ETHICS IN CITIZEN SCIENCE

Ten principles of citizen science for school-based projects

Example: [NIH SEPA All About Arsenic](https://nihsepa.org/project/data-to-action-a-secondary-school-based-citizen-science-project-to-address-arsenic-contamination-of-well-water/)

Citizen science involves everyday people who are generally not professional scientists contributing meaningful data to scientific efforts aimed at better understanding the world around us. In 2015, the ‘Sharing best practice and building capacity’ working group of the European Citizen Science Association, led by the Natural History Museum London developed ten principles of citizen science with input from many members of the Association. Their goal was to set out some of the key principles which as a community they believed represented good practice in citizen science. Teachers and scientist partners in the NIH SEPA “All About Arsenic” project adapted these principles in 2022 to address ethics in citizen science projects happening in secondary schools, with a special emphasis on their project. These principles can be used to guide teachers, can be shared with students so they understand expectations of them and also understand what they can expect to gain by participation in a citizen science effort. These adapted principles also serve as a reminder for project leaders who should ensure that citizen scientists are prepared to make meaningful contributions, do so in ethical ways that respect boundaries and people, and receive credit for their input and efforts.

1. Citizen science projects actively involve citizens in scientific endeavors that generate new knowledge or understanding. It is important for students doing citizen science projects to know that their experience and contributions are real and have meaning. In some classes, students may collect data just to learn a new method or learn data literacy skills. But with citizen science projects, the data will be used to supplement a scientific data collection project or to make important decisions in communities. Students around the world have benefited from being a part of a citizen science project. Students who are engaging in citizen science projects may act as contributors, collaborators, or as project leader; no matter what their role, they all are making meaningful contributions to the project.

2. Citizen science projects have a genuine science outcome. This is true for all citizen science projects, including school-based projects. For example, students in the All About Arsenic project have been involved in sharing information with their town council, at public hearings, and in testimony in support of legislation to help mitigate arsenic exposures from well water. Other ways to be involved in a genuine science outcome is through contributing data to address a research question, inform conservation action, or affect management decisions or environmental policy.

3. Citizen scientists who work with or collaborate with professional scientists work at labs and universities (for example new research projects have been generated in the All About Arsenic project, including seasonal and temporal arsenic studies conducted by students and faculty at College of the Atlantic in Bar Harbor, ME) may be students or community members. All benefit from taking part. Benefits may include learning opportunities, personal enjoyment, social benefits, satisfaction through contributing to scientific evidence e.g. to address local, national and international issues, and through that, the potential to influence policy as well as the publication of research outputs.

4. Citizen scientists may, if they wish, participate in multiple stages of the scientific process. This may include developing the research question, designing the method, gathering and analyzing data, and communicating the results. For school-based citizen science, the point of entry into the “Citizen Science Project Cycle” can begin anywhere. For the All About Arsenic project, students conduct experiments, such as bioassays, in their classrooms that provide additional understanding of the impact of arsenic on living systems. This provides context for communicating the importance of the citizen science effort. Students in the project also have opportunity for data entry, downloading whole datasets, making decisions based on the outcomes of well water analyses, deciding where sampling efforts should be focused in the future, etc.

5. Citizen scientists receive feedback from the project. For example, how their data are being used and what the research, policy or societal outcomes are. For students this might mean including research results in curriculum that their teachers can share with them. For example, a graduate student at University of Maine used duplicate well water samples supplied by students to conduct behavioral bioassays with zebrafish larvae. Some of the larvae responded to contaminants in a hypoactive way and some responded in a hyperactive way. We shared these findings with teachers and students by creating curriculum that included graphing data and drawing conclusions about the effects of exposure to arsenic, in combination with other metals, on living systems while also learning how their duplicate water samples were used.

Students use a data literacy software called Tuva to analyze their data. It helps to provide feedback to students by making data accessible and easy to visualize.

Student data are used to create posters and talks that scientists present at scientific meetings These should be shared with teachers and students and made available for classroom use. It is important for project outcomes to be shared in the classroom, not only what scientists are summarizing and presenting, but what other students have been producing in their citizen science projects. Advocacy work as well should be shared among all partners.

6. Citizen science is considered a research approach like any other, with limitations and biases that should be considered and controlled for. However, unlike traditional research approaches, citizen science provides opportunity for greater public engagement and democratization of science. For students in the All About Arsenic project, this means having opportunities to have their data inform decision making and public policy. In the All About Arsenic project, students have experienced the upside of citizen science engagement by providing testimony in public hearings about legislation that supports safe drinking water for rural residents. Students have also learned where things can go wrong in a project. Real-world projects provide students with the opportunity to experience both success and failure in trying to get their message across. They learn how to control for negative outcomes.

7. Citizen science project data and meta-data are made publicly available and where possible; results are published in an open access format. Data sharing may occur during or after the project unless there are security or privacy concerns that prevent this. Using a citizen science platform like Anecdata that gives the public access to student data is a good way for students to share their data. Privacy features on this site provide opportunity to reflect on what is important to share and what should be kept private. Another way to make data publicly available is participation in conferences, meetings, and science fairs. Scientist partners can offer ways to students to participate in authentic events on their campuses. Also, students can share data in their communities at public meetings, like town council meetings and other public hearings.

8. Citizen scientists are acknowledged in project results and publications. This means students and their teachers should be mentioned in acknowledgement sections of papers and posters and where possible included in author lists. Acknowledgements work in all directions….students acknowledging scientists, scientists acknowledging students etc. Everyone then recognizes they are part of a bigger research community.

9. Citizen science programs are evaluated for their scientific output, data quality, participant experience and wider societal or policy impact. For school-based programs the evaluation could look like using Tuva for data literacy evaluation or Ripple Effect Mapping for identifying and acknowledging the contributions of partners and understanding how successes are built on networks of people. Our external evaluation of the program ensures that we learn from each other’s experiences and continue to make improvements in the program.

10. The leaders of citizen science projects take into consideration legal and ethical issues surrounding copyright, intellectual property, data sharing agreements, confidentiality, attribution, and the environmental impact of any activities. For school-based programs, this can be accomplished by having conversations with students about data privacy and ethical issues. How are these being dealt with by project leaders? How can students contribute to creating checks and balances in projects so that legal and ethical issues do not arise? What kinds of agreements might be necessary as school-based citizen science projects move forward?

*ECSA (European Citizen Science Association). 2015. Ten Principles of Citizen Science. Berlin. http://doi.org/10.17605/OSF.IO/XPR2N*