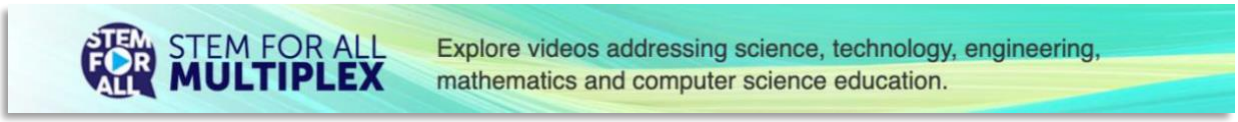

Addressing Climate Change in School and Community:
Learning, Discussing, Doing
STEM for All Multiplex Theme Synthesis
January 2021

Climate change presents an extraordinary challenge for STEM education, and an extraordinary opportunity. The scope and complexity of the changes now under way is leading to an intensive, world-wide scientific research effort, and concomitant advances in mathematics and engineering. Obviously, all this research activity offers exciting material for STEM education of all kinds, and curriculum standards and materials are taking increasing advantage of it — not only because the content is important and relevant, but also because we can see, almost week by week. how knowledge is made, tested, debated, and applied.

On the other hand, the immensity of likely climate impacts makes this a focus of urgent action for governments, agencies, and citizens. Moreover, the effects on lifestyles, economies, and infrastructures means that the choices before all communities require difficult decisions about priorities for action and expenditures. Differences of opinion in communities have political dimensions as well, so that educators have to be aware of how their communities will view the science being taught or cited in K-12 education, or in education for the public at large. For these reasons and more, climate change education is multi-dimensional: interdisciplinary, intergenerational, theoretical and applied, global and very local. The introductory blog for the Theme argued for the importance of coordination among these various strands, aimed at broad educational impact resulting in (among other things) an informed citizenry.

Our expert panel included four educators with experience in climate change education in formal, informal, and community settings, Leigh Peake, Chief Education Officer at the Gulf of Maine Research Institute in Portland, Maine; Trevor Lloyd-Evans, Director of the Landbird Conservation Program at Manomet, a conservation institution on the south shore of Massachusetts in Plymouth; and Gilly Puttick, an ecologist who has worked in science education research and development at TERC. Brian Drayton, the moderator, is also an ecologist and longtime TERC researcher. The participants in the Webinar were also from many different fields within education, including researchers among us, higher ed faculty, informal educators, and teachers at different levels from pre-K through college. In addition, there were science teacher coaches, administrators, and agency people. The very active chat during the webinar, and the discussion afterwards, yielded a wealth of resources and suggestions, which can be found here. *(More details about these experts can be found with the January Theme of the Month on the Multiplex site.)*

STEM education and the need for climate action

There is a real tension that that all climate educators have encountered, between the imperative to action and peoples' needing to just learn about the world they're in, in order to make sense of the problem. How do we think about an educational program, when the imperative for action is so strong? This is a question that was raised both in the panel, and by one of the participants, Alan Peterfreund, who wrote: “Given the politicization of our public discourse, I wonder whether we are clear about how we present and focus on the science of climate change in a manner that allows the politics and call for action being a response to a deeper scientific understanding.”

STEM education, as envisioned by the NGSS, for example, advocates participation in the process of science, a contextualized way to learn science, and this can make a bridge between learning and action. This is because research has shown that when people (of any age) have access to something concrete to do, they are more receptive to learning about climate change. Such application is not only a safety valve, relieving the feelings grief and anxiety that many feel as they learn about climate change, but also helps the learner come to grips with the complexity of the actual problem itself. For example, designing and conducting some mitigation activity with your own family at home, to get them to reduce their energy use, is a way to actually start thinking about what the science really means. Citizen science, such as exemplified in some programs at Manomet and at GMRI, provide another kind of avenue. How did our panelists talk about this problem?

Trevor Lloyd-Evans commented: “If I put a bird in your hand and you let it go, it's a wonderful experience; I can remember the first time somebody put a bird in my hand and it flew away — after the banding, and the weighing, and the measuring, and the taking of the scientific data. But the birds are just indicators of what's going on. I think when we were dealing with the middle school students, we had a couple of challenges. One, is that we had to encourage the students to understand that climate change is happening in their backyard, it's happening right around the school. Which is why we took the students out and we measured leaf emergence, and we measured canopy development during the spring. But it’s awfully hard to really talk about climate change. That’s one of the functions of curriculum materials, such as those we developed with our partners at TERC.” Gilly Puttick spoke to the relation she tries to make between science and action in her work with school-age children: “I think it depends very much on the age of the children. You can't confront 9-year-olds with how urgent it is. You can engage committed high schoolers, who are really eager to make a difference, and who want to find ways to make a difference. It depends on the audience. Also, we've tried to focus also on lots of little changes making a difference, because they add up. Again, age appropriately, I think that, yes, we need large scale. We need governments to act. But I think that students who grow up understanding what a difference one person can make, become active concerned citizens.”

Leigh Peake added the community dimension, acknowledging that students learning in school about climate change and other current issues may be from homes or

communities that are critical of the science: “We're mindful that some of those 10-year-olds are going home to dinner tables with people who don't believe in climate change. I don't want to put them in the position of being the ambassador or the person who has to make that point. I think, always we're thinking about how we are working at both those levels at once. But that the main thing is making sure that, that youth feels empowered in their own knowledge and their own analysis of a situation, regardless of what the adults around them.”

One of our participants, William Spitzer of the New England Aquarium, wrote “There is a great deal of research that shows that in order to effectively communicate about climate change in a way that supports effective, collective action we need to frame the issue in a way that connects to widely held values, explains the basic mechanism of how it works so that people can link the problem to the solutions, and provides examples of realistic solutions that match the scale of the problem. Our work on the NNOCCI project (see "Constructive Dialog about Climate Change" video in the playlist) shows how this plays out in an aquarium/zoo/nature center setting.”

Connecting to community

One of the challenges of climate change education is helping articulate the local/global link, in a way that's meaningful, that comes home to the learner. An example raised in the chat accompanying the expert panel was the strategy of and getting kids involved in hands-on activities like planting trees for carbon mitigation. Another strategy is to focus on the teachers and parents of the children, which can also be a way to reach out into the community, and link with other parallel efforts. Leigh Peake said: “What we hear when we talk to teachers, is that they definitely are the in-between in their community. They're aware that some of the families that they're working with are maybe not interested in their kids learning a lot of climate change. We had one teacher run out of town on a rail, for really working hard on climate change education. The focus on data literacy has been a really great hook for teachers. There are very few people who can't recognize that data is an incredibly important thing for kids to understand, in this day and age. It's a nice segue for the teacher when they're talking to parents. The one vehicle we have for parents, is a field notebook, that goes home from an informal experience the students have had, including video reflections that the kids made. They might say, ‘I noticed that lobsters are moving north.’ It provides fodder for those conversations to happen at dinner tables, when it's comfortable for them to happen.” Trevor Lloyd-Evans added: “Students learn very clearly from their peers, as well. Of course, we hope that it will then spread back into the family table, as Leigh has said.”

From learning to social change

Conservation scientists have learned to add anthropologists or sociologists to their teams, because any topic in environmental science has human dimensions, as Homo sapiens is so important a species on the landscape! This “biocomplexity lens” which has informed much of Puttick & Drayton’s curriculum work, requires some careful attention to the needs and voices of the stakeholders. At some point, one hopes that

communities can find agreement on the nature of the problems they face, and on some steps that they can take together, informed by the science, to make real change.

In the discussion, William Spitzer quoted the National Academies' 2018 report *How People Learn II: Learners, Contexts, and Cultures*, which introduced the concept of science literacy at a "community" level in addition to an individual level. Spitzer added, "A community-based approach is more likely to be successful since it can focus on concerns of value to the community; utilize scientific knowledge as a means to public ends; and involve deliberation, collaboration, and other forms of civic participation to work toward community-level solutions that are socially acceptable, feasible and effective. This approach can create the conditions under which communities can participate in joint meaning-making, consistent with a "non-persuasive" approach that promotes understanding of causes and consequences rather than experts advocating particular policies or actions."

Spitzer cited the work of sociologists Gary Fine and Brooke Harrington based on the concept of "tiny publics," i.e., "small groups that are a basis for affiliation, sources of social and cultural capital and a support point in which individuals in the group can have an impact on other groups or shape broader social discourse." Wolff-Michael Roth and Stuart Lee argue that these kinds of group affiliations where scientific literacies are negotiated and grown. Drayton pointed out a kindred approach being taken by a study of the "invisible fabric" of vernacular science in contemporary America, seeking to understand the mechanisms by which communities mediate the evaluation of various kinds of knowledge about the world — whether "mainstream science" or quite alternative accounts.

This requires some pedagogical attention, as Leigh Peake said, to the scales at which people can and can't make a difference: "We perceive there's a gap, between what the 10 -year-old can do, what the family can do and what would actually change the world. Being aware that some of what we're doing is just to make ourselves, and the kids, and the families, feel better by taking action. But being aware that there is this larger scale at which the action has to take place, really, it's about changing industry. The industry change would actually make much more mitigation than all of the actions of all the individuals."

Gilly Puttick noted that when start including behavior change in our educational agendas, there are important areas of research that can help educators design their work: "I think that we need a combination of climate change education and a theoretical framework that's based on this trajectory. From awareness, to learning, to intent to act, to action, to actually acting, along that continuum. Being able to design programs that are aware of how people move towards behavior change. For example, a lot has been learned in the anti-smoking community, in other public behavior change programs. I think that's a very interesting approach."

Designing expansively for deep learning about climate change and its implications

Bill McKibben argued some years ago that we might best confront the changing world by thinking of it as a new world, “Earth,” whose life and behavior are similar but significantly different to the Earth that Homo sapiens has hitherto known. Science (STEM) education in and for such a world will require us to design and collaborate in new ways, across institutional, social, and disciplinary boundaries. Leanna, a participant in the chat, raised the importance of horizontal integration across humanities and sciences, to help people grapple with the multiple elements of this problem. Gilly Puttick said: “We’ve tried a couple of approaches. One has been to focus on systems thinking, so that the local connects to the global. To start to see those connections, how everything is connected and what the feedbacks are, in terms of both behavior and physical impacts of climate change. Another has been to integrate game design into a science class, where students are focusing on the meaning of the game that they're creating to help others understand some aspect of mitigation or climate science.” Leigh Peake spoke about a collaboration with the Portland Museum of Art: “We have something locally called the Osher Map Library, which has these gorgeous maps, going back through history in Maine. We’re exploring combining an artistic, cartographic and scientific representation of changes in Portland's waterfront. I think there's so much opportunity to give people different entry points to these topics, by different kinds of representations.”

Next steps?

Climate change is a problem that doesn't admit of a final solution, at least within the foreseeable future. The adaptations, and the evaluation of the status quo, and the science you need to learn, and the emotions you need to deal with, the rhetoric you need to use to debate and educate, are changing incrementally, week by week, as the physical changes at the global level unfold. It may be difficult to mobilize ourselves around a problem, that within most of our lifetimes, will not have a solution. Of course, we really need to learn & teach the fundamental flexibilities and equipment of an educated person: To be able to think, to reason together, to look at data, and all of those things.

In considering what new strategies might augment or enhance current climate change education efforts. Leigh Peake commented: “One thing I think that the world would benefit from, is more visionaries. In the sense of, I think if we were portraying the future of industries, for example, we talk about this a lot with the fishery. How do we portray an image of a thriving, healthy, economically viable fishery, that accounts for climate change, as opposed to being in a battle around the current impacts of climate change?”

Trevor Lloyd-Evans spoke about the potential value of citizen science with almost any constituency: “I think the citizen science has been a tremendous boon for many of us. Just getting the students, the adults, the college graduates, whoever it happens to be. Getting them outside and really experiencing getting their hands-on things and then

contributing. Now, in my bird world for example, we have a thing called eBird. We have iNaturalist, which is documenting all of these. I think this gives people a feeling that they can really contribute to a database, which they are, which will have meaningful results. Going back to some of those sites, you can see atlases appearing now, you can see climate change being documented, you can see ranges changing, you can see phonology changes. This is all as a result of numerous citizen science projects. More coordination among that hands on aspect would be something that I would really love to see."

Finally, a couple of panelists spoke of the value that can come with a more rapid development of new technological tools for field work to aid in data collection, identification, and other aspects of scientific investigation and reporting. For example, Leigh Peake said: "We just started using, which many people may already know about this, eDNA technology. Which is, basically, instead of sampling the species, we can sample the water around the species, and they leave behind a DNA signature. Any kid can do that. Eventually." There is scope for some rapid translational research for education and citizen-science tools.

Recommendations for educators

The global phenomenon of climate change is also a crisis for every locale. The panelists pointed out that the focus and the scale of climate education and action should reflect the ages and capacities of the learners with whom they are working. This, with the interdisciplinary nature of the crisis and its science, suggests that opportunities for collaboration for hands-on learning, service-learning, and workforce development are abundant within school and community. Three suggestions that panelists made as examples are:

- The Youth Climate Summit of the Wild Center, in the Adirondacks, brings youth together for a 2-day event to learn about climate science and strategies for mitigation and adaptation. They have created a "do it yourself" toolkit so that any community can organize their own summit (Resources here. *Note*: Free sign-in required.)

- Attend to climate justice issues, where STEM and social justice intersect. It is evident that the climate crisis is, and will continue to, differentially affect less privileged and powerful communities in every country. There are community-based organizations concerned with environmental justice which educators should investigate. As one panelist said: "How do we help the organizations that are already in our communities, as well as bringing new ones to the community?"

- Learn and collaborate with youth empowerment organizations. As an example, the Institute for Educational Leadership really knows how to work in community schools and empower students in science and thinking forward to meaningful careers.

Recommendations for researchers

- More research is needed on the relation between learning and motivation to action. Is there anything like a developmental trajectory reflecting an interaction between knowledge and application of knowledge? For example, is the case that starting to take action leads increases motivation and capacity for learning and for action, e.g., the capacity to take bigger steps with more consequence?

- More research about the interaction between STEM learning and community interpretation of STEM ideas may provide further insight into the role of identity and other socio-economic factors in shaping attitudes towards climate science and action.

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