Education for Sustainability and Resilience in a Changing Climate

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Abstract: Educators, researchers, planners, and policy-makers are faced with the challenge of preparing current and future generations for adaptation to the impacts of climate change. Pedagogy related to living sustainably and creating resilience is a complex field of educational practice that involves cognitive, social, and affective aspects of teaching and learning such as environmental decision-making both in a reactive and an anticipatory framing; learning in both formal and informal environments; learning to understand complex systems; and understanding both scientific and socio-cultural aspects of climate change issues related to sustainability and resilience. This symposium brings together a set of diverse research projects that, together, shed light on teaching and learning about sustainability and resilience in a changing climate.

Introduction

The disparity between ecology (which is cyclical) and contemporary production and consumption processes (which are relatively linear) gives rise to unprecedented structural violence and human rights abuses (Bales, 2004) as well as climate change and related effects such as atmospheric and oceanic warming, extreme weather events, reductions in snow and ice, and global mean sea level rise (IPCC, WG-I SPM, 2013). This structural violence and climate change can be traced back to issues of sustainability and resilience across environmental, health, and social factors (Adamson, Evans, & Stein, 2002, Orr, 2012). Thus, the research presented in this symposium is directed at designing educational interventions to catalyze positive social action that addresses the *un*sustainability of and lack of resilience in contemporary attitudes, behaviors, and consequent systems of production and consumption.

According to Orr (1992), this truly global crisis of unsustainability is "qualitatively different, without any historical precedent" and "unprecedented in its sheer complexity" (p. 19), transversing energy, resource use, climate, waste management, technology, cities, agriculture, biological diversity and resilience, international security, politics, and human values — a clear and urgent mandate for rejuvenated participation in civic culture, and "an ecologically literate and ecologically competent citizenry" (p. 1).

Educators, scientists and policy-makers are thus faced with the challenge of preparing current and future generations to make decisions that will mitigate the effects of, and allow us to adapt to, the severe impacts of structural violence and climate change. Learning about sustainability and resilience are essential elements of how communities around the world can change their ways of living and adapt to the changing environment, which is, in turn, essential to ensuring human resilience. As Orr (1992) writes, "The goal of ecological competence implies a different kind of education and a different kind of educational experience that develops the practical art of living well in particular places" (p. 84).

The related attitudes and behaviors are complex and dynamic, and likely influenced by personal experience and knowledge, as well as cultural and political knowledge and values systems. For example, research has shown that cultural and political values play an important role in how individuals understand climate science (Leiserowitz et al., 2012). These cultural and political values also influence what actions individuals are likely to take based on their understanding of the science of climate change (Leiserowitz & Smith, 2010). Estrada's (2011) Tripartite Integration Model of Social Influence (TIMSI), suggests that supporting climate change related behaviors involves individuals (a) gaining self-efficacy; (b) identifying with concern about climate change, and; (c) adapting to the values of that group. However, the learning processes by which individuals negotiate the aspects of TIMSI while understanding climate science and its impact on their everyday life are not well understood. Helping people learn about the science of sustainability and resilience is complex enough that even those that are knowledgeable about climate science struggle to incorporate knowledge about climate change into their everyday lives (Pidgeon & Fischhoff, 2011). Understanding the content, incorporating the content knowledge into decision-making in everyday life, and using the content knowledge to conceptualize sustainable mitigation and adaptation strategies requires learners to not only connect their own actions to consequences, but also to change attitude and behavior patterns.

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Research in sustainability, resilience and environmental adaptation addresses the learning goals of (a) understanding issues of sustainability and resilience across spectra –from the personal to the global– and (b) being able to situate one's self within various systems and subsystems. Pedagogy related to living sustainably and creating resilience is a complex field of educational practice that involves cognitive, social, and affective aspects of teaching and learning. More specifically, educational considerations include (but are certainly not limited to) environmental decision-making both in a reactive and an anticipatory framework learning in both formal and informal environments, learning to understand the complex systems of climate and ecosystems, and understanding both scientific and cultural aspects of the problems at hand, such as climate change.

While all of the above aspects of related pedagogical practices are being studied discretely within the learning sciences, we propose a systems approach to the topic, the pedagogy, and the related processes of teaching and learning. Learning to adapt and build resilience requires individuals to: (a) learn how to make sustainable decisions (Atran, Medin & Ross, 2005); (b) learn how to anticipate problems (Hewson, 1992); (c) learn within their informal and formal environments (Bell et al., 2009); (d) learn to understand and resolve complex issues (Resnick & Wilensky, 1998); (e) learn within their cultures (Banks, et al., 2007); (f) learn how to resolve problems (Hmelo-Silver, Marathe & Liu, 2007), and; (g) learn how to collaborate with each other (O'Donnell, Hmelo-Silver & Erkens, 2013) to build a sustainable and resilient future.

In this symposium we bring together scholars studying some of the aforementioned aspects of educational practice across a diverse set of learning environments in addressing the question of how we in the learning sciences can contribute to this "different kind of education" (Orr, 1992). The symposium includes discussion of a variety of challenging issues faced by youth and adults, students and teachers as they address sustainability and resilience in local and personal, as well as globalized contexts by researchers from different disciplines within the learning sciences community.

Our exemplars are geographically and culturally diverse. By profiling how youth in Bhutan merge formal and informal value systems to engage environmental decision-making processes, the symposium not only invites conversation about how youth in Bhutan learn to engage with complexity but also how they merge formal and informal knowledge so as to learn environmental problem solving strategies that lead to sustainability. As a part of the symposium we discuss how rural communities in Ghana and Tanzania use an anticipatory learning framing to learn about processes that would help them plan for the future changes occurring due to the impact of climate change. In this presentation we also discuss the importance of connecting the past and the future to the present lives of Native American students. Finally, the symposium includes a project that discusses the challenges faced by teachers in the United States while teaching climate change in the formal classroom.

Learning to Make Decisions in the Bhutanese Himalayas

Sameer Honwad, New York University

Learning to make decisions in everyday life that lead to environmental sustainability will allow communities to better cope with current impacts and shape future ones (Smit et al., 1999). Literature in environmental adaptation suggests that environmental decision-making that would help mitigate the impact of climate change and help communities adapt to the changing environment requires that individuals: (a) learn that everyday actions (eating breakfast, using technology, washing clothes, etc.) are interactions with the environment; (b) understand that everyday actions/decisions have an impact on the environment at a local, national and international level, and; (c) understand that the long-term impact of these actions/decisions is an important aspect of how one can adapt to the changing environment (Bhagwat et al., 2005).

Using the three points mentioned above, this study examines the current status of how youth in the Bhutan Himalayas understand the environmental decision-making process. The study focuses on the Bhutan Himalayas, communities in the mountain regions of Asia that are highly vulnerable to the negative impacts of the climate change and therefore are in an urgent need to understand and learn to adapt to the changing environment. The retreat of the Himalayan glaciers threatens Bhutanese populations by decreasing their access to water supplies and dramatically changing the landscape that they rely upon for subsistence (Anthwal et al., 2006). The retreating glaciers also pose a threat to the Bhutanese economy, as their main income generator is hydro-electricity. Given the urgent need to help the people in Bhutan to adapt to the changing environment, this study focuses on how to help youth in Bhutan understand the process of decision-making that would lead to greater environmental sustainability.

The study examines the process of environmental decision-making through the lens of education/learning and comments on the improvements required in formal environmental sciences/education curriculum so that young people can reflect on the decision-making processes, understand how to mitigate the impact of climate change, and adapt to the changing environment. The study addresses five research questions: 1. What are the main activities that occur in the everyday lives of college students in Bhutan? 2. How do the youth in Bhutan conceptualize their everyday life decisions in terms of the impact on their local environment? 3.

How do Bhutanese youth understand the impact of their everyday life decisions on the environment beyond local level—at national and international levels? 4. How do Bhutanese youth conceptualize the long-term impacts of their everyday life actions/decisions? 5. What role does the formal environmental sciences/education curriculum play in the everyday life decision-making processes among the youth in Bhutan?

The study seeks to address the deficiency in the literature for environmental decision-making processes from a learning and education perspective. The goal of the study is to help youth understand that everyday life decisions involve environmental interactions and that in order to be good stewards of the environment the focus needs to be on reflecting on everyday life decisions. The study also seeks to move beyond the current paradigm of environmental education, which discusses good decisions (recycling, riding a bicycle, buying organic food, etc.) and bad decisions (driving a non-fuel efficient car, not buying local, eating meat, etc.) in terms of having an impact on the environment. The study keyed on two questions: how do people live their everyday lives? and, how can we make our future generations aware of good problem solving skills that would lead to sustainability? As Sillitoe (2007) emphasizes, there is a need to engage the complexity that characterizes people's everyday lives and the relationships that they share with their place. Thus, the study is designed to take the first step so as to understand how people live their everyday lives and how they understand the impact of their lives on the environment.

The study used ethnographic methods—participant observations and interviews—to answer the research questions. Twenty-two first year college students participated in the study. The main finding of the study was that students do not view their everyday life actions/decisions as a part of interaction with the environment. While more than 50% of students understood that their food-, technology-, and transportation-related decisions had impact on the environment, only 1 student understood that recreational activities/decisions also have an impact on the environment. It was observed that students struggled with thinking about their everyday life actions having impact at a broader scale. While a majority of the students understood that there could be some impact at the broader scale, they exhibited a poor understanding of the impact itself. This can be observed through examining the answers of why might there be an impact at the global scale. For example, when asked whether their food habits would have an impact at a broader scale, a majority of respondents talked about wasting food as the only impact that would happen at the broader scale. While food wastage is definitely a global problem, there are several other problems such as mass production of agriculture or import/export of food that were missed. Thus, overall the students were not able to display an understanding of interconnectedness. The idea of interconnectedness is an important concept in the learning to adapt and build resilience conversation. Interconnectedness helps students understand how environmental decisions are tied into one another and impact local and global environmental systems.

The students also displayed an idea that there are 'good' and 'bad' environmental practices. When discussing impacts, the students only discussed those that were considered negative. Even when told that they should talk about both negative and positive impacts the students only discussed negative impacts. This is a perspective that is often observed in environmental education programs. The idea that there are good practices and bad practices is a not always conducive to advancing the sustainability discourse. Other research also indicates that environmental education research aimed at adaptation and resilience building should move away from imparting to the students knowledge about 'good' decisions and 'bad' decisions (Tilbury, 1995).

Student respondents did not see their environmental sciences curriculum as a part of their everyday life. Even though they discussed getting their information from the environmental sciences curriculum, they were not able to connect the information in the curriculum to their everyday lives and thus are not able to understand the interconnectedness among the environmental phenomena and lives of people all over the world. The curriculum itself takes on a broad view of the environment. While the authors try to connect the curriculum to the everyday lives of the students, it is observed that the curriculum does not succeed in connecting the content to the students' everyday lives. Also, the curriculum is further isolating to the students of Bhutan as the authors have a universal/Western science viewpoint.

The main findings above suggest a different approach to designing an environmental sciences curriculum for the students of Bhutan to help them adapt to the changing environment. An environmental sciences curriculum that focuses on adaptation to climate change needs to address the element of interconnectedness. Interconnectedness requires the students to understand how local systems and global systems are connected to each other and also have the students think about their decisions in terms of future impacts. Learning about the environment would require learners to think about the known (local–short term) and the unknown (global–long term). The learners also need to understand that even the smallest of the actions/decisions in their everyday lives create a disturbance/adjustment in the environment. To deal with a problem of such dynamic nature requires constant dialogue (deliberation/mitigation) and collaboration (sharing of knowledge). It will require equity, as collaboration studies have observed that any collaboration between non-equal partners is not successful. Thus, any design for environmental science education in the future should put the above-mentioned elements in the center and the content matter as support material. Every chapter/lesson in

the curriculum should be outlined as local and global, short-term and long-term, and should have an emphasis on mitigation, collaboration, and consensus building.

Resilience Through Relationships: Utilizing the Past to Build a Better Future

Rose Honey, Harvard University

Adaptation and resilience building includes an understanding of the past to build a sustainable present and future (Smit et al., 1999). This presentation examines a curriculum development process that incorporates the past, present and future with the intention of helping Native American students to adapt to their changing environments while learning about their traditional culture and the world around them. Research suggests that for Indigenous children who live in traditional communities, incorporating cultural relevance into science lessons can help students to negotiate their life-world culture into the culture of school science (Aikenhead & Jegede, 1999). It also promotes student intrinsic motivation to learn about the environment around them (Honey, 2013). Spotlighting the development of a curriculum that is developed for Native American communities as they move through western/modern and traditional cultures demonstrates how to combine Native learning processes such as relationship building, respect for the environment, and interconnectedness with scientific experimentation and concepts. As the TIMSI model explored by Estrada (2011) suggests, this curriculum encourages teachers and students in early learning classrooms to think about the water in their community from both a cultural and Western Modern scientific perspective, thus hoping to promote deeper integration and "durable motivation to persist as a scientist."

Discovering Our Relationship with Water is an early learning science curriculum being developed as part of The Handbook on Designing Curriculum Honoring Tribal Legacies: An Epic Journey of Healing. This multi-literacies handbook, supported by the National Park Service, revisits the history of Lewis and Clark and the Corps of Discovery and integrates culture and Indigenous perspectives into curriculum units that focus on a variety of learning disciplines (Honoring Tribal Legacies, 2013). One important goal of this project is to connect present-day people, including tribal communities, to the places associated with the Lewis and Clark expedition. The Lewis and Clark National Historic Trail provides an opportunity to demonstrate the continuum of human history in these same locations and the subsequent relationships that have developed and will develop with our environment and our culture into future generations. Through the lens of history, young learners will be guided to think about our relationship with water, and what human relationships with water were like during the time of Lewis and Clark. Through future iterations of this curriculum aimed at older learners, students can begin to think about how humans have adapted to changes in our relationship with water today and can then begin to discover what our relationship with water might look like in the future. The ability to learn from the past and transfer these lessons toward problem solving in the future is an important skill in a world where we need to learn to adapt to a changing environment.

Water is fundamental not only to our survival, but to our personal health, to the food that we eat, to industry in our communities, to travel, and almost any activity that we participate in. The relationships that we have with water will determine our lifestyles and possibly our survival into the future. Focused on early childhood education (ages 3–5 years), this curriculum is aligned with Common Core State Standards and Next Generation Science Standards. It aims to guide students to discover and build their own relationship with water, learn how water is connected to their community, and begin to understand the importance of water in our environment. Through these lessons, students will begin to build foundations for thinking about human and other organism's relationship with water in the future. There are six units or "learning episodes" which incorporate three main elements: Honoring Tribal Legacies, Scientific Experimentation, and Lewis and Clark and the Corps of Discovery. One goal that honors tribal legacies is to have students look at water as a sacred and living entity that takes care of us, and that needs to be taken care of by us as humans. Another component is to guide young learners to explore water through experimentation, and familiarize them with the idea of scientific exploration. And finally, utilizing Lewis and Clark and their quest to find a water passageway to the Pacific Ocean, the curriculum connects details of their journey to lessons about water and relationships with tribal people. Incorporating these elements into each lesson helps guide students to consider the past while predicting and problem solving in the present and for the future. The six learning episodes are:

1. *Connections: The Water in Our Community*. This episode focuses on how we are connected to the water in our community.
2. *Balance: Sinking and Floating*. This learning episode is focused on balance and the importance of having a balanced relationship with water.
3. *Transformation – Gas, Liquid & Solid*. This episode recognizes that water can transform, and that this can help to keep nature in balance.
4. *Cycles – The Movement of Water*. This episode teaches that water moves from place to place as part of the water cycle.

5. *Reciprocity – Happy & Healthy Water*. The focus for this unit is on how we can take care of water and how water takes care of us.
6. *Relationships – Plants, Animals & Water*. This learning episode teaches learners that we all have a relationship with water.

Thinking about how water looks, feels, and sounds, envisioning boats floating or sinking in rivers, imagining water freezing in the winter and thawing in the spring, looking for food in water such as plants and fish—all of these are vehicles toward thinking about our relationship with water and the relationship that water has to many different things in our world. Engaging students at a young age in these teachings will inspire and initiate a journey of play and inquiry that are designed to promote understandings, discoveries, and relationships related not only to water, but also to the world around us. By bringing past events into lessons for the future, teachers can guide students toward a type of learning that helps them to gain a sense of self, feel more connected within their community and with the world around them and fosters a sense of stewardship and relationship building so that at a young age, students begin to build relationships with our environment and learn to take care of everything in the world that we are connected to.

In this presentation, the design process associated with the curriculum will be discussed as well as how stakeholders from various backgrounds and with different agendas help to shape the curriculum aimed at the adaptation process. Additionally, there will be an emphasis on the methods of including affective domains of learning such as engagement and relationship building into an environmental science curriculum. This motivates students to care for their environment as they bridge the gap between formal and informal learning environments, and promotes an understanding of our past as a means toward building a sustainable present and future.

Climate Change, Anticipatory Learning, and Co-resilience in Vulnerable Places

Kenneth Tamminga, Pennsylvania State University

The flurry of climate change and resilience discourses at larger scales of theory and praxis can overlook the tenuous relationships between rural communities and their landscapes. Our interdisciplinary project, Anticipatory Learning for Climate Change Adaptation and Resilience (ALCCAR), was funded through a grant from the National Science Foundation's Human and Social Dynamics Program. It took place in rural Ghana and Tanzania from 2009 to late 2012, and involved a consortium of U.S. and African scholars and non-governmental organizations (NGOs). Disciplines represented on the research team included geography, learning science, landscape architecture, climate science, community development, and disaster management. We explored community-level adaptive capacity using the concept of anticipatory learning, defined as learning about and imaginatively engaging with alternative futures as climate change impacts are increasingly felt. We were interested in how iterative social-ecological learning may enhance a community's capacity to make flexible decisions in the face of growing uncertainty and climate change. We argued that resilience of social-ecological systems relies on iterative learning, reflection, and innovation based on past knowledge ('memory'), present understandings ('monitoring and observation'), and anticipation of future change ('envisioning') (Walker et al., 2004; Tschakert & Dietrich, 2010). This grounded methodology emerged from an interplay between the applied scholarship of investigators and the local sensibilities of co-investigators drawn from regional NGO partners, broadly informed by theory in the learning sciences, management studies, and community planning and development.

We conducted a series of participatory research and learning activities (n=15) in each of the 8 rural communities, and in the context of 3 kinds of relational spaces: *visceral/embodied* (e.g. walking journeys, environmental monitoring), *discursive/dialogic* (e.g. scenario building, local theatre, futures mapping), and *material/diffusive* (e.g., scaled-down climate projection trainings, landscape inventories) (Tschakert, Tamminga, and Dietrich, 2013). We report here on several tools that seem relevant in the context of these proceedings.

The walking journey activity emerged following start-up events that gauged community-scale anticipatory learning capacities through participatory decision-making and information flows. It quickly became apparent that many of these processes were situated spatially through a localized vocabulary of places and pathways. Thus, we worked with our NGO partners in devising walking journeys with select influencers who led us through their daily working environs and special places. The 3 thematic journeys were *Elemental* (water and soil), *Biodiversity* (local and regional flora and fauna), and *Place* (sacred and special places and pathways). Earlier social network mapping and advice from village leaders were used to identify a pair of key informant-guides for each theme. The pair then devised and led a 3–4 hour walk through the landscape surrounding their village, interpreting the history of change, current status, and sustaining capacities along their designated theme. Videotaped data were transcribed and coded, with findings showing a range of place-based awareness. The walks helped us to see how resident experts learn from the land, how they are connected to its past and present, and how they share land-based knowledge. However, levels of expertise, deep understanding of natural process, and extent of knowledge sharing through the village varied largely from one pair of guides to the next. An

unanticipated positive outcome was that reference to the walking journeys as a way of knowing was repeatedly made during later community-wide activities (e.g. community theatre, layered mapping, exit interviews), indicating a collective confirmation of the niche role that place-based influencers could play in building adaptive capacity.

Concurrently, the environmental monitoring activity engaged small groups of resident volunteers in gathering and assessing environmental data. We instructed these citizen scientists in observing and charting local phenomena of relevance to their small-scale farming and fishing economies (e.g. temperature, rainfall, erosion, patterns crop yield and prices). After 12-18 months of data collection, monitoring results provided opportunities for sharing knowledge, and corroborated earlier village-scale instruction on downscaled climate projections led by the team's climate scientist. As one participant noted, the monitors and walking journey guides represented each community's "living library." Post project, and with the ongoing assistance of regional NGOs, monitoring groups continue to collect data and share insights at the village and district levels.

The scenario building activity initiated the final phase of research focusing on the future. Representative groups of women and men developed three distinct visions of their community set in the year 2035, under several possible climate change regimes. Facilitated through our NGO practitioner partners, we introduced information about future precipitation and temperature from downscaled climate projections, injecting trends and surprises beyond the community's embodied knowledge. Participants explored and navigated their values, fears, and dreams for the future. The creative co-learning process resulted, once again, in varied scenarios, from idealistic to realistic to rather gloomy. In Ghana, optimistic scenarios were most frequent; in Tanzania, apprehension and realism were at the fore. Even within village groups, some scenarios revealed contested trajectories. Yet all participants got a taste for the creative power of envisioning uncertain-but-plausible futures, and all were eager to proceed with more detailed conceptualizations.

The layered mapping activity played out a nascent form of community planning and resource management. Facilitated by our NGO partners who we trained in advance, a layered mapping exercise was conducted with participants from across the community. Acetate overlays allowed ideas to be placed over the Community Map paper base that had been constructed during the earlier scenario building. The two overlays, *Concern & Opportunities* and *Ideas for the Future*, addressed the working themes of resource allocation, environmental hazards, infrastructure, civil discourse, and longer-term environmental monitoring. All participants were invited to contribute using dry-erase markers, applying commonly understood symbols as a sort of iconographic shorthand. This was followed by a reflective group-wide discussion that considered the mapping process, its content, degree of inclusivity, and next steps. We found that participants were quite adept at basic concept mapping, and spatially well aware of competing resources and spaces. More significantly, we witnessed almost all participants beginning to grasp the sense of empowerment that could come from even this sort of rudimentary 'proto-planning' as a creative and negotiated endeavor. However, idealism consistently outweighed realism in all 8 communities; setting attainable, flexible and complementary goals remains a subsequent step to tackle.

Community leaders are now working with our NGO partners in refining and scaling up planning options in anticipation of climate change impacts and opportunities. Grounded anticipatory learning and participatory envisioning of preferred-but-realistic futures is just a part of the complex challenge of building local capacity to achieve co-resilience: communities and working landscapes that each sustains the other through time.

Learning to Research: Fostering Climate Change Education Through Student Climate Research

Ofelia Mangen Sypher, Christopher Hoadley and Armanda Lewis, New York University

The "Learning to Research" (L2R) project was a three-year experiment in fostering climate change education through student-led inquiry oriented climate research conducted in the context of the GLOBE program (globe.gov). Normally, GLOBE uses scientist- and educational researcher-developed curriculum to involve students worldwide in earth science data collection, aggregation, and to some extent analysis. Dissemination is carried out primarily through teacher training on pre-developed data collection protocols, teacher and student conferences, and through online sharing of data. L2R took a different approach in which teachers were asked to create student- or teacher-led inquiry science curriculum on climate change, using either existing data or data they would collect. In this novel teacher professional development model, teachers were given face-to-face professional development (3 days in-person per cohort), and then were supported to connect with professional scientists, GLOBE educators, and each other online to design their own curriculum. They also participated in monthly seminars on Adobe Connect in which shared project-related issues and solution, as well as heard career-oriented presentations by professionals using climate-related STEM knowledge in a wide range of careers (from scientists to disaster relief and public health professionals).

In this symposium, we discuss two sets of findings from the project. First, we present the results of a study of collaboration processes on the curriculum design teams. This study examined collaborative outcomes using the TACIT framework (Hoadley, Lee, & Sockman, 2006) based on five dimensions of collaborative challenges: Trust, Awareness, Contextualization, Incentives, and Techniques for Coordinating. Results indicate that these dimensions of the collaboration did help predict success on designing and implementing climate change curriculum. Of the surveyed participants, those who reported that they successfully completed their projects also had higher mean TACIT scores than those who reported that their teams were "partially successful at achieving goals" (p=.999). We speculate on ways these dimensions might have been influenced by the project design, the collaboration factors (group type, communication media, co-location, etc.).

Secondly, we discuss cases that explore how climate change teachers perceive of their participation in technologically enhanced, collaboratively based professional development activities with respect to educational and research objectives. Such markers of successful L2R integration, which were triangulated with survey data, include the degree to which teachers access expert knowledge, report changes in their own or their students' disciplinary knowledge, and observe instances of student-led use of data to explore climate-related issues. Additionally, we will illustrate the unanticipated difficulties in helping teachers address climate change in their classrooms, and how these unanticipated difficulties were addressed in successive cohorts in the teacher training. These unanticipated difficulties included: participating teachers' misconceptions about the fundamental processes of climate change; the need to have strategies for addressing the politics of teaching climate change; challenges surrounding collaborative project-based learning; and the difficulty of having students generate answerable questions about climate through data-driven inquiry. Changes in the program for later cohorts included: increased training on basic climate science; a reduced reliance on distant teacher-peers as co-implementers of geographically distributed curriculum and increased reliance on them as advisers and/or sources of case data; more emphasis on regular, technology mediated check-ins with the whole group; and additional mentorship on the development of specific research questions and collaborating with local scientific experts.

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