**S**tudents may know about efforts to address environmental problems in their communities—but do they use the science they learn in school to help solve these problems? In recent years, citizen science projects have emerged as a means to involve students in scientific inquiry, particularly in the fields of ecology and environmental science. A citizen scientist is "a volunteer who collects and/or processes data as part of a scientific inquiry" (Silverton 2009, p. 467).

Participation in citizen science fosters an appreciation for the diversity of scientific fields (i.e., conservation biology, ornithology). The National Science Foundation (NSF) supports citizen science projects as a means to recruit future generations into the science, technology, engineering, and mathematics (STEM) disciplines by directly involving students in scientific research. Examples include NestWatch, a bird nesting monitoring program; Project Budburst, a program developed to track climate change through recording the timing of flowers and foliage; and Project SEED, which involves science researcher mentoring underserved high school students.

Teachers have expanded citizen science projects to include not only gathering and analyzing data but also civic participation and action (Zaikowski and Lichtman 2007; Ryken et al. 2008). This effectively merges hard sciences with social sciences. In a survey of adolescents in seven countries—Chile, Czech Republic, Norway, Poland, Portugal, Sweden, and the United States—social movement citizenship such as participating in community action and environmental protection was deemed just as important as conventional citizenship activities (i.e., voting) (Torney-Purta and Amadeo 2003). In light of this growing interest, teachers must explore effective ways to engage students in citizen science projects to promote STEM education and environmental awareness. This also helps us dispel the myth that science is just a static body of knowledge.

In this article, we present the multidisciplinary Project Citizen approach to teaching and learning science and engaging students in action-oriented citizen science.

PROJECT CITIZEN

PROMOTING ACTION-ORIENTED CITIZEN SCIENCE IN THE CLASSROOM

CARIE GREEN AND WILLIAM MEDINA-JEREZ
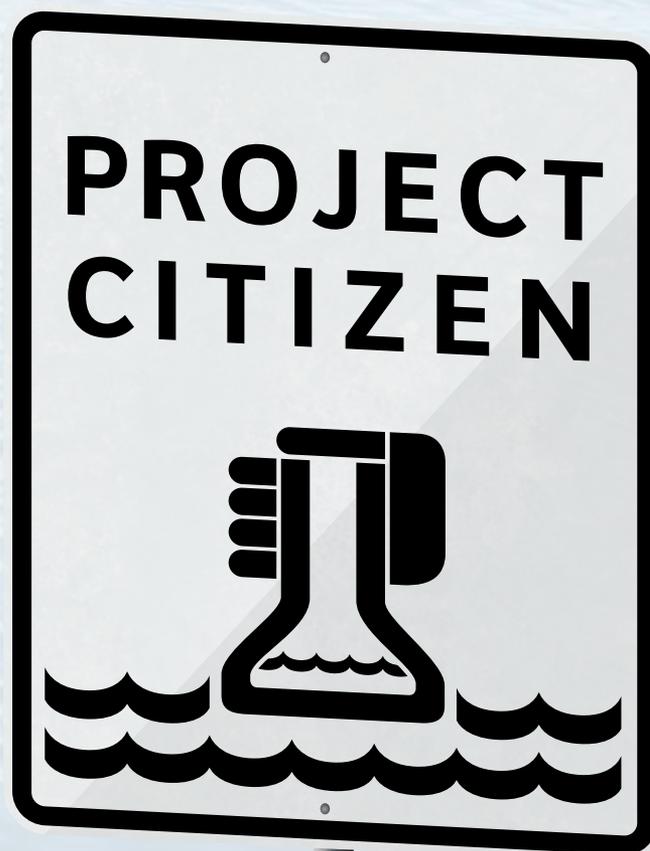
Project Citizen

Project Citizen, a curricular program administered by a national network of coordinators in every state, promotes competent and responsible civic participation by giving students a vehicle to influence and monitor public policy (Center for Civic Education 2009). High school teachers can adapt Project Citizen as an approach for teaching a variety of subject areas. English teachers can use Project Citizen to emphasize speech and writing skills; social studies teachers can emphasize civic ideas and practices; and mathematics and science teachers can focus on analytical thinking and scientific inquiry.

Project Citizen helps students learn to express their opinions, decide which part of government is most appropriate for dealing with problems they identify, and influence policy decisions at that level. Students work with each other, teachers, and volunteers as they identify a problem to study, gather information, examine solutions, develop public policy positions, and create action plans. Project Citizen–trained teachers guide and encourage students to understand the problems in their communities and propose solutions to these problems. Through the monitoring and influencing of public policy, students express democratic values and principles and develop feelings of political efficacy (Center for Civic Education 2012). Figure 1 provides an overview of the steps of Project Citizen.

Step 1: Identifying public policy problems

In this critical step, Project Citizen teaches students to distinguish between public policy, which always involves government, and civil society, "a free society that is outside formal political and legal institutions" (Gerston 2002, p. 5). Students then identify potential environmental problems that can be dealt with through public policy. Some problems may be common across the country, but others may be more prevalent in certain communities (i.e., rural, urban) (Figure 2, p. 60). In this paper we use water quality of a local stream as an example of an environmental problem.

Step 2: Selecting a problem for class study

Students determine how widespread various problems are perceived to be by gathering information through surveys, interviews, library and government agency visits, environmental legislation reviews, and other resources. Based on their initial findings, they select a single problem for further study. For example, students may undertake a project in which they act as water chemists, selecting water samples from a nearby river for analysis to monitor water quality and possible sources of pollution, such as sewage and farm runoff. Before taking this field trip, students learn how to complete tests, such as nitrate and ammonia water kits, pH strip tests, and two-probe systems that test temperature and dissolved oxygen.

FIGURE 1

The steps of Project Citizen.

Before Project: Students distinguish between public policy and community solutions.

Step 1:   Students identify public policy problems in their community.

Step 2:   Students select a problem for class study.

Step 3:   Students research the problem.

Step 4:   Students develop a class portfolio, which includes:
  ◆   A problem explanation
  ◆   Alternative policies
  ◆   A public policy statement

Step 5:   Students present their portfolio to decision-makers and interested parties.

Step 6:   Students reflect on their learning experience.

After completing a classroom chemistry unit, discussing water quality, and practicing the water tests, students visit the local river to conduct the actual tests. (**Safety note:** When working in or near water, students must wear lifejackets and be directly supervised at all times.) Returning to the classroom following the field trip, students pool their data with that of other classes at their school and discuss the quality of the aquatic ecosystems.

Step 3: Gathering information on the problem

With teacher guidance, students next gather further information about the selected topic. As students process, analyze, and discuss the data, they formulate potential solutions to the problem. For example, students may be concerned that a local agriculture fertilizer factory may be a "point source" of pollution, directly contaminating the river. To test their assumption, they can repeat their water tests for nitrates, dissolved oxygen, pH levels, and so on. (**Safety note:** To prevent accidents, instruct students on the proper way to handle test materials and remind them to observe the laboratory safety procedures established in their classrooms. Do not allow any chemicals to enter the stream; return them to the classroom for proper disposal. Remind students to wash their hands

---

FIGURE 2

A typology of Project Citizen topics.

Type of Problem	Examples
1. Problems in schools	The school curriculum does not address skills that adequately prepare students to get jobs when they graduate.
2. Problems regarding young people	Some working parents do not have enough money to pay for adequate child care during working hours. As a result, young children may be left home alone, sometimes in dangerous situations.
3. Problems involving community standards	Some stores advertise and sell tobacco and alcohol near schools. Others sell materials that some people might think are obscene near schools.
4 Problems involving basic liberties	Large numbers of people do not vote in elections. This is especially true in local elections.
5. Problems concerning the environment	*Problem topics in rural settings* ◆ Some communities have problems that involve the loss of areas that help avian species during migration. ◆ Some communities do not have recycling programs, or those programs they have do not work well. ◆ Some communities do not have access to a good selection of healthy food choices. ◆ Some communities have cases of unsafe hunting, which may affect safety in the outdoors. ◆ Some communities have problems with overpopulation of some animal species. *Problem topics in urban settings* ◆ Some communities have problems with the deterioration of the air quality due to heavy traffic, which may contribute to cardiorespiratory problems in children. ◆ Some communities do not offer their students after-school opportunities that provide academic enrichment. ◆ Some communities do not have facilities for outdoor recreation. ◆ Some communities do not have the resources to deal with inhumane treatment of animals. ◆ Some communities have problems with lawnmower emissions.

(Center for Civic Education 2012)

---

thoroughly before and after testing water samples. Students must wear safety goggles.)

As part of their investigation, students may note water discoloration or the disturbance of animal habitats. They may choose to interview local residents about their concerns about the environmental issue or even look at historical records to learn about changing patterns in the aquatic fauna and flora. After students collect sufficient data, they analyze and interpret their findings. Teachers should encourage students to produce high-quality data that will convince stakeholders that the problem exists. Students can create line graphs or pie charts to help present their findings. They may also include photographs of the affected site or comments from local residents. Students can select collected materials to include in their portfolio and documentation binder.

Teachers and students can contact local universities or research centers to inquire about partnership opportunities that support the research students are doing in their Project Citizen projects. Collaborations pair science teachers and students with graduate students and faculty from science departments to carry out a scientific research study. Partnership opportunities also exist in the form of grant projects that include an educational component.

Once students obtain convincing data to explain the problem, they need to use public policy to address the problem. First, students research what existing policies relate to the problem. Because the problem persists, the existing policy apparently does not sufficiently address it or is not being enforced. The teacher should guide students in this research, such as helping students identify the governing body responsible for mitigating the problem.

For the water pollution activity, students research the Clean Water Act and determine if the stream is protected under national law. They then research the National Pollutant Discharge Elimination System, which is the permit system for regulating point source pollution. This leads students to identifying enforcement agencies (e.g., the Environmental Protection Agency) and state environmental agencies. Eventually, students may obtain a copy of the permit for the agricultural facility. They may then identify discrepancies in the regulatory permit, at which point students may propose a revision of the existing agreement between the private entity and the governing agency.

Project Citizen teaches students to research and understand the positions of various stakeholders who may have diverse viewpoints on an issue. Ultimately, students come to their own conclusions and approaches to solving the problem. Students can address controversial issues such as the loss of jobs versus the enforcement of environmental regulations. Teachers can guide students to prevent tensions between local residents and organizations and companies that support the local economy.

Aligning with the *Framework.*

Project Citizen aligns with the practices described in *A Framework for K–12 Science Education* (NRC 2012). When students engage in the design and development of a project like the sample project described in this article, they can

1. Ask questions and define problems (Practice 1): Students identify problems in their communities and then draft and defend a public policy proposal.

2. Plan and carry out investigations (Practice 3): Students collect data by designing and conducting experiments or by approaching other information sources like experts in the field, libraries, and environmental legislation.

3. Analyze and interpret data (Practice 4): Students work together to discuss and answer the research question and examine alternative solutions to the problem.

4. Use mathematics and computational thinking (Practice 5): Students process both qualitative (i.e., survey of microinvertebrates in water samples) and quantitative data (i.e., water quality tests). They also use graphical representations to document the problem under investigation.

5. Construct explanations and design solutions (Practice 6): Students work as a group to explain the problem they chose to study, why the problem is important, why a certain level of government should deal with it, and propose an action plan.

6. Engage in argument from evidence (Practice 7): Students develop and justify a specific public policy that the majority of the class agrees to support.

7. Obtain, evaluate, and communicate information (Practice 8): Students
   ◆ participate in a Project Citizen showcase to inform an audience of the relevance of the problem,
   ◆ explain and evaluate alternative policies that may help solve the problem,
   ◆ discuss the class' choice as the best policy to deal with the problem, and
   ◆ demonstrate how the class could develop support for the policy in the local community.

Project Citizen teaches students that community problems are complex and the solutions do not always please everyone. The goal is to devise solutions that take all shareholders' interests into account. The Constitution Opinion form, available on the Project Citizen website (see "On the web"), helps students ensure that what they propose is constitutional. The Controversial Issues Questionnaire (Figure 3) can help teachers and students identify, discuss, and plan for problems that may become contentious upon investigation. Culminating this step, students draft a public policy statement reflecting their research and recommendations.

Step 4: Developing a class portfolio

All of students' collected data is placed in a project portfolio, which usually consists of two items: a documentation binder and a portfolio display. The documentation binder includes selected evidence of student's work throughout the project, such as raw data. For instance, for the water pollution activity, students' binders may include measurement notes, letters to and from public officials, or copies of surveys distributed to local residents. Students also construct a four-panel portfolio display. On each panel, students

- explain the problem
- suggest alternative policies

FIGURE 3

Controversial issues questionnaire.

1. Why is your issue important?
2. What makes your issue controversial?
3. What positions can be taken in regard to your issue?
4. What arguments can be offered to support each position?
5. What evidence did you find to support those arguments?
6. Who might be influenced by each position? How might they be influenced?
7. What are the costs to society of each position?
8. What are the benefits to society of each position?
9. What additional information would you like to have before making a policy recommendation? Where might you find this information?
10. What are your recommendations on this issue?
11. What compromises might your group make to reach consensus?
12. What steps can you take to promote the adoption of your group's proposed policy?

- develop a public policy, and
- create an action plan to explain how they will go about getting the proposed policy adopted by the appropriate governing officials or agencies.

Many states hold an annual Project Citizen showcase in which students present their work to a panel of judges. The judges select a winning team from each participating state to compete in the national showcase. State legislators and other volunteers evaluate the merit of the student projects (Center for Civic Education 2012). See the Project Citizen website for more information (see "On the web").

Step 5: Presenting your portfolio

The ultimate goal of Project Citizen is for students to present their plans to appropriate policy makers. Students can schedule a public hearing at school or, if invited, at an official public forum, such as a city council or a state legislature meeting. If students present at school, they may want to invite concerned citizens, local businesses, and state or local government officials. For the water pollution activity, students would want to present to local representatives of state or national environmental agencies. Students can hold practice presentations and invite classmates, parents, and other interested parties at school.

Step 6: Reflecting on your learning experience

Finally, students should reflect on their overall learning experiences during the project. Depending on the content and the subject area emphasis, teachers may frame questions around specific learning objectives for the project. In the water pollution example, teachers may ask students to define point-source water pollution, describe the process of water sampling, or expand on their newfound civic knowledge (e.g., how to define public policy or identify government officials or regulatory agencies). Students should also frame their reflections around the skills they gained during the project (e.g., analysis and interpreting of data, communicating results). Teachers might ask students what they would have done differently or to identify their next steps.

Assessment

Teachers have found that the Project Citizen program works best when students with common interests in specific problems work in small teams of four to six. Though the program is designed as an authentic assessment curriculum, teachers have developed recommendations for grading Project Citizen. Recommendations for the implementation of Project Citizen in high school classrooms and a rubric developed through the Center for Civic Education are available online (see "On the web").

Project Citizen's success is partially due to its student-centered nature, so teachers should encourage student ownership from the very beginning. Student participation may dwindle if teachers force students into topics of little interest.

Conclusion

Project Citizen expands on the notion of citizen science through coupling scientific inquiry with civic literacy to address real-world problems. It engages students in STEM learning and environmental activism. Students learn that it is possible for them to identify problems, approach the relevant regulatory agencies, and affect decision making in their community.

Carie Green (greecari@isu.edu) is an assistant professor in the Department of Education Foundations at Idaho State University in Pocatello, Idaho, and William Medina-Jerez (wjmedinajerez@utep.edu) is an associate professor in the Department of Teacher Education at the University of Texas–El Paso in El Paso, Texas.

Addressing the standards.

Project Citizen activities address both the Science as Inquiry and the Science in Personal and Social Perspectives National Science Education Standards (NRC 1996). As an interdisciplinary curricular program, Project Citizen focuses on state and local government, applies learning to real-world issues, uses cooperative learning, and serves as a performance assessment instrument. Since Project Citizen supports open-inquiry investigations, students also develop critical-thinking skills when they are challenged with multidisciplinary problems (Ting Chowning 2009). The Project Citizen–inquiry investigations connection is evident in the design and execution of Project Citizen (Figure 1, p. 59).

Following an inquiry-oriented format, Project Citizen also promotes the practice of the Common Core State Standards strands related to reading and writing in science. The standards in 9–10 and 11–12 grades target literacy skills common in the practice of science.

On the web

Center for Civic Education's Project Citizen program:
www.civiced.org/index.php?page=program_information
www.civiced.org/index.php?page=student_forms
Project Citizen implementation recommendations and Common Core State Standards connections: www.nsta.org/highschool/connections.aspx

References

Center for Civic Education. 2012. Project citizen. www.civiced.org/index.php?page=we_the_people_project_citizen

Gerston, L.N. 2002. Public policymaking in a democratic society: A guide to civic engagement. Armonk, NY: M.E. Sharpe.

National Research Council (NRC). 1996. National science education standards. Washington, DC: National Academies Press.

National Research Council (NRC). 2012. A framework for K–12 science education: Practices, crosscutting concepts, and core ideas. Washington, DC: National Academies Press.

Ryken, A.E., L. Bowers Foreman, M. Tudor, and G. Koehler. 2008. Cougars and the community. The Science Teacher 75 (4): 36–40.

Silverton, J. 2009. A new dawn for citizen science. Trends in Ecology and Evolution 24 (9): 467–471.

Ting Chowning, J. 2009. Why societal issues belong in science classes? The Science Teacher 76 (7): 8.

Torney-Purta, J., and J.A. Amadeo. 2003. A cross-national analysis of political and civic involvement among adolescents. Political Science and Politics 36 (2): 269–274.

Zaikowski, L., and P. Lichtman. 2007. Environmental research puts science into action. The Science Teacher 74 (4): 47–51.