Putting the citizen in science

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Abstract:

Ask your students to name a scientist, and you will get many answers: Albert Einstein, Marie Curie, Jane Goodall, or, perhaps. Bill Nye, the Science Guy. The word "scientist" generally conjures up visions of white-coated individuals in laboratories with brightly colored potions in test tubes, researchers typing frenetically on computers, or investigators outside with large binoculars, staring at some rare animal, trying to learn its habits before it becomes extinct. We assume those people studied long and hard to become experts in their fields before they started doing "science." Rarely would any of us think that we could make valuable contributions to scientific fields of study without a formal education and training. However, citizen-science projects allow us to do just that.

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Article:

Ask your students to name a scientist, and you will get many answers: Albert Einstein, Marie Curie, Jane Goodall, or, perhaps. Bill Nye, the Science Guy. The word "scientist" generally conjures up visions of white-coated individuals in laboratories with brightly colored potions in test tubes, researchers typing frenetically on computers, or investigators outside with large binoculars, staring at some rare animal, trying to learn its habits before it becomes extinct. We assume those people studied long and hard to become experts in their fields before they started doing "science." Rarely would any of us think that we could make valuable contributions to scientific fields of study without a formal education and training. However, citizen-science projects allow us to do just that.

"Citizen science" is a term used to describe scientific experiments that use people without formal scientific training to collect the data (or, in some cases. mark up already collected data) needed for the experiments. Many of these projects are ideal for students who are learning about science in school, and indeed, many projects are targeted toward students. Technology has allowed citizen-science projects to flourish because of the ease of capturing and submitting data.

Technology has also enabled scientists to mentor students from a distance through interactive tutorials and rapid responses to inquiries. Today, citizen-science projects can be found in areas of study as diverse as astronomy. botany, marine biology, ornithology, and paleontology. The opportunities for collaboration within our schools, school libraries, and communities are plentiful.

Numerous benefits can be gained by using citizen-science techniques to conduct scientific research. The biggest benefit to science is that with more people participating in scientific research, more data is collected. Teams of trained scientists are often limited by time available to collect data and the distance they are able to travel. Citizen-science techniques allow data to be collected over large geographical areas and over long periods of time. The large sets of data generated can reveal trends that would not be obvious in smaller samples. Benefits also extend to those who participate in citizen-science projects. Participants are exposed to the scientific process by actually conducting research, experience that lays a foundation for scientific inquiry in their future. Students engaged in citizen science are offered opportunities that could increase enthusiasm for science after working with and being mentored by experts in the field. Proponents of citizen science believe that participation in these projects may increase the scientific-literacy skills of the participants, a known concern in the United States (National Science Foundation 2012). Introducing students to citizen-science projects in school may help set the stage for increasing the number of scientifically literate adults able to make more informed decisions about public policy and their own personal health.

History

Professional science as we know it is a relatively recent phenomenon. Only in the 20th century did formalized science education programs in colleges and universities become widely available to the public. Before then, most individuals conducting scientific research were themselves amateurs--often well-off gentlemen (or an occasional gentlewoman) who could spend time pondering the mysteries of the universe. A famous example is Benjamin Franklin, a self-educated man, who conducted many experiments and notably flew a kite during a thunderstorm to "discover" electricity in nature. Once formalized education became the norm, by and large people were required to have scientific credentials to contribute to the body of scientific knowledge. Only in two areas of scientific study did amateurs continue to make discoveries and have a significant impact: astronomy and ornithology. It is, therefore, unsurprising that these two areas are represented by many citizen-science projects.

Although records of bird strikes to U.S. lighthouses were kept as early as the 1880s, the First formalized citizen-science project in the United States was the Cooperative Observer Program (COOP), authorized by an act of Congress in 1890 that established the Weather Bureau. Observers record data, such as temperature and precipitation, and send daily reports to the National Weather Service. This program continues today with observers now submitting their reports electronically (Dickenson and Bonney 2012).

Another early formalized citizen-science project is the Christmas Bird Count. Frank Chapman of the (then) Audubon Society began the project on Christmas Day 1900. At the turn of the century, it was a popular holiday tradition to engage in a "side hunt"; people would divide into teams, or

sides, and go hunting. Whichever team brought in the most killed animals won the competition. Chapman suggested a competition of counting birds 4A rather than killing them, and the idea took off; 25 bird counts happened in 1900 (National Audubon Society 2012a). The Christmas Bird Count continues today, and in 2011. 2.215 bird counts took place throughout North and Central America (National Audubon Society 2012b).

Types of Projects

Many different citizen-science projects on a multitude of subjects--from astronomy to zoology--are available to interested participants. There are also projects that stray outside science as their focus: one Zooniverse project has participants helping to transcribe ancient papyri. Selecting a project may be the most difficult part of getting started! In addition to varying by topic, citizen-science projects can also vary greatly in format. In general, projects fall into two broad categories: those that ask participants to actively make observations and submit data, and those that ask participants to mark up data already collected.

Projects that require active observations may be best to make children feel that they are really doing science. In these projects, they observe and take measurements just as a trained researcher would. To help ensure consistency among hundreds, if not thousands, of participants, training materials are always a part of citizen-science projects. Materials may be instructions that accompany a kit, online modules that walk a participant through the process of observing and submitting data for the project. or instructions that accompany each step of the project. These training materials offer educators an excellent opportunity to mentor students. An example of a project that has participants actively collect data is the World Water Monitoring Challenge (WWMC) <www.worldwatermonitoringdav.org/default.aspx>. Participants measure the turbidity, pH, temperature, and dissolved-oxygen content of water from a local water source. Water monitoring kits are available for purchase (about $21 shipped; classroom kit also available) if one does not already have the tools to take the measurements. Included with the kit are instructions on how to measure these indicators and submit the observations to the WWMC website. Like many other citizen-science projects, the WWMC, through its website, allows participants to see data submissions from other locations, so students can feel connected with others taking part in the experiment throughout the world. In coordination with this project, guests, such as operators of local water plants, could be invited to the school in the role of a community mentor.

Projects that ask participants to mark up data are often set up like games. Zooniverse's recently introduced project Seafloor Explorer shows participants images of the seafloor. First, the participant marks what substrate is present (sand, shells, gravel, etc.) and then marks any species of animals seen. Scallops, fish, starfish, and crustaceans are counted and "measured" by clicking and dragging a mouse over their dimensions. Participants can classify one image and stop, or continue and mark as many images as they want. Because of their slightly addictive, game-like nature, people may end up spending more time on these projects than originally intended!

These projects are ideal to show students that contributing to science can be fun. Such tasks may also be useful for times when some students have finished their work ahead of others and need constructive projects to work on in a computer lab.

All projects are set up to cater to the convenience of the participant; they do not typically require a large amount of time, either to make observations or to submit data to the project. Cornell Lab of Ornithology's project, eBird, will accept an observation of one bird that you may have seen flying by as you walked into your school building. Longer observation times with multiple species are welcome, of course, but not necessary. Submitting an observation online to eBird takes only a couple of minutes, depending somewhat on the number of species you observed. Zooniverse's projects can be "played" for as long as one chooses.

Schools and School Libraries

Citizen-science projects are ideal ways to integrate science education with classroom activities and, indeed, the entire life of your school, including the school library. Because of the small time commitment required for many of these projects, citizen-science projects can become a daily activity if a teacher or school librarian so chooses. School librarians can aid in citizen-science projects with individual teachers, or collaborate and compare the observations from different classrooms and the entire school.

Teachers could have their students build on the findings of each project. For example, gathering data on birds that come to a feeder outside the classroom window and submitting the data to eBird could lead to a discussion of migration and to research assignments on bird species. If, by chance, a student already has a marked interest in birds, he or she could serve as a peer mentor to other students in the class or school. Other lesson plans could be tied into a project as well--in this case, a discussion of feather structure and light refraction as a physics lesson, a poetry unit that uses poems that feature birds, a music class that plays and discusses works that may have been influenced by birdsong, or a history lesson on John James Audubon and the exploration of America in the early 19th century. Arts and crafts projects can easily coordinate with the theme of the projects. as well. (Anyone want a pinecone birdfeeder?) During all of these citizen-science endeavors the school librarian could collaborate and integrate with research on birds, building LiveBinders on Audubon, or creating Learnist or Pinterest boards featuring the students' arts and crafts projects. The collaboration opportunities are endless; citizen-science projects are set up for these types of ventures.

The school librarian is integral to the success and integration of these projects: first, by finding and coordinating citizen-science projects for the classroom or school, and second, by supporting the projects and the students' learning by providing relevant resources for each project. To support the project and any accompanying lesson plans. librarians can collect resources such as books (field guides, fiction and nonfiction with similar themes), videos, music, and online resources. Many citizen-science projects make this task easy by providing on their websites additional resources and lesson plans to assist teachers. Some projects provide lists of individuals willing to speak to community groups and schools about the projects. These individuals could also serve in the role of community mentors.

At the end of the school year, data can be aggregated to give students an idea of how much data they have contributed. End-of-year projects could also be based on this cumulative data. Students could be assigned to groups and asked to present a poster on what they have found over the

school year. If available, community mentors could even judge the posters in a contest with a desirable incentive as a prize for first place. If different classrooms are participating in different projects, students, as subject specialists or mentors, could make project presentations to other classes; these presentations could be effective tools to instruct one another and to stimulate students' interest in various subjects.

Citizen science is, at its core, about collaboration, whether it's librarians working with teachers to facilitate a project, educators helping various citizen-science projects gather data, or students working collaboratively to complete the ventures themselves. In the context of AASL's Standards for the 21st--Century Learner (2007), citizen science connects with standards on thinking critically, making informed conclusions, and creating new knowledge. Common Core Standards are met by drawing conclusions, distinguishing facts, and making judgments while participating in citizen-science projects.

Collaboration at this level is a win for everyone: students, scientists, teachers, and librarians. Not only can science at this level be incredibly interesting, but it's fun, too. And you don't even need a test tube!

USEFUL WEBSITES AND APPS

Zooniverse <www.zooniverse.org> is home to some of the largest citizen-science projects. The Zooniverse team is continuously working on projects and adding new ones. If you are looking for a new citizen-science project for your school or library, this site is a great place to start. Create an account to see the projects and keep track of your class's account, too.

SciStarter <www.scistarter.com> is another citizen-science website and an excellent source of ideas. This website is the one to visit for ideas, classroom activities, and research projects in which your students can take part. The idea is to bring together citizen scientists from all around the world in one online location to have a shared space for their projects.

Project BudBurst <http://neoninc.org/budburst> is a group of citizen scientists who monitor plants as the seasons change. Data is being collected across the country; thousands are participating, and your classroom or school library can, as well. Project Bud Burst is open to all age levels and range of abilities; a downloadable app is available to make experiments mobile.

Leafsnap <http://leafsnap.com> is a free app developed by Columbia University, University of Maryland, and the Smithsonian Institution as an electronic field guide. Users can identify a tree by taking a picture of its leaf. The app contains high-resolution images of trees, leaves, bark, seeds, fruit, and more. Leafsnap is a good resource to accompany work in the field when doing BudBurst projects.

eBird <http://ebird.org/content/ebird> is a real-time, online collaborative checklist for bird-watching citizen scientists. It exists to list the existence and absence of birds in a particular area, and for the science of ornithology, this is an incredibly useful site. It offers supporting materials for 2 educators. eBird welcomes birders to record their sightings and observations, and to upload

their images to the eBird database. Data can be viewed in multiple graphic formats; the site is available in English. French, and Spanish.

World Water Monitoring <www.worldwatermonitoringday.org> allows you to engage your students in monitoring their water as part of a worldwide collaborative project. Students share their findings in an effort to protect a precious resource. Visit the site to download lesson plans, fact sheets, and other resources; to order testing kits; and to view data gathered by teams around the world.

Museum of the Earth (Mastodon Matrix Project)
<www.museumoftheearth.org/reseach.php?page=Mastodon_Research/Mast_Matrix> lets your students examine a bag of sediment (dirt) that is 9,000 years old. Students document what they find and are encouraged to go to the website to record what they find. The Mastodon Project provides information and instructions so students will know what to look for in their bag of sediment. Students may find anything from rocks and shells to bone fragments. Very exciting!

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