




CLIMATE CHANGE EDUCATION

EFFECTIVE PRACTICES FOR WORKING WITH EDUCATORS, SCIENTISTS, DECISION MAKERS AND THE PUBLIC

PRODUCED BY THE CLIMATE CHANGE EDUCATION PARTNERSHIP ALLIANCE

CONTENTS

Cover images, left to right, top to bottom

1. Educators present about common communication approaches referred to as "traps" because they tend to lead to unconstructive thinking and dialog.
2. Teachers in a MADE CLEAR Climate Change Academy record observations in a coastal ecosystem
3. Participants in the Signs of the Land: Reaching Arctic Communities Facing Climate Change Camp play a game of EcoChains: Arctic Crisis.
4. Mayor of Imperial Beach, Serge Dedina, interviewed for Climate Education Partners' new movie, "Coastal Flooding in Our Changing Climate"
5. Young learners in Chuuk explore their mangroves and their five senses using PCEP high and low island poster activities.
6. A student participates in a collaborative climate change and art project at an urban farm in Philadelphia.

THE VISION OF THE CCEP ALLIANCE IS TO DEVELOP:

- models for educating and empowering citizens to make informed decisions regarding the changing global climate
- powerful, proven educational approaches
- a collaborative community of climate and learning scientists and educational practitioners

PREFACE

Produced by the Climate Change Education Partnership (CCEP) Alliance, this guide provides recommendations for effective education and communication practices when working with different types of audiences. While effective education has been traditionally defined as the acquisition of knowledge, Alliance programs maintain a broader definition of "effective" to include the acquisition and use of climate change knowledge to inform decision-making. The CCEP Alliance is supported by the National Science Foundation (NSF) to advance exemplary climate change education through research and practice.

THE ALLIANCE IS A NETWORK of six large multi-institutional projects along with a coordinating Alliance Office. The projects are:

Climate Education Partners (CEP)-an interdisciplinary collaboration among professors, scientists, researchers, educators, communications professionals, and community leaders concerned about the impacts that changes in climate could have on the quality of life in the San Diego, CA region.

Climate and Urban Systems Partnership (CUSP)–a diverse local network of climate-focused organizations in four cities (New York, Philadelphia, Pittsburgh, and Washington, D.C.) that delivers collaborative community-based educational programming.

Maryland and Delaware Climate Change Education, Assessment, and Research (MADE-CLEAR)–a collaborative partnership of Delaware and Maryland institutions that develops and supports the capacity for its partners to deliver research-based climate change education in public schools, on college and university campuses, and in informal education settings.

National Network for Ocean and Climate Change Interpretation (NNOCCI)–a network of informal science education institutions across the U.S. building capacity among informal educators at aquariums, zoos, and science/nature centers to use research-based communication techniques, with the goal of shifting the public discourse on climate change to be more productive, creative, and solutions focused.

Pacific Islands Climate Change Education Partnership (PCEP)–a collaborative effort across U.S. affiliated Pacific island institutions to implement culturally responsive, effective K–14 educational programs and resources focused on the science of climate change and its impacts on Pacific island communities.

Polar Learning and Responding Climate Change Education Partnership (PoLAR)–an interdisciplinary collaboration that includes experts in polar climate science, formal and informal education, learning theory, game design, and climate change communication that develops interactive and game-like educational approaches focusing on the changing polar regions for lifelong learners.

CCEPA Stakeholders, Collaborators, and Audiences

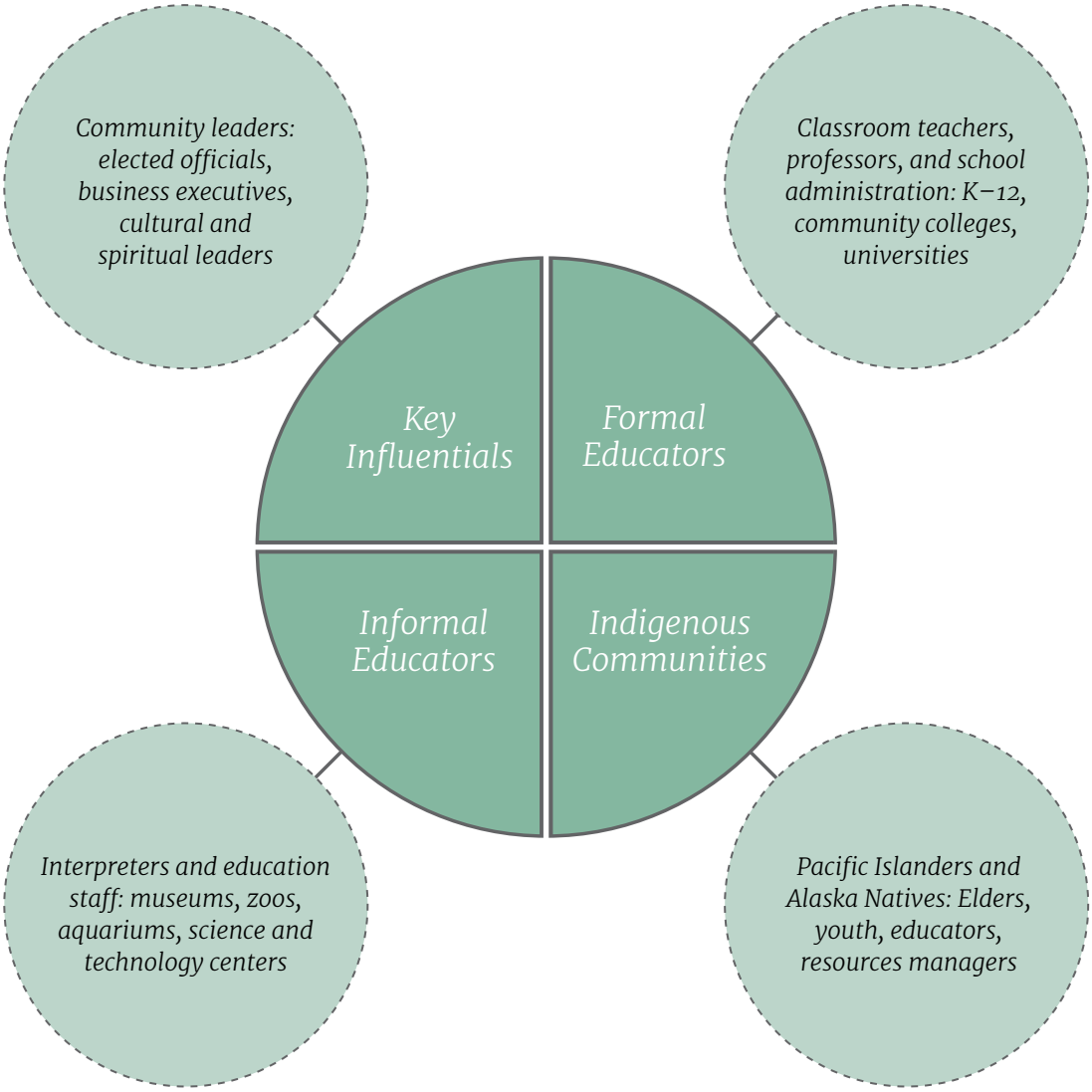


Figure 1: The Alliance recognizes that achieving its vision requires engaging a diverse range of communities. Together, its projects are using a variety of innovative strategies to reach key stakeholders, collaborators, and audiences. The Alliance has produced this climate change education guide with the hope that the lessons learned from its practices will be useful for other climate change education efforts seeking to provide education that results in informed decision-making and action.

At the core of all the Alliance projects is the recognition that educators have an opportunity to identify and tailor their education to their specific audience.

INTRODUCTION

Environmental educators have long held the belief that if education results in increased knowledge, then people will use that knowledge to make informed decisions that benefit society and the planet. Unfortunately, this "knowledge deficit theory" is not supported by substantial empirical evidence (Schultz, 2002). In addition, there is a growing body of evidence indicating that factual information coupled with social information regarding what other persons in a community or group are doing can be a powerful combination to influence people to use the information they acquire (Ardoin, N. et al., 2013).

In an effort to support innovative, multidisciplinary, educational approaches and deliver content in ways that result in informed decision-making, the National Science Foundation (NSF) funded six research-driven Climate Change Education Partnerships that included teams of climate scientists; learning/social scientists; educational practitioners working in very diverse settings, including the Pacific Islands, urban regions, and the North American Arctic; and state and national education networks. In addition, NSF funded an Alliance Office to foster collaborative interactions and activities among the projects. After five years of planning, implementing, testing, and revising CCEP programs, certain "key lessons" are emerging across the projects that may benefit other existing or developing climate education programs. This climate change education guide is being written to support education efforts for a variety of audiences.

At the core of all the Alliance projects is the recognition that educators have an opportunity to identify and tailor their education to their specific audience. Each population of learners has unique interests and motivations for learning about climate change. Thus, education methods and approaches that are effective for K-12 students may differ from approaches used for non-traditional audiences in aquariums or museums. The community members who come to an outdoor street fair may differ greatly in interests and motivation from key influential leaders who run businesses or city administrations. Likewise, learners bring with them a wide range of historical and cultural influences. This guide suggests some approaches to climate change education that have proven effective for specific audiences.

Finally, this guide seeks to provide a few tested models for the purpose of illustrating climate change education in different situations. Case studies of some of the various approaches to interdisciplinary climate education, using a plethora of modalities, including games, maps, tours, interactive models, video, place-based learning, and many other learning tools, will be described. In addition to the educational activity and resource modalities, this guide also describes how climate science content has been translated or deconstructed into more accessible components and what educational approaches the Alliance has found to be successful for specific audiences.

WORKING WITH KEY INFLUENTIALS

People in key influential positions across the country are making decisions that determine how communities address climate change. These key influential leaders depend on others working collectively with them to understand the causes and consequences of climate change in their region and to lessen its impacts. Working together with local scientists, educators, and a wide range of community leaders creates opportunities to not only learn from one another, but also to collectively find mitigation and adaptation solutions for challenges presented by impacts on a region's weather, natural resources, air/water quality and local economy. For example, each development plan, long-term lease, and construction project that key influentials consider connects with climate change.

"Our facility began implementing sustainable business practices more than 20 years ago, and we're proud to be an environmental leader in our industry. Our entire team is committed to minimizing waste, reducing energy and water use, composting food waste and purchasing environmentally sustainable products, which has earned our building a LEED Silver Certification. Every day is Earth Day at the San Diego Convention Center." –Carol Wallace, President and CEO, San Diego Convention Center Corporation

While key influentials comprise a diverse group of community leaders, elected officials, business executives, and spiritual leaders, they share some similar characteristics. They typically consist of people who have many responsibilities, little time, and a list of urgent matters to which they must attend. To begin working with these types of individuals and groups, it is useful to plan an initial meeting where one can share and learn about key influentials' needs, interests, values, and knowledge regarding climate change. In this first meeting, it is important to create the conditions for a collaborative input of information that will allow the key influentials to frame climate education in a way that enables them to meet their needs and together create an effective plan to support and enhance their current agenda. At first, many key influentials are less interested in the causes of climate change and more interested in learning what impacts they can expect in their local community, when the changes may occur, and what they can do about them. To be effective with this audience, information about climate change impacts and solutions needs to be embedded in the context of their concerns, which usually means providing information about conditions and impacts on a regional level

and if possible, even to the level of the community in which they are invested. The technique of linking climate change projections with extreme events can be effective; an example statement such as, "Droughts like this one are projected to become twice as frequent in 50 years" may quickly capture the interest of a key influential. In the case of healthcare officials, it is useful to provide maps of populations that may be vulnerable to a health threat predicted to increase due to climate change. Engaging key influentials in creating and owning informed statements that they can use effectively in their work is a powerful tool. Due to their limited time, keeping materials and contact opportunities concise, useful, and supportive of key influentials' agendas is always important.

"We are already taking steps to conserve and restore the lands along our rivers, streams and reservoirs, to protect our vital drinking water supplies that people, plants and animals all need. We must continue, as well as increase these efforts, not just for today, but for all future generations—after all, this is our legacy."

SCOTT PETERS, CONGRESSMAN, U.S. HOUSE OF REPRESENTATIVE, CA-52


Working with KIs
Translate scientific information carefully, in alignment with KI values
Provide access to concise, accurate, accessible information
Facilitate introductions to scientists
Share material targeted to their interests/audiences
Become a peer messenger (community)
Encourage networking with other KIs interested in climate issues
Provide PR opportunity where the decision-maker is recognized for leadership
Educate about what other leaders are doing that is helpful and builds community

Where to Start

Set up the first meeting through someone who is trusted by the key influential. If possible, have the contact person present at the meeting to introduce the climate change educator(s) and help facilitate the conversation. Let the key influential know that his or her peers are also interested in these issues. Focus much more on being a resource. Listen and respond to the person's questions and concerns, rather than sharing a lot of new factual information.

What to Try

Start with inviting key influentials to share their knowledge and experiences as they address climate change in their region. What climate change impacts do they already know about? This will help the educator(s) to assess the key influentials' prior knowledge. Other more specific questions about local impacts can also be asked. In addition, ask about their sense of efficacy—what they can do and what are they already doing to address these impacts? What are they concerned about—what issues matter to them? What type of information would be useful to them? What do they want their legacy to be for the next generation? What would they like to be able to do? One important service is to try to discover if there are misconceptions about climate change impacts or timing that can be countered with a diplomatic introduction of research-based information or information from other experts in the community important to them. However, in an initial meeting, "correcting" is highly discouraged. The first meeting is about learning about their needs, interests, and hopes and setting the stage for building relationships.

While providing the big picture on climate change impacts is important in establishing the reasons for a community leader to take action that will lead to climate change mitigation and/or adaptation, it is often best to determine a small step that the leader can take to empower them in this area. For example, the key influential could host a meeting for others, give a presentation to another community group, allow their image to be used in educational materials, or appear in a locally-themed video about climate change. The key is to identify whether the person (a) is willing to serve as a connector to other opportunities or a spokesperson, (b) prefers to act as an observer, or (c) seems indifferent. It is appropriate to follow up with those who wish to engage further and together create a community of informed persons who actively share and engage in decision-making related to community resiliency to and mitigation of climate change.

How to Follow-up

Contribute to key influentials seeing themselves as members of a larger group. Plan for a long-term relationship in which the involved scientists and educators are resources to the decision makers. Key influentials are often working to advance multiple issues and have to balance many priorities. Be alert to events in the community and create a shared e-space for ideas and information. Encourage opportunities for useful and relevant climate change information to be exchanged. The key components for engaging with key influentials are to be useful, collaborative, respectful of their time and agenda, and celebratory of their actions that improve the community's understanding, resilience, and mitigation of climate change. Publically highlighting what key influentials do is essential in helping them to educate the larger community about what can be done to address the challenges of a changing climate.

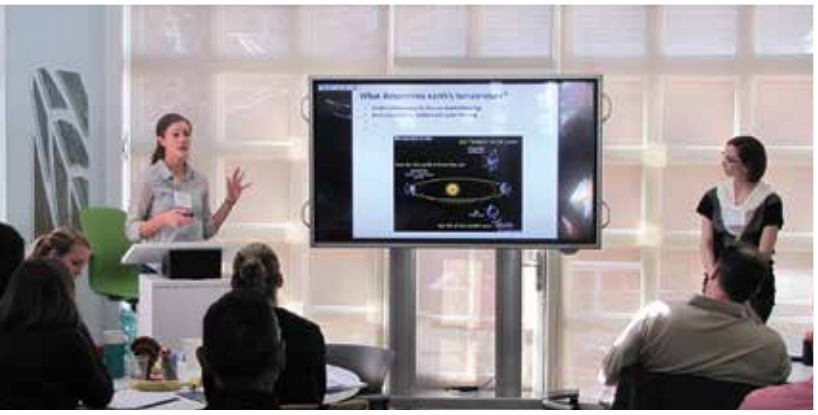
Project Highlights with Key Influentials

NNOCCI: Informal Science Education Institution CEOs

The National Network for Ocean and Climate Change Interpretation (NNOCCI) works primarily with educators, but considers Chief Executive Officers' (CEO) level support to be important to the success of their work. NNOCCI requested that the CEO of New England Aquarium, Dr. Nigella Hilgarth, try to get onto the agenda of a meeting of CEOs to succinctly translate project goals and indicators of progress. Dr. Hilgarth was pleased to seek that opportunity to share the work her staff have been involved in leading, and several other CEOs who have supported their own staff members' participation in NNOCCI activities recommended this topic be included on the agenda. As a peer messenger sharing positive indicators that the aquarium and science center industry is fostering useful change, her message was well received and led to additional institutions applying to participate in NNOCCI training programs.

PoLAR: Alaska Native Elders

Alaska Native Elders have knowledge that includes their long term observations and experience of living off the land: stories, lessons, and insights about the environment and adaptive living that have been handed down through many generations. They are role models for successful adaptation to environmental changes and meeting challenges of a subsistence lifestyle. Beyond sharing their knowledge, sense of humor, and spirituality, they inspire, motivate, and guide the younger generation and provide



hope and encouragement, especially during difficult times. The PoLAR Partnership works closely with Elders to help develop and implement climate change projects and programming that engage Alaska Native communities, including the Signs of the Land: Reaching Arctic Communities Facing Climate Change Camp and other engagement events. Based on analysis of pre/post surveys, event attendees have indicated that the participation of Elder advisors was valuable in helping them to understand, respond, and adapt to climate change.

CUSP: Local Stakeholders

The Climate and Urban Systems Partnership (CUSP) works with a variety of local stakeholders and decision-makers, from the Philadelphia Mayor's Office of Sustainability to service providers and community development corporations. Building relationships with these stakeholders is a long-term process. To achieve this, CUSP offers a wide array of flexible opportunities for stakeholders to learn about climate change impacts and each other's work. From professional development workshops and collaborative mini-grants to informal gatherings such as a Movie and Mixer, CUSP allows partners to come together and learn from each other how to engage residents in climate change issues more effectively. CUSP also maintains frequent communication through the use of a Google Group listserv to promote these and other opportunities occurring in the communities it serves.

Case Study

Education to Support Key Influential Informed Decision Making

Climate Education Partners is working to share science about the changing climate with key influentials (KIs)—leaders in the community who include elected officials, tribal leaders, academics, laborers, and representatives from local businesses, nonprofits, ethnic and cultural communities, faith-based groups, and special interest groups. The project seeks to provide solid scientific information that enables KIs to make informed decisions on how best to protect the spectacular natural beauty, economic vibrancy and preserve the quality of life in San Diego, not just for today, but for all future generations.

Specifically, CEP developed a robust suite of integrated activities, planned over the course of the five-year project which included:

> Gathering local climate and key influential data

> Developing community education materials

> Implementing community information programs

> Evaluating best practices

> Serving as a model for other regions

Building Capacity

CEP began by listening to KIs. Nearly 100 interviews were conducted to gather information regarding the knowledge, efficacy, level of concern, values, and sense of community that leaders had regarding the changing climate in San Diego County (**see https://www.sandiego.edu/climate/discover-more/research.php** for a summary of the findings from the interviews). These interviews informed the framing, content, and goals when developing the *2050 Report* for leaders, which describes five major impacts to San Diego, and highlights the community of concerned leaders that currently exists. Easy to understand graphics, quotes from key leaders in the area, and a nod to the importance of doing this for the next generation fill the pages of this document (**see http://www.sandiego.edu/2050/**). The contents of this signature report informed the development of other educational resources and outreach activities, which included presentations at board meetings, city council meetings, government working groups, academic and technical conferences, corporate lunch-and-learn events, and more. During the events, CEP shared relevant resources and used diverse evaluation methods, including electronic pre-surveys, paper post-surveys, live polling using clickers, and voting with stickers on favorite content.

In addition, KIs attended local tours that provide place-based learning and offered KI "ambassador" opportunities. For example, the video *Answering the Call* (**see https://youtu.be/oERiAMtUmLg**) enabled KIs to publically assert their care and knowledge about the changing climate. Their participation in making the video was just as important as having other KIs view the video. This brings attention to regional leaders' good works in the community, which shifts perceptions of norms regarding what they can do.

Impacts and Lessons Learned

Widen and deepen the "Community of Leaders" by being organized. CEP found that it is very important to develop engagement strategies that entail tailored communication with KIs and community partners. Critical to being able to respond to KIs' needs, is having a database that enables contact information to be sorted and organized by these categories so that engagement with each group is more deliberate and aligned with project goals and the needs of the KIs.

Capitalize on opportunities to engage more deeply with partners. Several of the outreach activities have resulted in new opportunities for engagement with the same partners. For example, as a result of CEP's participation in the U.S. Environmental Protection Agency Tribal Conference, CEP was invited to help tribes develop a greenhouse gas inventory and to participate in their major Earth Day community event. Other partners such as SDG&E became a key collaborator and host for both a Lunch & Learn event for their own employees (including many in upper management) and for CEP's recently completed tours on wildfires and drought. In all of this outreach, CEP has chosen to respond to the needs of KIs, as opposed to dictating their needs.

Respond to demand for educational resources. Several groups reached out to CEP to utilize CEP's resources, such as the San Diego Airport Authority, who requested access to the *2050 Report* content, quotes, and information to be used to inform interested supporters of their *Good Traveler* campaign. Also the Union of Concerned Scientists and the Public Health Alliance of Southern California requested permission to use CEP's infographics. CEP has made infographics, educational videos, and all reports available to KIs and their staff to use as needed to further KI climate education efforts on their website. Being responsive to the needs of KIs and community partners is a high priority.

Use an action research model to test theoretical models, as well as evaluate the project's activities. CEP collects and stores data gathered through surveying, polling, and other evaluation tools. For example, data from multi-year polls (conducted in years 2011, 2012, 2014), as well as KI interviews (conducted in 2011 and 2013), have provided comparable data for deeper analysis of trends over time, which contribute to the evaluation of the program. Communication and social science theories have been used to help diagnose barriers and opportunities. Multi-disciplinary teams in communication with KIs have helped form action plans. After taking action, data helps the CEP team identify effective practices and test theoretical educational models. This action research process helps CEP to iteratively refine its outreach, resources, and activity engagement.

Critical to being able to respond to KIs' needs, is having a database that enables contact information to be sorted and organized by categories.

WORKING WITH FORMAL K-14 EDUCATORS

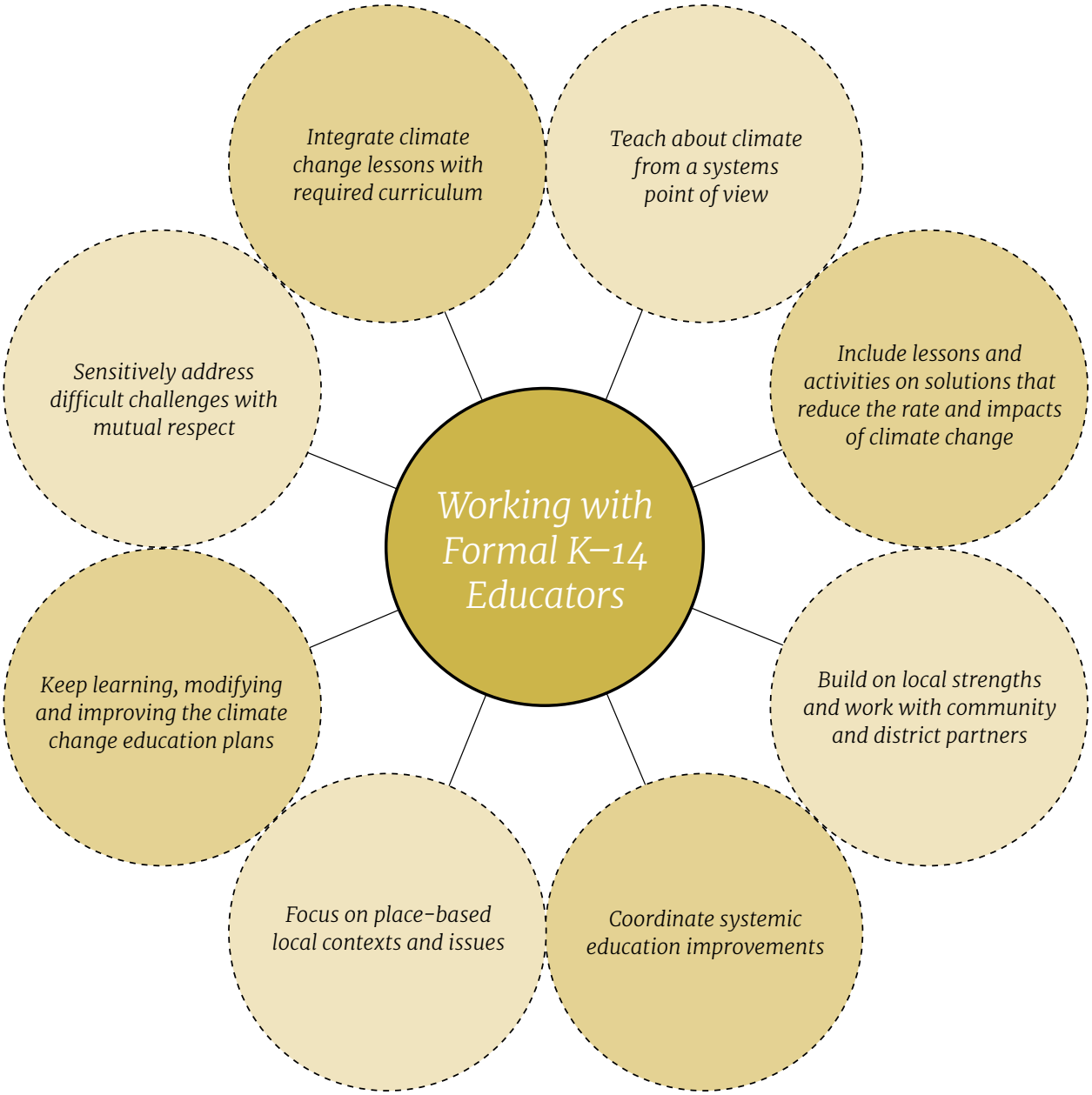
Global climate is driven by Earth's complex systems of ocean and atmospheric processes, powered by solar energy. Changes to global climate are best analyzed and understood from a systemic perspective. Strategies to mitigate global climate change due to anthropogenic activities and increase the resiliency of ecosystems and communities to climate change must be developed and implemented in the context of the linked ocean and atmospheric systems.

Student learning in formal education, like global climate, is a function of complex systems that arise from the interactions of students, teachers, administrators, families, policy makers, and the larger community. Systemic strategies provide the most effective approaches to increase the quality of student learning. One key guiding philosophy is that all stakeholders share a focus on continuously improving, assessing, and communicating about student learning.

A study by WestEd (2002) analyzed diverse award-winning school districts and identified five key elements that promote success in improving student learning. These key elements can be applied to improving climate change education:

- ***Shared systemic vision*** to support all students acquiring the desired climate content and skills;
- ***High quality professional development*** of teachers as a learning community that continuously improves members' understanding of climate change content and skills, and how to best share that knowledge and skills with their students;
- ***Multi-level communication and dialogues*** clearly articulating the advances in climate change education that are happening, and how the school policies and changes support student learning;
- ***Roles and structures*** in all parts of the system ***fostering partnerships*** so all stakeholders effectively help manifest the shared systemic vision of climate change education
- ***Data-driven decision making*** using multiple sources of data regarding educator and student climate change knowledge and skills to inform and guide analysis and iterative improvements of climate education in the school system.

While the study focused on K-12 formal education, many of these key elements can be applied to college settings.



The **Next Generation Science Standards** *(NGSS Lead States, 2013) promote systemic high quality science education by interweaving three instructional dimensions: disciplinary core ideas, science and engineering practices, and crosscutting concepts. Unlike the majority of prior education policy documents, the NGSS specify and promote rigorous climate change education. Disciplinary core climate ideas are appropriately addressed throughout the K-12 grade span. Students acquire knowledge about climate change and skills to interpret, address and respond to it by applying a wide variety of science and engineering practices. Students utilize crosscutting concepts such as Systems and System Models to build a coherent understanding of climate change and prepare students for college and career.*

Where to Start

Work with education stakeholders to plan a facilitated and transparent process that fosters brainstorming and mutually inclusive discourse about climate change education and incorporates research-based guidance. Convene key stakeholders and partners early; listen and learn about their experiences, comments, and questions regarding climate education; and consult the research literature for context and best practices. Work together to identify existing strengths and then analyze the status and issues involved in improving climate education at the targeted level of intervention (e.g., state colleges and departments of education, district, school, and/or grade levels). Make sure there is genuine support and participation at the appropriate administrative levels to help guarantee that actions can actually be meaningfully and sustainably implemented.

What to Try

As in all environmentally focused education initiatives, climate change education must have a strong place-based, local focus. Work with key leaders and stakeholders to identify critical community strengths and concerns, relying on local partners to provide insight into ongoing local environmental issues and environmental education efforts. For initial interventions, pick topics or subjects that are naturally aligned with climate change, such as science and environmental education classes or a local environmental education project (e.g., a school garden or an ecosystem restoration project with the local college). It is also valuable to emulate successful models (e.g., more broadly implementing a successful pilot climate science curriculum or professional development model that aligns pre- and in-service learning) so that initial changes have a greater chance of achieving the positive results that help generate enthusiastic momentum. Collaborate with participants and partners on professional development efforts to build on teacher strengths while addressing their content and pedagogical needs to implement the climate teaching and learning goals. Curricula should be informed by learning science research, connected over many grade levels, and progress from simple to more abstract and global understandings. The local context should be incorporated as fully as possible.

How to Follow-up

Formative assessment efforts should focus on informing and guiding the instruction and learning of targeted climate-related knowledge and skills; these should be articulated at the start of an intervention to facilitate data collection and analysis. Continue to engage in dialogue with participants and stakeholders in developing lessons and assessment instruments that provide insights into how students are thinking and what they are learning. Use the insights and data from a variety of assessment measures to guide the continuous improvement of climate change education. For example, if student work indicates misconceptions about the causes or mechanisms of climate change, then professional development, curricula, and/or instruction should be reviewed and appropriately revised.

Project Highlights with Formal K-14 Educators

PCEP: Three Connected Climate Change Education Interactives

PCEP works to improve climate change education in a very large geographic region that includes 10 different major governmental entities (states, territories, and independent countries) in the Pacific Ocean. In addition to helping these entities revise their science education standards and build professional capacity, PCEP develops and provides educational resources that are particularly appropriate for the region. A set of three connected Climate Change Education Interactives, developed in collaboration with Public Broadcasting Station WGBH, has a Pacific orientation, but it is also adaptable to many other locations (PBS LearningMedia, 2015). An introductory interactive (Carbon Dioxide and the Carbon Cycle) explains the factors that determine the atmospheric concentration of carbon dioxide. The second interactive (Earth's Energy Flows and Climate) connects the causal chain from higher CO2 levels to higher temperatures and other climate change impacts. The concluding interactive (Impacts of Climate Change in the Pacific Region) illustrates impacts of climate change and adaptation strategies for ecosystems and human systems. The interactives can be used in a range of middle and high school grades, as well as for resources in teacher education at the college level.

PoLAR: Using the EcoChains Card Game in the Classroom

To enhance student engagement, teachers are using educational games in the classroom, as games are increasingly seen as valuable tools for climate change education and engagement (Wu & Lee, 2015; Eisenack & Reckien, 2013; Mendler de Suarez et al., 2012). However, without evidence about the effectiveness of educational games, especially as they compare to more traditional educational approaches, teachers may struggle to justify the use of these tools in the classroom. A new controlled study by the PoLAR Partnership on the EcoChains: Arctic Crisis card game (Pfirman et al., 2015) found that game-based learning can be as effective in teaching content as a text-and image-only instrument, and more effective in improving retention of new content knowledge over time as well as increasing engagement in subject matter.

A controlled experiment of the EcoChains: Arctic Crisis ecosystem card game developed under the PoLAR Partnership showed that the game was as effective as, and in some respects more effective than, reading an article covering similar subject matter. The follow-up survey found that EcoChains players actually recalled new information about the Arctic food chain better than those who read the article. Participants were also more engaged in the game than the article. They found it to be more fun, and they were happier while playing than while reading. EcoChains aligns with Next Generation Science Standards LS2 Ecosystems: Interactions, Energy, and Dynamics and ESS3 Earth and Human Activity.

Case Study

Teaching Climate Change in a City Classroom

From a community school on a Pacific Island to a large public school in a major East Coast city, using place as a focal context is a powerful approach to climate change education. This MADE CLEAR case study highlights a grade six classroom in Baltimore, but local context and connections can be included anywhere as an important theme for climate change education.

In Ms. Wilson's Baltimore city school, teachers in all subjects must incorporate student activities in reading, writing, and speaking into their lessons, and climate change is taught as part of the grade six curriculum in Earth and Space science. Although the school is in an area with serious environmental challenges, this dynamic 6th grade teacher, with support from administrators and non-profit partners, has integrated place-based climate change education, with local connections and activities that contributed to its designation as a Green School this year.

Building Capacity

Ms. Wilson attended a MADE CLEAR Climate Change Academy and used the information and resources from that training to plan how to incorporate climate change into her classes. Teachers in Maryland are required to include literacy skills and practice in argumentation from evidence in every subject area, and science classes must include math and engineering components. An additional requirement in Maryland mandates environmental education in every grade. These guidelines provide a strong motivation to incorporate field studies and schoolyard-based learning into the science curriculum. Using climate change as a topic, and with ongoing contact with MADE CLEAR through professional development workshops, webinars, and teaching resources, Ms. Wilson was able to integrate all these required elements naturally and smoothly over the course of the school year. The students were excited and proud of their role in helping the school earn Green School certification.

Impacts and Lessons Learned

Ms. Wilson's students now approach the topic of climate change by looking at some of the components of the climate system: the carbon cycle, weather, and atmospheric processes. Student observations of weather patterns help them see the short-term processes in action, in their own neighborhood. Ms. Wilson then introduces graphs and visualizations of climate data to provide a long-term view of changes over time and changes in CO2 concentrations in the atmosphere. Using the "claim-evidence-reasoning" approach, her students investigate the evidence for global climate change and how human activities are creating a rise in global temperatures. To help students make a personal connection with the topic, Ms. Wilson guides students in investigating local sources of greenhouse gas emissions and local energy use. These studies provide motivation for the students' engineering projects, where they research solutions and design and construct models for interventions to increase energy efficiency, reduce emissions, and mitigate local impacts of climate change. This year, Ms. Wilson's students engaged in an action-research project, partnering with a local foundation that provided support and resources. After studying the importance of carbon sequestration and the value of trees in providing shade and mitigating high urban temperatures, the 6th-graders planted more than 40 native trees on school grounds.

These studies provide motivation for the students' engineering projects, where they research solutions and design and construct models for interventions to increase energy efficiency, reduce emissions, and mitigate local impacts of climate change.

Lessons learned through the MADE CLEAR Climate Change Academy include the following steps:

- Incorporate climate change education into existing structures and requirements
- Include a local connection and local concerns
- Work with partners to increase the impact of actions by a small group
- Recognize and celebrate progress
- Even an unpromising context can be fertile ground for climate change education

WORKING IN INFORMAL ENVIRONMENTS

An informed and engaged citizenry is critical to sound local, state, and federal decision-making. However, most people in the United States were never taught about climate change in school. Currently, approximately a quarter of Americans are school age, between 5 and 18 years old (Davis and Bauman, 2013). The rest, about 240 million people, learn about climate change issues through informal settings, such as television, the internet, the workplace, museums, zoos, and aquariums. Surveys of visitors to U.S. zoos, aquariums (Luebke et al., 2012), and national parks (Thompson, Davis, & Mullen, 2013) indicate far more interest and concern about climate change among visitors to informal science institutions than the average U.S. adult. This presents a significant opportunity for learning about climate change in informal environments.

Informal learning is inherently voluntary, self-motivated, and guided by the learner's needs and interests (Dierking et al., 2003). Recognize that people in informal settings are there by their own choice. They will move on if they are not interested, and they will only stay if engaged and if their values are respected. Visitors to informal learning environments come with a wide array of prior knowledge, worldviews, and perspectives. Learning experiences that are singularly focused on increasing climate science knowledge (e.g. describing the global climate system) do not necessarily compel visitors to engage in the issue (Allen and Crowley, in press).

Where to Start

Informal learning experiences can be made more meaningful by orienting participants as to how they are connected to values they already hold deeply. Colleagues are encouraged to consider this point carefully in project planning stages because it may open new ways to shape informal learning experiences about climate change.

Inviting curiosity, facilitating fun, challenges, and competition can all help to maintain engagement through activities (Wu and Lee, 2015). To build a longer-term impact on participants, foster a sense of hopefulness, that each person has the capacity to help, and that positive action can make things better.

What to Try

Embed climate change learning in multiple settings, from exhibits to documentaries. Include information about active local groups working to reduce the causes of climate change as well as preparing for its impacts. Try things out to see how audiences respond, using prototyping and formative evaluation to provide evidence of what works.

About 240 million people, learn about climate change issues through informal settings, such as television, the internet, the workplace, museums, zoos, and aquariums.

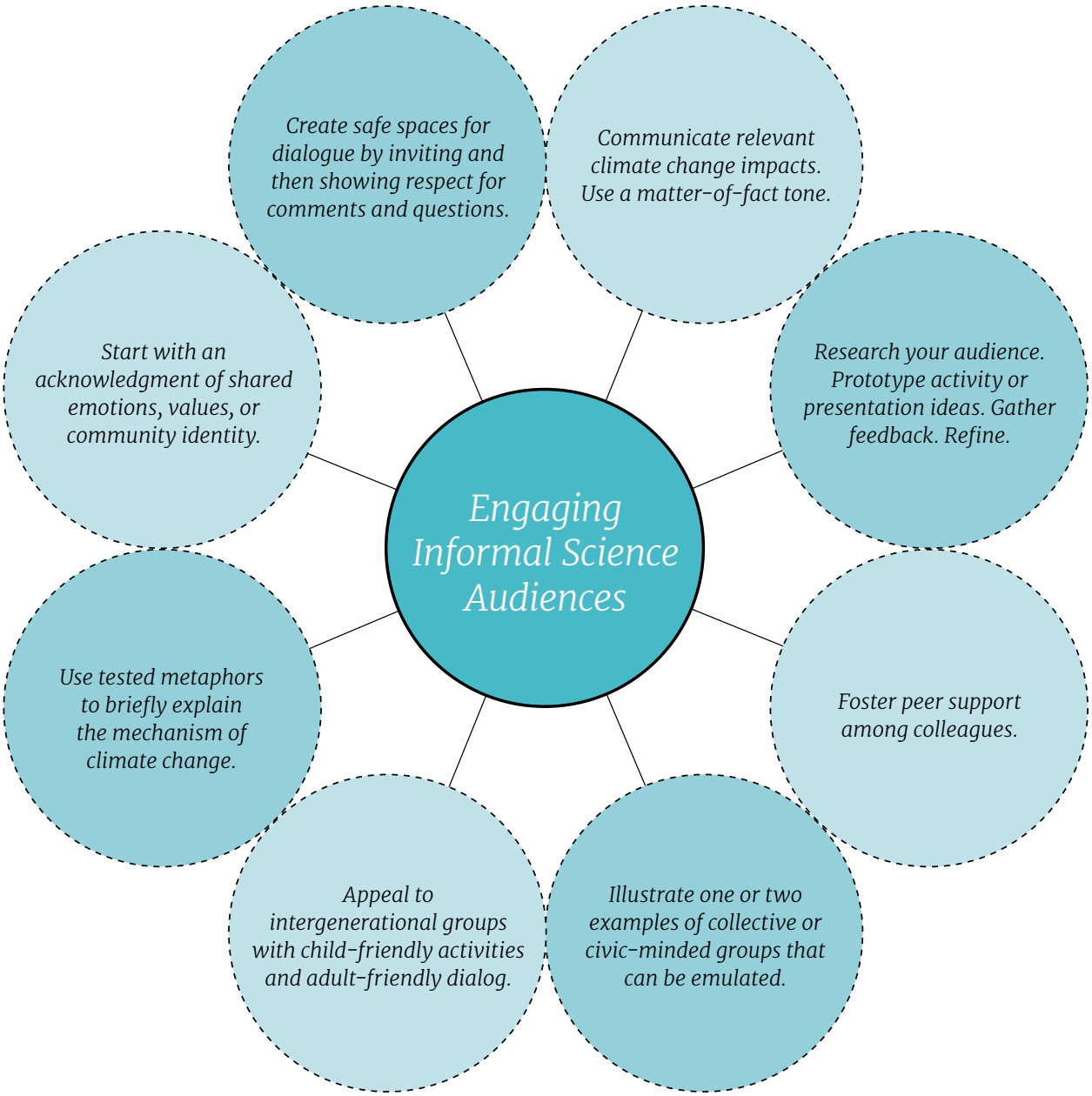
Train interpreters and other staff to engage participants through questions and shared values. Most people are concerned with quality of life and want to leave a positive personal legacy for the next generation. Focus on the co-benefits of action. For example, preparing coastal regions for future sea level rise can also help to prepare for the next storm surge.

Effective climate change experiences in informal learning environments provide opportunities for participants to explore local relevance and solutions. Illustrate that anyone can join with others to take steps to reduce the extent of climate change and to respond to changes and build positive relationships at the same time. Develop examples of groups that are engaged in climate change mitigation or preparation for resilience in the face of climate change impacts. From this suite of examples, choose one to share and facilitate discussion about ways that participants could join in similar efforts. Take care to focus on groups working for collective action and civic engagement. Working toward systemic change is essential to addressing challenges of this scale. Shift conversation from individual-level responses (e.g., riding your bike) to collective responses (e.g. supporting the construction of more bike lanes). Share examples of how others are working together to achieve success to promote a sense of hope and self-efficacy—"Others are doing it, so I can, too."

How to Follow-up

Encounters with climate change issues through informal learning environments are often measured in seconds to minutes and only rarely in hours. This is not enough time to develop a full understanding of the range of issues associated with understanding and responding to climate change. However, lifelong education often spans 60-70 years, with multiple opportunities for repeated encounters. Curiosity piqued on one visit or program can be reinforced days, months, or years later, by another bit of information, and then again by participation in yet another activity.

It is essential to create an engaging, memorable experience that immediately connects with people. Curiosity linked to personal values and a sense of hope can help motivate interest and effort to continue learning and to engage beyond learning.


Engaging Informal Science Audiences
Create safe spaces for dialogue by inviting and then showing respect for comments and questions.
Communicate relevant climate change impacts. Use a matter-of-fact tone.
Start with an acknowledgment of shared emotions, values, or community identity.
Research your audience. Prototype activity or presentation ideas. Gather feedback. Refine.
Use tested metaphors to briefly explain the mechanism of climate change.
Foster peer support among colleagues.
Appeal to intergenerational groups with child-friendly activities and adult-friendly dialog.
Illustrate one or two examples of collective or civic-minded groups that can be emulated.

Project Highlights with Informal Learning Environments

MADE CLEAR: Climate Change Education for Delaware State Parks

Educators in Delaware's State Parks system are developing new activities and presentations to bring climate change into their interpretive programs for students and the public. Each interpreter is choosing a habitat, historic structure, or creature at his or her own park and using that high-interest focus as a starting point for dialogue on climate change, its local impacts, and appropriate actions to slow the rate of change. In one park, the program highlights salt marsh habitats and their vulnerability to sea level rise, while in an agricultural history site, the focus is on climate change impacts on the growing season. Each interpreter is working to make the local climate connections vivid and compelling and to provide guidance and encouragement for every visitor to contribute to solutions.

NNOCCI: Focusing Attention on Collective Action

Many educators are focusing on how people can participate in civic or collective activities to make change at a systemic, rather than individual, level. For example, at the New England Aquarium when interpreters make presentations about Caribbean coral reefs they explain that when the ocean absorbs CO2 emitted through the burning of fossil fuels, it becomes more acidic, harming marine life and undermining the stability of the whole ecosystem. They then share examples of existing groups working together to create change. One organization they often mention is Home Energy Efficiency Teams of Massachusetts (**www.heetma.org**), which was organized as a grassroots group to facilitate home energy efficiency. HEETMA has facilitated dozens of volunteer work parties to increase energy efficiency in homes and small businesses.

Case Study

Building Capacity for Productive Public Engagement

NNOCCI provides in-depth training, called *Study Circles*, for informal educators from aquariums, zoos, and science/nature centers across the U.S. Led by the New England Aquarium in collaboration with the Association of Zoos and Aquariums, FrameWorks Institute, and the Woods Hole Oceanographic Institution, NNOCCI's impact evaluation is conducted by the New Knowledge Organization, Pennsylvania State University, and Ohio State University.

Informal educators possess a high level of public trust (The Ocean Project, 2009; Fraser and Sickler, 2009). Properly equipped, they can accelerate effective public engagement. However, informal educators need training to increase their confidence in scientific knowledge, guidance on interpreting the complexity of climate change, and support from their peers to take on a leadership role in addressing this often distressing and controversial topic.

Building Capacity

NNOCCI training focuses on how to increase public understanding, self-efficacy, and support for solutions related to climate change causes and impacts. Each *Study Circle* brings together pairs of educators representing ten institutions from across the country with two climate scientists and three facilitators. Participants invest about 100 hours over six months, learning and practicing research-based communication techniques and climate science.

Study Circles use a *strategic framing*™ approach (Gilliam and Bales, 2004), which supports effective communication by (1) building on careful empirical research to understand what people already value, believe, and understand and (2) designing and testing communication strategies that help translate complex science in a way that allows people to examine evidence, make well-informed inferences, and embrace science-based solutions. This approach explains causes and consequences to orient thinking and discourse toward effective interventions. For example, explaining that burning fossil fuels releases large amounts of carbon dioxide into the atmosphere, where it acts like a heat-trapping blanket, has been shown to help non-experts think more effectively about ways to address the root cause—burning fossil fuels (Frameworks Institute, 2014). Understanding the chain of cause and effect helps individuals to appreciate the root source of the problem, and what kinds of solutions are likely to be effective.

Impacts and Lessons Learned

By focusing on specific applications and solutions to real-world problems, crisis-framing and despair is minimized. Appealing to strongly held universal values and concepts, such as responsible management and stewardship, can minimize polarization and contention. Interpreters trained by NNOCCI help the public to see themselves as potential participants in civic issues, rather than simply as individual consumers of knowledge.

The NNOCCI initiative has reached more than 120 aquariums, zoos, and science/nature centers in 30 states. Visitors to institutions that have participated in NNOCCI training express greater hope and confidence about their ability to communicate about climate change,

"You said something that was really interesting that I never thought of. As a person, I kind of say, 'climate change, I can't do anything.' But when you equated it to the heart, like, we can do exercise, and—and maybe there is something that we can do. Because when you put it on my level, to something I have control over, it's like, 'oh, maybe I saw something differently.' And that's the first time. I mean, yes, I recycle, but it just felt a little more personal."

believe that it makes a difference when they talk about the issue with friends/family and others, and report participation in personal and civic actions to reduce climate change. The New England Aquarium has been applying the lessons learned from NNOCCI in the Visualizing Change project, a related NOAA-funded collaboration among several aquariums, focused on developing strategically-framed "visual narratives" that take advantage of global datasets presented on platforms such as the Science on a Sphere. Quotations from observations during formative evaluation demonstrate that after listening to a strategically-framed presentation, visitors can describe climate change causes, impacts, and solutions.

Solutions:

"CO2 is affecting the oceans, the ecosystems, and our current energy system needs to change."

"I think the government has to be involved in finding a solution. For example, where we live there is some type of public transportation, but I think the schedule is one bus every hour. If you rely on that as your main form of transportation, you're going to get to work in two hours. So it's not feasible, and therefore you have to drive your vehicle. If we had a good public transportation system, we could use it, instead of relying on our cars."

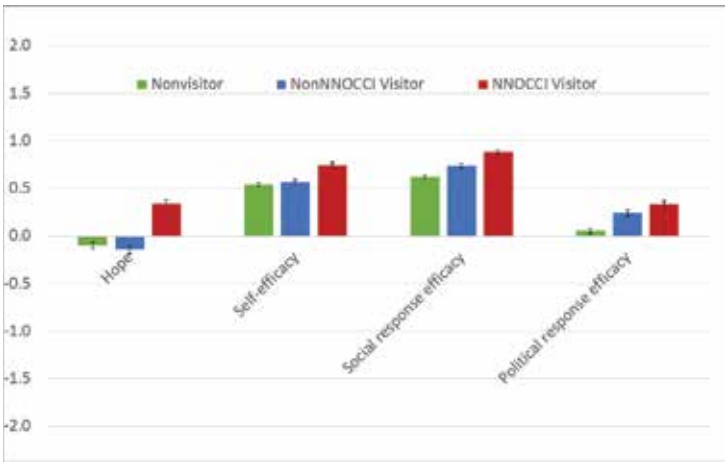


Figure 2: Visitors to institutions that participated in NNOCCI training tend to be more hopeful and to see themselves as more able to create positive change than people who don't visit NNOCCI-affiliated institutions.

Case Study

Climate City—Informal Learning at Community Festivals

Effective climate change programs provide opportunities for visitors to explore local relevance and solutions. **CUSP** develops and delivers programming both in museums and in the community that focuses on local climate risks and educates about local solutions in which people can get involved at the community level. CUSP is currently active in New York City, Philadelphia, Pittsburgh, and Washington, D.C. and is led by the Franklin Institute in Philadelphia. Community programs range from short tabletop interactions at festivals, to a 10-part program at senior centers or afterschool centers, to educational workshops at community meetings. The CUSP audiences are diverse and can include families, children, adults, community groups, and climate professionals from local organizations.

Building Capacity

Community festivals are an important part of community identity and where audiences with shared values come together. CUSP partner organizations, which range from environmental education centers to city government departments, often table at festivals for community outreach purposes, usually without any coordination. CUSP brings together such organizations under one tent and one overarching message, which the project calls *Climate City*. The objective is to engage the public in informal learning about how climate change impacts their local community and what community-level responses are available. Short, attention-grabbing, and engaging interactions using hands-on activities connect audience interests, climate-related messages, and the work done by partner organizations.

Impacts and Lessons Learned

Visitors to the *Climate City* tents indicated they were drawn in by the family-friendly activities and curious about the specially designated area. Follow-up surveys with visitors to the *Climate City* area indicated the interactive activities were memorable and led visitors to notice climate-related things in their daily lives (e.g. water systems, green spaces, energy use). Coordinating a diverse group of organizations requires a lot of logistical support. If an institution or organization wishes to plan a *Climate City* type event it should start planning the event well ahead of time and communicate often with the organizations that will be "tabling". Some organizations might not see the climate connection or relevance of climate change to their work right away. So it is important to work closely with them to find the right way to frame their message. CUSP has found that inviting partners to bring activities for an casual gathering a week ahead of the event and going through them as a group allows for stronger group cohesion and resonating messages. It is also important to be prepared for a range of conditions (outdoor and indoor) and range of perspectives. Have answers to common climate questions prepared and ready. However, it is CUSP's experience that visitors do not challenge the facilitator, but rather, are happy to learn that there are community-level efforts to address climate change in their city.

The lessons learned in NNOCCI and CUSP about engaging developers of informal learning experiences are in line with the recommendations found in Bell et al. Eds., 2009:

- Design materials and presentations with an audience in mind, and learn as much as possible about core values that audience holds dear as well as prior knowledge, experiences and interests that audience is likely to have in mind. Some values are cross-cutting, such as family, community, and health (ecoAmerica, 2015).
- Plan to explain, early in the facilitated experience, how this activity or lesson or presentation is about what the community values. Then connect relevant science information to those community values, issues, and concerns the audience frequently has in mind.
- Develop tools and materials through a collaborative and iterative design, testing and evaluation process, and include learners, educators, designers, and subject matter experts in the process. Through this process, develop multiple, interactive ways for learners to engage with concepts and phenomena.
- Train staff or volunteers to facilitate discussions and to integrate questions, everyday language, and concerns into the learning experience.

"This experience was a great example of engaging people who were previously unaware or uninterested in climate change...(The activity) brought intention to change behaviors based on the experiences. Other events or webinars that the organizers have attended are often aimed at professional audiences or only provide information at high literacy levels, both of which this activity avoided." CUSP ACTIVITY FACILITATOR

WORKING WITH INDIGENOUS COMMUNITIES

Environmental change is now happening at a rate previously unforeseen and is often compounded by multiple social and economic issues, posing a significant challenge to the adaptive capacity of communities faced with immediate climate change impacts. Many Indigenous groups are on the frontlines of climate change: Alaska Native villages face coastal erosion and inland wildfires, Pacific Islanders are displaced by sea level rise, and American Indians of the Southwest are managing dwindling water supplies (Bennett et al., 2014). Indigenous systems of knowledge, cultural practices, and traditional as well as current livelihoods are deeply linked with the natural world and have enabled Indigenous peoples to adapt to constantly changing impacts of weather and climate on the basis of their observations and experiences.

One Indigenous elder offered the following during a meeting of our Commonwealth of the Northern Mariana Islands (CNMI) Local Professional Learning Community (LPLC):

"We need to emphasize the importance of having Indigenous peoples do most of the work now, keeping in mind that there are many Indigenous peoples who are schooled in both so called Western ways as well as their own. Just imagine how much time and effort could be saved by doing this. Indigenous peoples are aware of their contexts and relationships. These are rooted in their minds and actions. I sometimes get the feeling that we will forever be at the receiving end of things while the givers are trying very hard to be culturally sensitive about our ways of knowing. I think there is some irony in this. Thank you for the opportunity to comment."

Indigenous environmental knowledge developed over generations and used to manage natural resources through place-based solutions has the potential to influence local and global responses to the changing climate (Vinyeta & Lynn, 2013). Western climate science, particularly impact assessments and projections of future change, may also help inform Indigenous community responses to climate impacts. For the most part, these perspectives have not actively come together to benefit all. Collaborating in discussion and research about climate change offers rich opportunities for mutual learning among Indigenous ways of knowing and living, Western scientific knowledge, and technological advances, thereby benefitting communities' responses at the frontlines. At the same time, this collaboration further informs formal and informal science education for Indigenous and non-Indigenous learners.

"Climate change will bring us together. We have to talk about what's going to happen, what's going on, and then we might help the next generations."

FROM 2ND TRADITIONAL CHIEF TRIMBLE GILBERT, GWICH'IN ATHABASCAN ELDER

Many involved in climate education through the Climate Change Education Partnership Alliance are situated within Indigenous communities—communities who are significant, strategic partners in contributing to understandings about climate and the environment. When mutual exchanges build from and honor Indigenous community values, cultural and place-based knowledges, and traditional pedagogies of place, important understandings about the environment and response to change emerge (Barnhardt & Kawagley, 2005). Cultural leaders and Elders, as well as youth, academics, government agencies, and community-based organizations, all need to hold a stake in an educative process that allows each group to speak on its own terms. Such a collective approach reinforces the importance of engaged collaboration and provides essential insights into living in times of a changing climate. The multiple and mixed, local and global contexts of Indigenous communities today make these exchanges even more complex. Yet, when the work is collective, compelling and competing interactions between Indigenous knowledge systems and Western science can be generative, offering solutions not considered previously for a resilient, transformative, and self-sustainable future.

Figure 3: The circular representation offers multiple, interconnected approaches for engaging with Indigenous communities that work toward collective impact to support current and future generations as they respond and adapt to a changing climate.

Where to Start

Identify research team experts who are members of the local Indigenous community, as they are essential to the success of any project. These individuals, who bring professional and cultural expertise, will have access to invaluable local and traditional ecological knowledge (LEK/TEK). Whether or not these liaisons themselves hold this knowledge, they can bring other community members to the table who can provide valuable insights into how environmental conditions have changed over time as well as how the community has responded to variability in the past. This place-based evidence complements Western climate science research and observations, and should be an integral part of any programming. These experts will also ensure that important community protocols for using LEK/TEK in climate change initiatives are used (CTKW, 2014).

What to Try

Indigenous experts can mediate the kinds of place-based approaches that focus on local impacts and solutions most relevant to the participating communities. For instance, an emphasis on interconnectedness, including intergenerational relationships, aligns with holistic ways of thinking more effectively than an approach that focuses on only one aspect of climate change. Including topics such as health, livelihoods, and food security may increase engagement.

Local experts can identify those Elders and individuals who lend a depth of understanding and credibility that is recognized by participating communities, and in turn can facilitate ways to include Native languages and concepts. Elders are frequently the holders of traditional knowledge, whose locally-grounded approaches, experiences, and guidance are often acknowledged and deeply respected. Allow time to reflect, process, respond, and share, following local community protocols or an alternative facilitated process. Incorporate various styles of learning and communicating (e.g., tactile modes such as hands-on activities, or visual modes through video).

How to Follow-up

Strong relationships will yield the most successful results. This takes time and will be facilitated through cultural liaisons, who can help create opportunities for sustained engagement, regular input, and identifying what supports might be needed. Communities empowered to develop climate change research projects, communication tools, and solutions that are responsive to their place will be most receptive and committed to incorporating culturally accurate and scientifically valid principles and practices. This often means regular communication with partners, including specific opportunities for partners with specialized knowledge and experiences to offer feedback to the process or product in development.

Case Study

Insack Lasr, Our Mangrove Forests from Kosrae

PCEP's LPLC in Kosrae, Federated States of Micronesia has produced a video resource featuring elders from Kosrae. The development of the video, *Insack Lasr: Our Mangrove Forests*, engaged the Kosrae elders in sharing observations of environmental changes in their community. The project is a convergence of PCEP's approaches to teaching and learning about climate—centering on LEK, utilizing the collective expertise of climate scientists and practitioners, and tapping into the power of partnership among schools and communities.

In the final video, eight community elders were interviewed, chosen because of their expertise in fishing and harvesting resources from the mangroves. Elders addressed the following questions:

> How do you use the mangroves?

> What changes are you noticing in the mangroves?

> Is climate change affecting the mangroves?

> What can we do about the changes to the mangrove forest?

Building Capacity

The topic of mangroves emerged as a focal point through ongoing conversation with a core group of educators and environmental agencies. The Kosrae LPLC formed in March 2013, as a small group of formal and informal environmental educators interested in working together on a classroom resource that engaged LEK to support climate education. With guidance from PCEP, this team developed a few questions about weather and climate in Kosrae and then identified three local elders to share their observations of changing patterns. However, the group wasn't satisfied with the outcomes of the interviews—the topic of 'weather and climate' was too broad to have a deep conversation.

To determine a more relevant topic, the LPLC reached out to their community. In July 2013, the Kosrae LPLC, along with PCEP staff from Honolulu and Kosrae and PCEP climate scientist Dr. Julian Sachs, convened a meeting with a broader group of local formal educators and environmental professionals to identify (a) what children are learning in school related to their environment and (b) what the group—as educators, parents, and community members—would like their children learn about their environment. Based on input from this broader group, the LPLC identified mangroves as a critical topic—not only due to its pervasive practical use in the community, but also because mangroves are noteworthy indicators of changes in climate and its impacts. Interviews with community elders were to be conducted in Kosraean and recorded and shared on video with English subtitles. This would allow Kosraean viewers to exchange ideas in their own language, while still allowing accessibility to other viewers.

With support from PCEP staff and climate scientist, Dr. Julian Sachs, the Kosrae LPLC developed an interview protocol and recorded eight interviews. The group followed an iterative process in developing the final video. This meant multiple group editing

sessions, taking six months from the last interview to the first pilot, then an additional four months of editing to produce the final video. This long process required patience, as the LPLC debated proper Kosraean spelling and needed to continually translate into English to allow all editors to participate.

However, the long process allowed the whole team to better understand the ways climate change and human impact are changing the mangroves in Kosrae, and truly grasp and own the story being woven together.

By January 2014, the classroom lesson was developed for grades 3–5 and the initial pilot was conducted with a grade 4 class at Utwe Elementary School. The pilot was followed by the last round of edits and another round of pilot lessons to 90 students in grades three to five. While the main purpose of the lesson was to gauge the effectiveness of the video in teaching students about the importance of mangroves and the impact of climate and human activity on mangroves, the lesson also included explicit language instruction and hands-on tasks to engage students and ensure that the content was accessible to them. Lessons were co-taught by PCEP staff and LPLC members, while teachers observed. After the lesson, teachers reported that the video and lesson were engaging for students and connected well with the Kosrae State science curriculum. Teachers appreciated having a resource for students that features local people and focuses on a familiar, locally-relevant topic.

By April 2014, the video and accompanying lesson, *Insack Lasr, Our Mangrove Forests,* was complete. The LPLC disseminated the lesson and video to all elementary schools in Kosrae and to their colleagues at a local education conference.

Impacts and Lessons Learned

Creating and disseminating *Insack Lasr* had impacts beyond the classroom, strengthening relationships among LPLC members that continue to benefit climate education in Kosrae. The iterative editing process—with multiple visits over several months—relied on cultural, language, and scientific expertise from each LPLC member. This deep engagement created a sense of ownership and allowed LPLC members, even within a small community, to better understand the strengths of each partner. *Insack Lasr* sparked future collaboration on other climate and environmental education projects led by LPLC members.

Through the process of engaging elders and LPLC partners in the production of *Insack Lasr* provided PCEP with a suite of lessons learned that may help other climate change education projects working with Indigenous people. They are as follows:

- Identify a team of experts who are part of the Indigenous community and bring their own cultural and professional expertise and insight into community issues and knowledge of the peoples' past responses to environmental change;
- Connect with Indigenous leaders who can bring in other community members;
- Multiple visits over time can allow relationships to build and give additional time for reflection, processing, and feedback; and
- Allow the community to take the lead. Understand the facilitator's role as a thought partner and be prepared for mutual learning.

Project Highlights of Learning Together With Indigenous Communities

CEP: Collaborating with Tribal Leaders in the San Diego Region

Over the past few years, CEP has engaged in climate education and outreach activities with tribal community leaders in the San Diego region. Through an ongoing relationship with the Native American Environmental Protection Coalition, CEP connected with members from all tribal communities located in or near San Diego. Discussions with the Pala Band of Mission Indians and the La Jolla Band of Luiseño Indians helped identify a need for updated information and resources about tribal rights and policies in the San Diego area, especially as they relate to changing environmental conditions and natural resource management. Working with the University of San Diego's Tribal Liaison, CEP is investigating the potential for the tribally-led development of an interactive website that would support the Pala Band of Mission Indians, the La Jolla Band of Luiseño Indians, and other local tribal communities in addressing issues related to climate change as well as help inform regional policymakers about the history and rights of these communities.

PCEP: Seeking Local Wisdom in the Pacific Region

In early August 2015, Typhoon Soudelor struck the island of Saipan in the CNMI. With winds up to 120 mph, this super typhoon, described as the worst storm to hit the CNMI in nearly 30 years, caused widespread damage to architecture and infrastructure. These sad circumstances gave real time meaning to PCEP discussions about community resilience in the aftermath of major weather events. Despite their personal losses, several of our CNMI LPLC members (a diverse group of Indigenous and Western science knowledge holders) continued to share knowledges and implement practices that would help communities adapt immediately to the changing weather, restore ecosystems destroyed by Tropical Cyclone Soudelor, and address the ways these circumstances are already impacting community health. These particular conversations exemplify one of the ways that Indigenous communities and climate change educators collectively work for the benefit of their communities.

Case Study

Signs of the Land—Reaching Arctic Communities Facing Climate Change Camp

The *Signs of the Land: Reaching Arctic Communities Facing Climate Change Camp* is a PoLAR Partnership project that facilitates in-depth dialogue about climate change and its impacts on Alaska Native communities. The Association of Interior Native Educators (AINE) and the University of Alaska Fairbanks International Arctic Research Center (IARC) collaboratively developed the camp, with significant Alaska Native Elder involvement, to test a model for engaging and representing Indigenous communities in the co-production of climate change knowledge, communication tools, and solutions-building. The project was based on the AINE Academy of Elders camp model originally developed in 1996.

Camps have traditionally played an important role in Native life throughout Alaska as well as in other Indigenous communities through the U.S. A cultural camp setting can serve as a learning environment that engages participants in hands-on, inquiry-based activities under the guidance of local experts, including Native Elders, and connects climate change to participants' lives in culturally and educationally meaningful ways. In addition to increasing knowledge and awareness of climate impacts and responses, a camp setting can foster capacity building for participants to serve as climate change educators and communicators in their communities and workplaces.

Building Capacity

The Signs of the Land camp was held over the period of four days in July 2014 at Howard Luke's Gaalee'ya Camp, located along the Tanana River in Fairbanks, Alaska. Twenty-six people participated in the camp, ranging in age from 20 to 90 years old. Participants included Alaska Native Elders, classroom teachers, local resource managers and planners, community members, and climate scientists. The camp wove together traditional ecological knowledge, local observations, Native language documentation, and climate science through a mix of:

- Storytelling and sharing of perspectives from Elders on changes experienced over their lifetime, as well as observations of environmental change from all participants
- Presentations by local experts focused on climate change in Alaska, including key indicators of change, impacts on environmental conditions, and implications for traditional activities like subsistence hunting and fishing
- Dialogue and discussion amongst all participants about culturally-responsive ways to learn about and respond to climate change, with built-in time for reflection
- Hands-on, community building activities, including playing an ecosystem card game and a marine spatial planning simulation, as well as crafting traditional tools such as the *Toh* or walking stick historically used for safety, communication and physical support, and survival necklaces
- Documentation of guiding beliefs, songs, and concepts expressed by Elders in their Native language, within and related to the context of climate change discussions

Participants confirmed the value of Elders in helping them understand, respond, and adapt to climate change, and indicated that the camp setting facilitated an in-depth discussion and sharing of knowledge.

Impacts and Lessons Learned

Based on analysis of pre/post surveys, participants' attitudes showed positive change after the camp. Participants reported:

- Increased awareness of scientific or technical language used in climate science;
- Improved ability to locate resources, tools, and strategies for learning about climate change; and
- Enhanced capacity to communicate climate change in a relevant way to their audiences and communities.

Participants also confirmed the value of Elders in helping them understand, respond, and adapt to climate change, and indicated that the camp setting facilitated an in-depth discussion and sharing of knowledge.

Project partners came away with several valuable insights on how to increase the effectiveness of the camp experience. In an effort to guide young people in the changes ahead and foster intergenerational connections, Elders directed the project partners to invite more Alaska Native youth to participate. The camp facilitators determined a need to spend more time near the beginning of camp laying the foundation for climate science understanding. Participants expressed a desire to further discuss individual and community responses, solutions, and adaptation to climate change. Camp facilitators noted shifts in their own thinking and behaviors following the camp, evoking the realization that every person who takes part in the camp, including staff, Elders, and climate scientists, should be considered a "participant". A camp setting also validates the relationship to the land, and the knowledge and historical experience Elders possess, making it easier for Elders to remember and share. Finally, project partners recognized a need to identify opportunities for on-going dialogue, network building, and support among participants.

CONCLUSION

While each audience has different needs, and specific strategies are needed for reaching them, there are some common elements in CCEP's climate change education effective practices. It is important to start with audience questions—not with the educator or presenter's answers, i.e. audience questions should come first. This will not only help foster engagement, but it will trigger prior knowledge—the first building block for acquiring new knowledge. It is also imperative to identify shared values. Knowing the audience's values and priorities can lead to empowering them.

One time or limited engagement opportunities will not be as effective as engagement over time. So it is important to follow-up with strategies appropriate for the audience. Peer groups can allow like-minded participants to work together to address climate change issues in their regions or local environments. These peer groups may be through the workplace, through community organizations, church groups, or social networks. Through the co-development of ideas and strategies with participants, a more transparent relationship is formed and participants will become more engaged with the topic and activities, leading to eventual solutions-based scenarios.

As part of its vision, the CCEP Alliance developed the models described herein to educate and empower citizens. It is hoped that as a result, the proven approaches and strategies will lead to more informed decisions regarding addressing, adapting to, and mitigating climate change.

The CCEP Alliance recognizes that communication strategies may differ for unique audiences. This guide provides recommendations for effective education and communication practices when working with the specific audiences reached by the CCEP projects. The Alliance welcomes the replication of the approaches outlined in this guide. If you should be interested in learning more about each of the CCEP Projects and are looking to speak with Project staff, please visit the Alliance website, **www.ccepalliance.org**, for further information.

It is imperative to identify shared values. Knowing the audience's values and priorities can lead to empowering them.

REFERENCES

Allen, L.B. and Crowley, K. (in press). Moving beyond scientific knowledge: Leveraging participation, relevance, and interconnectedness for climate education. *International Journal of Global Warming*. Retrieved from upclose.lrdc.pitt.edu/articles/2015%20Allen_Crowley_IJGW_in_press.pdf.

Ardoin, N., Heimlich, J.E., Braus, J. and Merrick, C. (2013) *Influencing Conservation Action: What Research Says About Environmental Literacy, Behavior, and Conservation Results*. New York City: National Audubon Society. Retrieved from http://web4.audubon.org/educate/toolkit/module3.php.

Bales, S. N, and Gilliam, F.D. Eds. (2004) *Communications for Social Good*. The Foundation Center. Retrieved from www.fdncenter.org/for_grantmakers/practice_matters/.

Bales, S.N., Sweetland, J., and Volmert, A. (2015) *How to Talk About Oceans and Climate Change: A FrameWorks Message Memo*. Washington, DC: FrameWorks Institute. Retrieved from www.frameworksinstitute.org/climate-change-and-the-ocean.html.

Barnhardt, R., and Kawagley, A. O. (2005) Indigenous knowledge systems and Alaska Native ways of knowing. *Anthropology and Education Quarterly*, vol. 36, no.1. pp. 8-23.

Bell, P, Lewenstein, B, Shouse, A.W., Feder, M.A., Eds. (2009) *Learning Science in Informal Environments: People, Places, and Pursuits*. Washington, D.C.: The National Academies Press. 336 pp.

Bennett, T. M. B., Maynard, N., Cochran, P., Gough, R., Lynn, K., Maldonado, J., Voggesser, G., Wotkyns, S., and Cozzetto, K. (2014) Indigenous peoples, lands, and resources in J. Melillo, T. Richmond, and G. Yohe (Eds.) *Climate Change Impacts in the United States: The Third National Climate Assessment*, Washington, D.C.: U.S. Global Change Research Program. pp. 297-317.

Climate and Traditional Knowledges Workgroup (CTKW) (2014) *Guidelines for Considering Traditional Knowledges in Climate Change Initiatives*. Retrieved from: http://climatetkw.wordpress.com/.

Davis, J. and Bauman, K. (2013) *School Enrollment in the United States: 2011 Population Characteristics*. Retrieved from https://www.census.gov/prod/2013pubs/p20-571.pdf.

Dierking, L. D., Falk, J. H., Rennie, L., Anderson, D., and Ellenbogen, K. (2003) Policy statement of the "Informal Science Education" Ad Hoc Committee. *Journal of Research in Science Teaching*. vol. 40. pp. 108-111.

ecoAmerica, Lake Research Partners, and Krygsman, K., Speiser, M., and Perkowitz, R. (2015) *Let's Talk Climate: Messages to Motivate Americans*. Washington, D.C. Retrieved from http://ecoamerica.org/wp-content/uploads/2015/11/eA-lets-talk-climate.pdf.

Eisenack, K. & Reckien, D. (2013). Climate Change and Simulation/Gaming. *Simulation & Gaming*, vol. 44, nos. 2-3, pp. 245-252.

Frameworks Institute (2014) *Getting to the Heart of the Matter: Using Metaphorical and Causal Explanation to Increase Public Understanding of Climate and Ocean Change*. Retrieved from http://www.frameworksinstitute.org/assets/files/PDF_oceansclimate/occ_metaphor_report.pdf.

Fraser, J. and Sickler, J. (2009) Measuring the cultural impact of zoos and aquariums. *International Zoo Yearbook*. vol. 43, no. 1. pp.103-112.

Luebke, J.F., Clayton, S., Saunders, C.D., Matiasek, J., Kelly, L.-A. D., and Grajal, A. (2012) *Global Climate Change As Seen By Zoo And Aquarium Visitors*. Brookfield, IL: Chicago Zoological Society. Retrieved from: www.waza.org/files/webcontent/1.public_site/5.conservation/climate_change/CLiZEN%20Report.pdf.

Mendler de Suarez, J., Suarez, P., Bachofen, C., Fortugno, N., Goentzel, J., Gonçalves, P., Grist, N., Macklin, C., Pfeifer, K., Schweizer, S., Van Aalst, M., and Virji, H. (2012). Games for a New Climate: Experiencing the Complexity of Future Risks. Pardee Center Task Force Report. Boston: The Frederick S. Pardee Center for the Study of the Longer-Range Future, Boston University.
NGSS Lead States (2013) *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Retrieved from: http://www.nextgenscience.org/next-generation-science-standards.

PBS LearningMedia (2015) *Carbon Dioxide and the Carbon Cycle*. Arlington, VA. Retrieved from: http://www.pbslearningmedia.org/resource/pcep14.sci.ess.co2cycle/carbon-dioxide-carbon-cycle/.

Pfirman, S., Lee, J., O'Garra, T., & Bachrach, E. (2015, December). Better retention through game-play – EcoChains: Arctic Crisis card game. Poster presented at the American Geophysical Union Fall 2015 Meeting. San Francisco, CA. Abstract retrieved from https://agu.confex.com/agu/fm15/meetingapp.cgi/Paper/75160.

Schultz, P.W. (2002) Knowledge, information, and household recycling: Examining the knowledge-deficit model of behavior change in T. Dietz, and P.C. Stern (Eds.) *New Tools for Environmental Protection: Education, Information, and Voluntary Measures*. Washington, D.C.: National Academy Press. pp. 67-82.

The Ocean Project (2009) *America, the Ocean, and Climate Change*. Retrieved from http://theoceanproject.org/communication-resources/market-research/reports/#2009.

Thompson, J.L., Davis, S. and Mullen, K (2013) Climate Change Communication Campaign Planning: Using Audience Research to Inform Design. *The George Wright Forum*, vol. 30, no.2. pp. 182-189.

Vinyeta, K., and Lynn, K. (2013) *Exploring the Role of Traditional Ecological Knowledge in Climate Change Initiatives*. US Forest Service Pacific Northwest Research Station. General Technical Report PNW-GTR-879. 37 pp. Retrieved from http://www.fs.fed.us/pnw/pubs/pnw_gtr879.pdf.

WestEd (2002) *Improving Districts: Systems that Support Student Learning.* San Francisco: WestEd. 64 pp.

Wu, J.S. and J.J. Lee (2015) Climate change games as tools for education and engagement. *Nature Climate Change*, vol. 5. pp. 413–418.

FURTHER READING

Barnhardt, R. (2015) Cultivating education for cultural sustainability in Alaska Native communities in G. Gipp, S.Warner, J. Peace, and J. Shanley (Eds.) *American Indian Stories of Success: New Visions of Leadership in Indian Country.* Santa Barbara, CA: Praeger. 361 pp.

Cajete, G. (2009) Seven orientations for the development of indigenous science education. In N. Denzin, Y. Lincoln, and L. Smith (Eds,) *Handbook of Critical and Indigenous Methodologies*. London: Sage Publishing. pp. 487 - 496.

Chinn, P. and Nelson-Barber, S. (Eds.). (in press) Indigenous STEM Education: Perspectives from Pacific Islands, Pacific Rim, and Southeast Asia. *Cultural Studies of Science Education*. New York: Springer Netherlands.

Climate Education Partners (2013) *San Diego, 2050 is Calling. How Will We Answer?* Retrieved from: http://www.sandiego.edu/climate/documents/2015-ki-interview-brochure.pdf

Climate Education Partners (2015) *San Diego, 2050 is Calling. A Brief Analysis from Interviews with the San Diego Region's 100 Key Influentials.* Retrieved from: http://cnap.ucsd.edu/pdffiles/2050.pdf

Climate Education Partners (2015) *Answering the Call.* Retrieved from: https://www.youtube.com/watch?v=oERiAMtUmLg

Estrada, M,, Woodcock, A., Hernandez, P.R., and Schultz, P.W. (2011) Toward a model of social influence that explains minority student integration into the scientific community. *Journal of Educational Psychology.* vol. 103. Pp. 206–222.

Fine, M., Tuck, E., and Zeller-Berkman, S. (2009) Do you believe in Geneva? Methods and ethics at the global-local nexus. In N. Denzin, Y. Lincoln, and L. Smith (Eds,) *Handbook of Critical and Indigenous Methodologies*. London: Sage Publishing. pp. 157 - 180.

Kincheloe, J. & Steinberg, S. (2009) Indigenous knowledges in education: complexities, dangers, and profound benefits. In N. Denzin, Y. Lincoln, and L. Smith (Eds,) *Handbook of Critical and Indigenous Methodologies*. London: Sage Publishing. pp. 135 - 156.

LaFrance, J. and Nichols, R. (2009) *Indigenous Evaluation Framework-Telling Our Story in Our Place and Time*. Alexandria, VA: AIHEC. 340 pp.

Leiserowitz, A. et al. (2014). *Climate Change in the American Mind*. Retrieved from: http://environment.yale.edu/climate-communication/files/Climate-Change-American-Mind-April-2014.pdf.

Michaels, S., Shouse, A.W., and Schweingruber, H.A. (2008) *Ready, Set, Science! Putting Research To Work in K-8 Science Classrooms*. Washington, DC: The National Academies Press. 220 pp.

National Research Council (2011) *Climate Change Education: Goals, Audiences, and Strategies. A Workshop Summary.* S. Forrest and M.A. Feder, Rapporteurs. Washington, DC: The National Academies Press. 98 pp.

National Research Council (2012) *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. 400 pp.

Nelson-Barber, S., Rechebei, E., and Limes, J. (2016) *Integrating local Indigenous knowledge and climate education in the Mariana Islands*. Paper to be presented at the annual meeting of the National Association for Research in Science Teaching, Baltimore, MD. April 14 – 17, 2016.

North American Association for Environmental Education (2010) *Excellence in Environmental Education: Guidelines for Learning (K-12)*. Washington, DC: NAAEE. Retrieved from: http://eelinked.naaee.net/n/guidelines/posts/Excellence-in-Environmental-Education-Guidelines- for-Learning-K-12.

Pacific Islands Climate Education Partnership (2015) *K-12 Climate Education Framework*. Retrieved from http://pcep.prel.org/resources/k-12-climate-science-concepts-and-skills-for-pacific-island-students/.

Pene, F., Taufe'ulungaki, A. and Benson, C. (2002). *Tree of Opportunity: Re-thinking Pacific Education*. Suva, Fiji: The University of the South Pacific Institute of Education. 141 pp.

Schultz, P.W. (1999) Changing behavior with normative feedback interventions: A field experiment of curbside recycling. *Basic and Applied Social Psychology*. vol. 21, no.1. pp. 25-36.

Schultz, P.W., Nolan, J.M., Cialdini, R.B., Goldstein, N.J., and Griskevicius, V. (2007) The constructive, destructive, and reconstructive power of social norms. *Psychological Science*, vol.18, pp. 429-434.

Stern, P.C. (2011) Contributions of psychology to limiting climate change. *American Psychologist*. vol. 66, no. 4. Pp. 303–314.

Spitzer, W. (2014) Shaping the Public Dialogue on climate change. Future earth—advancing civic understanding of the Anthropocene, Diana Dalbotten, Gillian Roehrig, and Patrick Hamilton (Eds.) *Geophysical Monograph* 203. Hoboken, NJ: John Wiley & Sons, Inc. pp. 89-97.

Thaman, K. Ed. (2003) *Educational Ideas from Oceania*. Suva, Fiji: The University of the South Pacific Institute of Education. 113 pp.

U.S. Global Change Research Program (2009) *Climate Literacy: The Essential Principles of Climate Science*. Washington DC. Retrieved from: http://www.globalchange.gov/browse/reports/climate-literacy-essential-principles-climate-science-high-resolution-booklet.

CONTRIBUTORS

John Anderson, New England Aquarium—National Network for Ocean & Climate Change Interpretation (NNOCCI)

Corrin Barros, Pacific Resources for Education & Learning (PREL)—Pacific islands Climate Education Partnership (PCEP)

Michel Boudrias, University of San Diego—Climate Education Partners (CEP)

Jessica Brunacini, Columbia University—Polar Learning and Responding Climate Change Education Partnership (PoLAR CCEP)

Malinda Chase, with the 2015-16 Board of Directors, Association of Interior Native Educators—Polar Learning and Responding Climate Change Education Partnership (PoLAR CCEP)

Christiana DeBenedict, University of San Diego—Climate Education Partners (CEP)

Karen Elinich, Franklin Institute—Climate and Urban Systems Partnership (CUSP)

Raluca Ellis, Franklin Institute—Climate and Urban Systems Partnership (CUSP)

Mica Estrada, University of California, San Francisco—Climate Education Partners (CEP)

Andrea Gingras, University of Rhode Island—Climate Change Education Partnership (CCEP) Alliance Office

Patricia Harcourt, University of Maryland Center for Environmental Science—Maryland and Delaware Climate Change Education, Assessment and Research (MADE CLEAR)

Marylin Low, Pacific Resources for Education & Learning (PREL)—Pacific islands Climate Education Partnership (PCEP)

Sharon Nelson-Barber, WestEd—Pacific islands Climate Education Partnership (PCEP)

Emerson Lopez Odango, Pacific Resources for Education & Learning (PREL)—Pacific islands Climate Education Partnership (PCEP)

Stephanie Pfirman, Barnard College, Columbia University—Polar Learning and Responding Climate Change Education Partnership (PoLAR CCEP)

Gail Scowcroft, University of Rhode Island—Climate Change Education Partnership (CCEP) Alliance Office

Nilmini Silva-Send, University of San Diego—Climate Education Partners (CEP)

Elena Sparrow, International Arctic Research Center—Polar Learning and Responding Climate Change Education Partnership (PoLAR CCEP)

Billy Spitzer, New England Aquarium—National Network for Ocean & Climate Change Interpretation (NNOCCI)

As part of its vision, the CCEP Alliance developed the models described herein to educate and empower citizens. It is hoped that as a result, the proven approaches and strategies will lead to more informed decisions regarding addressing, adapting to, and mitigating climate change.

www.ccepalliance.org

This material is based upon work supported by the National Science Foundation under Grant No. 1331592. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Graphic design services for this publication were provided by The Franklin Institute.






Climate Change
Education Partnership
Alliance






CLIMATE CHANGE EDUCATION

EFFECTIVE PRACTICES FOR WORKING WITH EDUCATORS, SCIENTISTS, DECISION MAKERS AND THE PUBLIC

PRODUCED BY THE CLIMATE CHANGE EDUCATION PARTNERSHIP ALLIANCE