Research Brief

Finding new objects in space, capturing earthquake information, sampling water quality, mapping the human brain, tracking invasive plant species, mapping bird distributions, understanding canine behavior — scientists who work on all these topics (and many others) rely on citizen scientists for help.

Some citizen science projects have continued for more than a hundred years. One familiar example is the Audubon Society's Christmas Bird Count, which began in 1900 with 27 volunteers collecting data. Now, tens of thousands of volunteers in North America participate. Because this annual event has such a long history, its data have real value to inform scientists, conservationists and policy makers about the effects of environmental changes on 588 species of birds and the ecosystems that support them.[1]

What Citizen Science Looks Like

Today, citizen science can be thought of as one type of crowdsourcing. This strategy, supported by mobile technologies and sophisticated data management software, invites many people to provide data, ideas or opinions related to a specific topic.[2] Because citizen science involves scientific projects that have defined goals and research questions, it applies formal structures to guide the efforts of volunteer participants.

Scientists who embrace the citizen science approach can select from several approaches for involving volunteers:[3]

- **Contributory approach.** This approach provides volunteer citizen scientists with guidelines and/or training so they can provide reliable data or contribute to data analysis, thereby helping professional scientists conduct reliable studies.[4] Most often, these volunteers act as field assistants to collect and report data on a specified topic, during a controlled time period and within a defined geographic area.
- **Collaborative approach.** Volunteers with deep interests and some experience or skills work with professional scientists to design data collection activities, analyze samples or data, and/or develop explanations of findings.
- **Co-created approach.** Here, citizen scientists actually co-create projects with professional scientists, and participate in everything from defining questions to disseminating results and outlining future inquiries.

Why Scientists Like Citizen Science

> Edith Law, from Harvard's Center for Research on Computation and Society, says this about citizen science: "It can teach people what scientists do and how they analyze problems."

When dozens, hundreds or thousands of people volunteer to participate in a scientific project, many things become possible. Without these volunteer assistants, some studies wouldn't exist, and the range and scope of many studies would be greatly reduced because project funding wouldn't support extensive travel and paid assistants. The huge data sets produced by telescopes in space, for example, require many eyes to review. (See Galaxy Zoo for an example, and select its interactive Navigator tool to use with students.)

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Citizen scientists sometimes make amazing discoveries. Putting more people in many places results in having someone in the right place at the right time, and introducing many more "fresh eyes" has already resulted in exciting discoveries. There just aren't nearly as many professional scientists as regular citizens, so the potential for learning increases when more people contribute.

Scientists also appreciate citizen science projects because they help people outside the world of scientific research increase their scientific literacy — that is, participants better understand the scientific process and the world around them. When citizens have greater knowledge, they have the ability to become more active in discussing and solving local, national and global issues.[5]

Why Citizens — and Educators — Like Citizen Science

Ordinary people of all ages and all walks of life want opportunities to dig deeper into their interests and hobbies. Internet access and mobile technologies, such as GPS devices and smartphones, make it easy to participate. Becoming a citizen scientist takes finding a project that fits your passions, receiving formal guidance on how to contribute and making the commitment to follow through.[6] People enjoy contributing to searches for answers to real questions and solutions to real problems.

Tips for a Successful Citizen Science Experience

- Do a needs assessment and use student surveys to find a good match between participants and projects. If groups of students express strong preferences for different projects, consider running two separate projects or scheduling different projects for the fall, spring and summer programming blocks.
- Even with an engaging, hands-on project, find ways to supplement the main investigation. Don't depend on the citizen science project alone to hold the attention of all youth over multiple weeks. Have students explore related questions when they're not engaged in actual data collection.
- Find meaningful ties to the community by connecting to local research initiatives, bringing in experts from museums and colleges, and considering how citizen science findings can impact public policy.

The desire to connect with and contribute to their community is as real for young people as it is for adults. While adults can organize ways to pursue their interests, students often depend on their families, teachers and out-of-school time educators to structure such opportunities for them. Creating that structure can have great benefits for student learning.

Citizen Science Learning Outcomes

Making observations, developing and testing hypotheses, designing new studies, understanding natural phenomena, addressing issues of local importance, gaining awareness of science-based decision making, becoming real participants in the scientific process — citizen scientists may experience any or all of these benefits, according to studies of participant outcomes.

Three studies of citizen science projects at the Cornell Laboratory of Ornithology discovered that participants demonstrated exactly the results one might hope.[7] Findings showed that participants used scientific thinking processes, made knowledge gains around local ecology and gardening, and evolved in their attitudes so that some students began to think of themselves as scientists. Other

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studies, too, have found increases in subject area knowledge and the scientific process, escalation of interest from data collection to deeper involvement in projects, and, again, development of an "I can do science" attitude.[8]

Measuring Citizen Science Impact

When a program invests in a new way to provide fun, real-world learning experiences, leaders and stakeholders want to know what works and what doesn't. Evaluating individual learning and program performance can help to fine-tune delivery, maintain student enthusiasm, encourage family and community support, and inspire students to focus on college and career goals.

Recognizing the value of capturing information on learner outcomes, the Cornell Lab created a tool for use by any group involved in a citizen science project. Its *User's Guide for Evaluating Learning Outcomes From Citizen Science* provides clear explanations of the evaluation process, plus customizable tools to help practitioners plan, implement and share results from citizen science participation. (Find the guide at http://www.birds.cornell.edu/citscitoolkit/evaluation.)

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[1] National Audubon Society, *History of the Christmas Bird Count* (Web page, n.d.), accessed June 7, 2016, at http://www.audubon.org/conservation/history-christmas-bird-count.

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[6] M. J. Raddick et al., "Citizen Science: Status and Research Directions for the Coming Decade," *Astro2010: The Astronomy and Astrophysics Decadal Survey, Position Papers,* no. 46 (2009), accessed June 16, 2016, at http://adsabs.harvard.edu/abs/2009astro2010P..46R

[7] L. Gommerman and M. C. Monroe, *Lessons Learned From Evaluations of Citizen Science Programs* (FOR291), (Gainesville: University of Florida/Institute of Food and Agricultural Sciences, 2012), accessed June 7, 2016, at http://edis.ifas.ufl.edu/fr359.

[8] M. J. Raddick, G. Bracey, K. Carney, G. Gyuk, K. Borne, J. Wallin, and S. Jacoby, "Citizen Science: Status and Research Directions for the Coming Decade," *Astro2010: The Astronomy and Astrophysics Decadal Survey, Position Papers,* no. 46 (2009), accessed June 16, 2016, at http://adsabs.harvard.edu/abs/2009astro2010P..46R.

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