Citizen Science Toolkit Conference

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evaluating citizen science: examining the goals of science education

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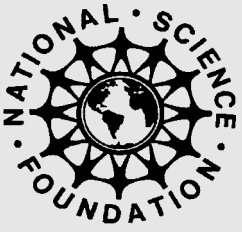

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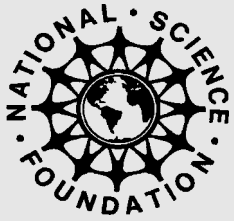
Note that this document did not originate as a formal paper. Rather, it reflects the more informal, idiosyncratic nature of a delivery prepared specifically for this live event.

Documentation of the conference is meant to serve as a resource for those who attended and for others in the field. It does not necessarily reflect the views of the Cornell Lab of Ornithology or individual symposium participants.

The following is the opening talk of the session titled "Citizen Science Project Design," delivered on day one of the Citizen Science Toolkit Conference



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For complete documentation of conference proceedings and to learn more about citizen science and the Citizen Science Toolkit, or to join the ongoing citizen science community, go to:

http://www.citizenscience.org

Evaluating Citizen Science: Examining the goals of science education

Kirsten Ellenbogen
Director of Evaluation and Research in Learning, Science Museum of Minnesota

Overview

I prepared this talk in advance but after getting to this workshop, seeing who is here, reading all the bios and talking to people, I changed it. So I'm going to give a little bit of the old talk and a little bit of the new talk.

Overview

- Evaluating citizen science (the old talk)
  - Who are you evaluating?
  - What do you want to measure?
- What is Science?
- Science processes and language
- Science Education

I am going to talk about the basics of evaluating citizen science, but I think there are a lot of places we can go to look at articles on that, so what I want to spend most of my time talking about is how science education is reflecting on evaluating these sorts of experiences and the notion of "What is science?" and therefore, what counts as science education?

So: evaluate what? The evaluation breakout group at this workshop is already bringing up the fact that we tend to spend a lot of time evaluating impact on public participants. We spend a lot less time talking about: What is the impact of our citizen science work on scientists? What is the impact on community? What is the impact on the environment? Some people would say "environment" and "community" shouldn't even be on that list, but we have a huge variety of citizen science projects, and these are some of the things that came up this morning during the evaluation group's breakout discussion as we started thinking about project impact.

Evaluate What?

- Evaluating impact on
  - Public participant
  - Scientist
  - Community?
  - Environment?

The Challenges

Another thing that comes up really quickly, and I'm sure we're about to get into this discussion in our evaluation breakout group, is why evaluation is difficult. Based on some of the articles that are out there and some of the experiences that I've had with evaluating

We're going to start out with Kirsten Ellenbogen. We've heard a fair amount about beginning with the end in mind, and I think that was the name of Kirsten's talk at one point. Kirsten has been at the Science Museum of Minnesota for a couple of years. Before that she was at the Institute of Learning Innovation, working with John Falk as well as with Martin Storksdieck and Kate Haley Goldman, both of whom are here, and a bunch of other good people. - Rick Bonney, Director of Program Development and Evaluation, Cornell Lab of Ornithology

citizen science, one of the first problems is that a lot of this is set up in a way that assumes a deficit model of the public. We walk into the situation presuming that the program is going to deliver everything and that we're not getting anything back from the public except the data. That often skews the evaluation in a way that doesn't really appreciate what some people call the "funds of knowledge" that learners bring to these situations. There is a real need to step back and ask, what are they bringing to the situation besides access to the data?

Funds of Knowledge: Theorizing Practices in Households and Classrooms, edited by Norma Gonzalez, Luic C. Mull and Cathy Amanti, 2005.

Another difficulty is high scores on pre-tests. This is something we could spend a long time talking about. When you are just talking about some basic concept knowledge, often the fabulous people we have collecting data on these projects already know a huge amount about the content. If your goal is to have them walk away understanding more about particular science content, you have no wiggle room, you have nowhere to go. So what else is there? What else should we be looking at?

Why it's Difficult

- Presumes deficit model of the public
- High scores on pre-tests
- Little regulation of training
- Varying previous experience
- Uncontrollable additional learning experiences

There is great variety in the kinds of experiences people have as they join a citizen science program. I've sometimes ended up with six or seven different types of participants, noting: these did the Web experience; these did the Web experience plus the in-person experience; these did neither; these joined a friend. There is such variety it makes it very difficult to generalize.

There are also uncontrollable additional learning experiences. Unlike those psychologists who get to study people in a black box, we have participants who read, who watch TV, who participate in other programs, who visit fabulous facilities like the Lab of Ornithology. There is an uncontrolled number of other experiences influencing what you are trying to evaluate.

Evaluating Impact

Traditional focus on the public

1) Understanding of scientific content
2) Understanding of science as a process
3) Ability to evaluate scientific information
4) Attitudes toward science
5) Attitudes toward the environment
6) changes in environmental behavior

…also identity

Evaluating Impact: Traditionally

I don't mean "traditional" here in a negative sense. In fact there is a great article, "Scientific Knowledge and Attitude Change: The Impact of a Citizen Science Project," by Dominique Brossard, Bruce Lewenstein and Rick Bonney. It lays out a really good overview of how you start evaluating impact, and it details things like scientific content (no surprise there); understanding of science as a process; and ability to evaluate scientific information.

"Scientific Knowledge and Attitude Change: The Impact of a Citizen Science Project," Dominique Brossard, Bruce Lewenstein and Rick Bonney, *International Journal of Science Education, 15* July 2005, 27(9): 1099-1121.

http://people.cornell.edu/pages/bvl1

I see very few examples of the latter in the evaluation reports. I think we are headed there. There was one great example in an earlier presentation today—someone said that they get back to folks after they've collected data and show them, "Okay, this is what we've done with the data." That is so close to taking it back to the folks who collected the data and saying, "How did we get

here and what is involved in this?" That is what I want to spend some time talking about in my discussion of current trends in the field of science education.

Additional factors include attitudes toward science; attitudes toward the environment; and changes in environmental behavior, which is a big brass ring if you can get there. And "identity" is something that I would like to add to this.

Revisiting the Basics, Defining our Terms

Our Definition of Science

I was going to spend my entire time talking about this traditional evaluation focus, but the more I talked with folks here I realized that in some ways we need to go back to the basics of asking, what are we talking about? If we are going to evaluate a citizen science program, what is the science, who is the citizen, and what are we hoping they learn?

This is a great time to be thinking about this because we have one document that has just been published and another document that will be published next year. The document that has been published is from the National Academies of Sciences, published by the National Academies Press. It is called *Taking Science to School: Learning & Teaching Science in Grades K-8*. Although the formal education model often has very little to do with what we are doing outside of the world of the school, it remains a very useful document to take a look at, and you can view the entire document online if you go to the National Academies of Sciences Web page.

www.nationalacademies.org

In fact, we are using it in a National Academies of Science committee that Bruce Lewenstein is cochairing with Philip Bell. The committee is developing a new book that is specifically going to be about learning science in informal environments. We are struggling with this issue right now: What is science when you are talking about an informal environment? What is science learning in these sorts of situations? I was going to try to pull selections from our committee work, but it is so much a work in progress that I felt it would be dangerous at this point to say, "Here's what the committee decided," when we haven't reached a decision point. It will be coming out in 2008 and in the meantime, you should look at the National Academies publication on formal education or follow the committee's progress online through the National Academies Web site.

Science is…

…both a body of knowledge that represents current understanding of natural systems and the process whereby that body of knowledge has been established and is being continually extended, refined, and revised.

National Academies Press. (2007). *Taking Science to School: Learning & Teaching Science in Grades K-8.*

You'll notice this definition of science splits into two parts. It represents a "body of knowledge," so it is about the content, right? And it is particular here. It says the "current understanding of natural systems," really focusing on the notion that this is our *current*

understanding. It's not necessarily where we will be twenty years from now or a hundred years from now. The second part of this is the process, and it's the process of how we came to know the content.

A lot of people talk about this in terms of, "If you want to talk about science, you have to include: What do we know, how did we come to know it, and why do we believe it?" That is how a lot of people summarize it, and that's a big shift from the science process that I learned, and a big shift from the science my father learned, which didn't really didn't even have process in there. And it's now evolving into something that my children will learn that is different from what I learned. So there is absolutely that shift in our understanding of what counts as science.

The Shift to Process and Talk

Part of that shift, based on the definition that I just showed you, is that there is this huge emphasis now on process and talk, and process is not the series of science posters on the wall in a science classroom that I had growing up. It's not: "Here is *the* scientific method." It is instead talking about things like how you engage people in logical reasoning about evidence and help them participate in the culture of scientific processes. There is also a focus on language of science. How do you engage people in moving from data into a theory? How do you help people construct and deconstruct hypotheses? How do you engage people in a scientific argument?

And I don't mean little kids fighting, I mean that there is a form of argument which is a valued skill in science process, and those of you who are practicing scientists know exactly what I'm talking about. When we send articles to peer reviewed scientific journals—any of us, whether we are social scientists or physical scientists—we are making an argument and people make an argument back to us. We have to defend our ideas. How much of this are we actually teaching in our citizen science programming?

Process & Talk

- Processes of Science
  - Logical reasoning about evidence
  - Participating in the culture of scientific processes
- Language of Science
  - Theory and hypothesis
  - Argument

Science Education

- Participate productively in scientific practices and discourse
- Generate and evaluate scientific evidence and explanations
- Understand the nature and development of scientific knowledge
- Know, use and interpret scientific explanations of the natural world

Redefining Science Education and What That Means for Citizen Science

What should science education really look like? What form of science education emerges from this definition of science? The list on the left doesn't reflect the emphasis that is in the National Academies book, but this is the emphasis that I am giving it for our meeting. First is productive participation, and again it's very much about the practice and the discourse. How much are participants talking to each other about the data that they are gathering? How much are they talking to the scientists? A number of programs have built various ways—Web communication, asynchronous communica-

tion between a scientist and a participating public—to really enable public participants to get engaged: "Okay, I found this, and it was different from what you asked for in this way. Does it count or does it not?" Engage the public in these arguments of science.

The second characteristic of science education is generating and evaluating scientific evidence and explanations. Explanatory conversation is a critical aspect of science education these days. If you go around a science museum, for example, and record the kind of conversations people have, most of them tend to be identifying things or describing objects. I would bet, and I haven't seen one of these studies yet, that if I took my camera and a microphone out to some of the citizen science programming, most of the conversation that we're going to hear is identifying and describing.

That is fine, and that is not to say that is not science talk, but we want some of the conversation to move from identifying and describing to explanatory conversation. For example, "How does this one fit in and how does it not fit in? Why is this one part of this group and not part of that group?" There is a huge amount of explanatory conversation that could go on: "Why are we collecting this data instead of that data? This one should be included because of X."

Moving our participants into that kind of conversation is a huge leap, but there is a lot of potential. In fact, I would argue that we have a better ability to achieve these goals of science education in a citizen science program than in most middle school classrooms.

"...I would argue that we have a better ability to achieve these goals of science education in a citizen science program than in most middle school classrooms."

The third characteristic of science education is understanding the nature and development of scientific knowledge. What we heard earlier in this conference about citizen science efforts suggests that programs are now helping participants understand why the data they collect is valuable. Helping people understand the role that they're playing in the development of scientific knowledge is critical.

The last characteristic is one that is much more common in the science classroom: knowing, using and interpreting scientific explanations of the natural world. For example, how should I read a scientific document, interpret it, and analyze it? People get that from a lot of different learning experiences, and certainly citizen science can contribute to it, but citizen science programs are best positioned to impact the first three.

Moving Forward

So where does this leave us? I want to end by making a plea for the integration of evaluation into the program planning process. The more that evaluators and educational or learning researchers are involved

from the beginning the better. We need to sit down together and say, "What are the goals of this program? Where are you headed with this?"

And I would urge that we focus on formative evaluation. We are all required in our programs to do summative evaluation: "Let's see how we did and report on that." There is a need for more formative evaluation so that the process is assessed in progress, so that we are able to do pilot tests and say, "Let's take a look and see how this is going. If we try it this way and that way, who is actually talking more about science? Which version of the program generates more explanatory conversation?" You have the opportunity to do that if you are working with an educational researcher or an evaluator at the very beginning of the process.

Moving Forward

- Integration of evaluation into planning process
- Revisit goals
- Expand (shift!) evaluation focus

Then there is revisiting goals. There is nothing in the grant guidelines that says that you can't revise project goals after you start. So the process of going through and figuring out that "Actually, what we are doing is leading us more in this direction," or "What this program can really contribute to the field will take us in that direction." The process of shifting or changing that comes with formative evaluation will improve our field.

We also need to examine our projects from the very beginning with an eye toward the goals of science education. What I am pushing for is an expansion or an actual shift of your program and evaluation goals. Citizen science programs have the potential to get participants to look at how we've moved from these data into these sorts of explanations, to understand how theory is developed, to understand shifts from data to evidence to explanation, to understand why we throw some data away and value other data.

The more we revisit what it means to do science, and reassess our goals for science education, the farther along we are going to be in making our programs a genuine contribution to creating a scientific citizenship.