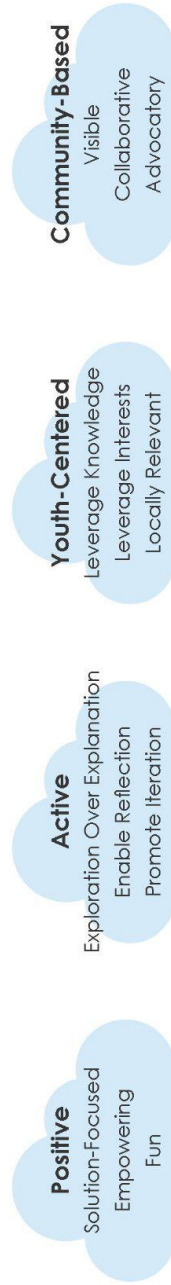
What aspects of the framework were the most helpful to you? Why?

What aspects of the framework were the least helpful? Why?

What would you add, remove, or modify to make the framework more helpful?

# Sustainability Communication Framework

Making sustainability meaningful, tangible, and actionable.



## WHY TO CARE

- Invoke Curiosity**  
Invoke a sense of wonder and encourage question-asking.
- Provide Exposure**  
Provide exposure to new and different natural environments and communities.
- Foster Connections**  
Foster personal connections to build appreciation and respect for others and the natural world.

## HOW TO THINK

- Systems Thinking**  
Help children connect cause to effect, understand equilibrium, and find leverage points for change.
- Non-Dichotomous Thinking**  
Challenge children with problems that are not black and white.
- Empathetic Thinking**  
Help children put themselves in the shoes of other living things to consider alternate perspectives.

## WHAT CAN BE DONE

- Inspiration**  
Show what peers and role models have done to illustrate what is possible.
- Action**  
Enable actions, big or small, to help them experience and practice making a difference.
- Feedback**  
Provide opportunities for children to see how their actions made a measurable difference, and what they can try next time based on their learnings.

Nattha (Bam) Singhasaneh (nsinghas@mit.edu), Alex Crease (acrease@mit.edu)