

Broadening the Landscape of Citizen Science STEM for All Multiplex Synthesis: March 2022

Introduction

Collaborations between scientists and members of the public have long played a part in the advancement of the natural sciences, and in some fields progress really depends on volunteer contributions to the gathering and interpretation of data, whether in natural history or social history. Further, movements such as the Nature Study movement of the early part of the 1900s have built a bridge between educators and natural sciences, that links student learning to foundational science practices in sense-making (and wonder!) about the world around us (Armitage 2009). This connection has seen a modern resurgence with participation from K-16 education, informal education, and a wide range of public interest and community groups. The rapid development of many web-based and mobile tools for data collection, aggregation, and analysis has involved more people, and often improved the quality of the science that can be produced.

Yet, as Heather Fischer and Martin Storksdieck write in [their blog](#), “we do not see a significant shift in the demographics of those engaging in citizen science which, across many projects, attract predominantly well-educated, white, male-tending participants.” The [March 2022 Multiplex Theme](#) examined the challenge of “broadening the landscape of citizen science.”

The Expert Panel

[Dr. Heather A. Fischer](#) was the moderator for this Theme. She is a Senior Researcher at the Oregon State University’s STEM Research Center. Our expert panelists were [Dr. Trena Ferrell](#), the NASA Goddard Space Flight Center Earth Science Education and Public Outreach Lead; [Dr. Elena Sparrow](#), a Research Professor at the University of Alaska Fairbanks; and [Blake McGhghy](#), Program Manager for Community Leader Engagement for Thriving Earth, a program of the American Geophysical Union. Our panel also included, as respondent, [Dr. Martin Storksdieck](#), the Director of Oregon State University’s STEM Research Center.

The Challenge

Citizen science, and other kinds of partnerships of scientists and members of the public, have, as Heather Fischer said, many characteristics of engaging, authentic science activity, “including positive STEM learning outcomes, self-efficacy for doing science, and increases in social well-being.” Indeed, the outcomes perhaps most reliably reported are affective ones, and such characteristics as the increase in science self-efficacy are often connected with increases in ecological and place identity and inclination to action to protect or enhance one’s place (Klotzer et al, 2021, Dickinson and Bonney 2012, Clayton and Opatow 2003).

Such activities invite and enable broad participation in scientific research (Pandya 2012), yet as noted above, so far we do not see a significant change in the demographics of participation (Cooper et al. 2021). Where this is true, the consequences can include a continued sense of disenfranchisement from science as a human activity, and as a means for addressing social and environmental problems — and by the same token an impoverishment of science itself. Cooper et al. write (pg 1386), “...citizen science is typically not truly an egalitarian variant of science, open and available to all members of society, particularly those underrepresented in the scientific enterprise.”

As Heather Fischer said in opening the conversation:

We know it's a problem. We want to focus on how to turn this [knowledge] into action. So that's the focus of our conversation today, is thinking about what are some different things that you as a project practitioner, as an educator can do to think about broadening participation in citizen science ...from underrepresented groups who might be interested in, attentive to, and willing to participate in scientific research?

The Necessary Dialogue Between Scientists and the Community

Very often, members of the public are invited to join a program that has been designed by a scientist, to answer the scientist's research question, as part of their own body of work. Such opportunities offer the participants very specific tasks to do — most often data collection — according to protocols and within constraints the scientist has defined. The ultimate products or outcomes of the project are aligned with the scientist's purposes and intent. Such opportunities can be exciting and meaningful, but they fit within a paradigm that locates the power of intention, method, and values in the scientist's position, often itself located within an institutional context that is remote from the volunteers' sphere of influence; cycles of exclusion are not questioned, or hard to alter even if questioned.

The panelists agreed that in order to broaden participation in citizen science projects, one has to begin with communities, and this means taking one of several approaches to changing the power relationships that tend to structure expert-novice collaborations.

Making the Opportunity Real: Connecting. The panelists agreed that the connection needs to begin with listening, and this will look different from one community to another. Before a conversation about the research can begin, however, it is important to establish a relationship and context for the conversation. Elena Sparrow recommended from her experience in Alaska that a first move is to find out who is already working with the community. Such people can help you make the next critical step — to find the influencers in the community, and learn from them:

...make that connection through a person who has been working with them. And so, I started out with Sidney Stephens.... And so she introduced me to what I would call influentials in the communities. And these are usually elders and local experts...I have partnered with the Association of Interior Native Educators and an indigenous colleague who directs this association. And it's really by learning a lot through [them] how to be introduced and get them to know you first before you can even introduce what you're wanting to do with them.

Blake McGhghy added “...this work begins with active listening, that you really understand what's important to the community and that they play an active role in identifying and framing the problem itself.” Further, a community that gets involved with a scientific question may have their own knowledge about the subject, have their own culturally embedded questions and priorities, which form part of the meaning of the research for them (‘knowledge mosaics’ *sensu* Bang et al.2007) As Elena Sparrow said:

there are different knowledge systems that are operating and honoring that and building on that...it's important to build on what they know...for communities to recognize that the knowledge that they have gotten from ancestors and their continuous long-term observations are very important.

Making the Opportunity Real: Where do research questions come from? Science research involving students or volunteers can have many origins, and still be inclusive, if that intent is part of the design and conversation from the beginning. If a relationship of trust and shared intent is developed with a community, then a project that is ‘top down’ in origin may be inviting and respectful. Some of our panelists told of a very different strategy, in which a key motivation is putting scientific knowledge and expertise at

the service of the community — an approach exemplified by AGU's Thriving Earth Exchange. Blake McGhghy said:

With Thriving Earth Exchange, the community science fellows are really trained in an approach to scope community priorities over the first month or so projects to really translate community priorities into one actionable project that's feasible to develop shared expectations and clear roles for everyone involved.

Trena Ferrell spoke about how the NASA programs make room for both 'top down' and 'bottom up' designs — but in including volunteers in NASA-designed research, methodologies and protocols are adjusted to suit the participant's constraints and interests:

we're very, very open to go from the bottom up...interested in seeing what people are interested in, what science they want to see. And in the science that we do provide, we give resources to support that science such as mobile phone apps to facilitate field work like mosquito surveys.

Another approach is to come to the community around a phenomenon of interest and co-design the research, including the methodologies, so that the community members can participate as fully as possible with resources that are within their reach. Heather Fischer said:

And that maybe you can think about the data that's coming out of the project and its fitness for what you want to use it for or what you want other people to use it for and that being open to rethinking your science methodology to be adaptable to what the community can do, maybe the resources they have in the community... but then also if you want to go deeper and you're working with specific community, thinking about their process of knowledge and their ways of knowing too and bringing that in as well. So it's a whole spectrum of possibility to rethink your methodologies as a scientist.

Making the Opportunity Real: Roles and activities. Part of the negotiation has to be developing "shared expectations, shared values and really co-create milestones and shared outcomes and shared learning and acknowledging that the learning is going to go in all kinds of directions for everyone involved." (Blake McGhghy)

Boundaries and frontiers. Citizen science and similar projects draw upon people that can be said to be from different cultures, and this ideally is a source of strength. Such partnerships hope to realize a synergy between people from different disciplines, aiming at preserving the strengths and integrity of both, while working across the cultural boundaries towards a shared goal (Star 2010, Star and Griesemer 1989). To ensure that power relationships are equitable, the goals and tasks need to be identified explicitly, as well as the processes of decision-making responsibilities for implementation, and the intents for the value of the outcomes. This means that all partners need to expect to be learning from each other. As they do so, they design materials, protocols, and procedures that both embody or reify the learning, and that also facilitate the shared work, and continued authentic engagement about the way the work is designed and carried out (Bopardikar et al. to appear, Drayton et al. 2017). This explicit approach can turn boundaries into frontiers, where none of the intersecting cultures have "ownership," and authentic shared exploration can emerge. As Heather Fischer pointed out, it is wise to recognize, too, when the 'secret sauce' to a good community partnership requires some explicit support such as some professional development for the scientists who are going to interact with that community. And some citizen science programs, may benefit from social science expertise as part of the partnership, as has become widespread in areas such as conservation biology. The following applies as much to citizen science and community science as to conservation biology:

Recognizing that conservation is about people as much as it is about species or ecosystems—an acknowledgement seldom explicitly made in conservation circles— suggests a significant shift in the nature and use of science in conservation. To preserve the earth’s natural heritage, the social sciences must become central to conservation science and practice. (Mascia et al. 2003 pg. 649)

Allies and intermediaries. In addition to seeking out ‘trusted messengers’ and influencers in the community to effect an introduction and open dialogue, the panelists suggested that researchers should seek out ‘intermediaries’ already established within the community. Such groups are often natural allies in educational efforts, but perhaps more important they can provide invaluable insight about the values, structure, and dynamics of the community that scientists are seeking to work with. Examples of such intermediaries that were mentioned include schools, government agencies, and community-based groups such as Girl Scouts. Trena Ferrell also mentioned the value of reaching out to ‘lifelong learners,’ who (as others have found, Dickinson and Bonney 2012) often have time to volunteer, deep local knowledge, and a desire to understand the research aims and methods. Addressing the ‘intermediaries’ strategy, Heather Fischer said,

if you are a project leader and you're looking to broaden participation projects and engage in specific groups, those intermediaries, those community groups that maybe are already doing certain work and working with those audiences, maybe that's your point of connection to that. They're the main folks to get into and talk to, and that you don't need to go find those individuals yourself.

Continuing conversations

Our [panel](#), participants, [playlist](#), and [resources](#) brought to bear a wide range of experience with the challenge of broadening the landscape of citizen science, yet it is clear that there is much more to be learned about scientist-volunteer partnerships of all kinds. Discussions about the differences between ‘citizen science,’ ‘community science,’ and other kinds of collaborations point up the tremendous diversity of strategies and opportunities now being explored. These in turn reflect the wide range of urgently needed research throughout the country and the world, as we hurtle into the Anthropocene Epoch, which so far is characterized by rapid changes all of which have human components and human impacts. As Martin Storksdieck said, in his concluding reflections,

if we want to enhance, embrace the idea that more people should be participating and could be participating...I think it comes from the foundational understanding that being part of this community science, citizen science, participatory science, volunteer science, whatever we want to call it, is a benefit to people and communities.

And if that is the case, then giving more people a chance to be part of it is a good thing in of itself. And I think that kind of moral obligation, but also utilitarian component of what we are trying to do here is important to keep in mind. We're doing it for two reasons: (1) because we know it's a good thing. We're convinced and we have evidence for that. And (2) because it's a moral obligation...You cannot shut people out of something because you do...things that prevent people who would legitimately want to participate, from participating.

Recommendations for Researchers

Educational researchers can make a valuable contribution to formal, informal, and adult education by documenting citizen science projects, examining the educational theories that are incorporated, and the theories of action that underlie the overall design of the projects, especially as it relates to broadening participation in such projects. Both educators and sociologists of science may find value in investigations framed in some version of activity theory such as CHAT (cultural historical activity theory) (Engström 1993) to understand how the partnerships function in relation to the interpretation, implementation, division of

labor, and products of the projects under study. Such a framing would enable a close examination of system elements that include, and that exclude people from the various aspects of the work and design.

Such projects also are good candidates for social-network analyses, to understand how relationships within the projects incorporate, facilitate, or marginalize participants' social and scientific/knowledge 'capital.'

As Martin Storksdieck suggested in his closing comments, one can conjecture that a broadening of participation, and the burgeoning citizen scientist movement, may drive (or enable) different kinds of science. What changes take place? What effects do these changes have on the identification of grand 'challenges' on the research funding priorities of government agencies and foundations, and on the training given to young scientists?

Recommendations for Administrators and Policymakers

Administrators and policymakers can play an important role in maintaining a focus on broadening the landscape of citizen science by broadening their own acquaintance with the diversity of communities in their area, becoming aware of 'intermediary' organizations that could help — or be helped — by involvement in a school-science partnership with a community focus.

Administrators and policymakers in all cases need to be aware of cultural/boundary issues that should be incorporated so that all partners derive value from their participation, as well as contributing value.

Such careful design of citizen science projects will provide the scaffolding for usable, formative evaluation of the project with respect to breadth of participation, conceptual learning, science practices learning, affective changes (e.g., changes in science identity or self-efficacy, place-identity, etc.) and changes in scientists' community understanding, gains in scientific knowledge, changes in research design, and affective changes.

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