Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education

A CAISE Inquiry Group Report

July 2009

About CAISE

The Center for Advancement of Informal Science Education (CAISE) works to strengthen and connect the informal science education community by catalyzing conversation and collaboration across the entire field—including film and broadcast media, science centers and museums, zoos and aquariums, botanical gardens and nature centers, digital media and gaming, science journalism, and youth, community, and after-school programs. CAISE focuses on improving practice, documenting evidence of impact, and communicating the contributions of informal science education.

Founded in 2007 with support from the National Science Foundation (NSF), CAISE is a partnership among the Association of Science-Technology Centers (ASTC), Oregon State University (OSU), the University of Pittsburgh Center for Learning in Out-of-School Environments (UPCLOSE), and the Visitor Studies Association (VSA). Inverness Research Associates serves as evaluator. CAISE is housed at ASTC's Washington, D.C. offices.

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Executive Summary

Introduction

This report describes how Public Participation in Scientific Research (PPSR), in the context of informal science education (ISE), can provide multiple opportunities to increase public science literacy.

The ISE field is large and continually evolving. In the broadest sense it encompasses the range of science learning opportunities and activities that people experience across their lifespan outside of school. ISE can be delivered via numerous venues including lectures, TV programs, films, exhibits, websites, digital games, and community projects that are experienced or viewed in homes, science centers and museums, zoos and aquariums, botanical gardens and nature centers, and youth, community, and after-school centers.

As the concept of ISE emerged in the 1940s and 50s it was called "Public Understanding of Science" (PUS), and the current ISE program at NSF, which is one of the largest funders of ISE project development in the United States, is a direct descendant of the Public Understanding of Science program created at NSF in 1958 (Lewenstein 1992). Many ISE projects still follow the PUS concept or model, which is premised on the idea that science, scientists, and other experts know and should determine what the public needs to learn. Explain science to the public, the reasoning goes, and both science and scientists will enjoy greater support, which in turn will lead to greater economic prosperity, enhanced quality of life, and world leadership in science and technology. Most PUS activities involve exhibits, lectures, media broadcasts, and public programs through which the public is informed about science and expected to embrace it.

Recent research has suggested several shortcomings in the PUS model, two of which are relevant to this inquiry. First, educational research shows that people have greater motivation to engage and learn if the subject matter is directly relevant to their lives and interests and/or if the learning process is interactive—one in which the learner can directly affect the learning process, content, and/or outcomes of the experience (Falk 2001).

Second, PUS usually focuses on delivery of specific content rather than on helping the public experience and understand the process of research, that is, the way that scientific questions are asked, answered, and debated by the scientific community (Lewenstein and Bonney 2004).

To address these concerns, many ISE programs, projects, and activities developed over the past two decades have aspired to actively involve the public directly in the multifaceted and iterative processes of scientific investigation. Such efforts include citizen science, volunteer monitoring, and participatory action research. Projects that fall into these categories allow participants to learn both science content and process while experiencing the fun and excitement of research.

In response to a request by the National Science Foundation, the Center for Advancement of Informal Science Education (CAISE) established an Inquiry Group to

- identify and describe the range of ISE projects and activities in which the public is involved in one or more of the various stages of research
- describe models for public participation in scientific research

- understand and describe the educational impacts of PPSR projects
- make recommendations for conceptualizing and developing future ISE activities that will enhance public participation in scientific research.

We hope that this report will serve as a starting point for discussion about the value and potential for PPSR projects as a form of informal science education. While we have attempted to capture current thinking in this area, we realize that the conversation is just beginning.

Models for Public Participation in Scientific Research

Scientific investigations include many processes, steps, or activities in which the public can be involved. These include:

- Choosing or defining questions for study
- Gathering information and resources
- Developing explanations (hypotheses) about possible answers to questions
- Designing data collection methodologies (both experimental and observational)
- Collecting data
- Analyzing data
- Interpreting data and drawing conclusions
- Disseminating conclusions
- Discussing results and asking new questions

From an educational perspective, PPSR models differ chiefly by involving the public in these steps to varying degrees and by altering the amount of control that participants have over the different steps. For this report we have divided PPSR projects into three major categories:

1) **Contributory projects**, which are generally designed by scientists and for which members of the public primarily contribute data
2) **Collaborative projects**, which are generally designed by scientists and for which members of the public contribute data but also may help to refine project design, analyze data, or disseminate findings
3) **Co-created projects**, which are designed by scientists and members of the public working together and for which at least some of the public participants are actively involved in most or all steps of the scientific process.

Impacts of Public Participation in Scientific Research

To investigate the educational impacts of PPSR we reviewed ten projects including examples of each model type—five Contributory, three Collaborative, and two Co-created. To standardize our methods of analysis for each selected project, we developed a rubric based on the evaluation framework described in *Evaluating Impacts of Informal Science Education Projects* (Friedman 2008). Our rubric describes potential impacts in the general categories of developing understanding and knowledge, enhancing engagement or interest, improving skills, changing attitudes, and changing behavior.

Next, for each project that we reviewed, we examined project descriptions and published reports to identify goals, objectives, and potential indicators for each impact category. Finally we determined measured outcomes (which were rare for most studies) and inferred outcomes (outcomes that seem to be happening but which are based on anecdote or perception as opposed to qualitative or quantitative evaluation).

In most cases, using this rubric to assess project impact was challenging because few if any of the projects that we reviewed used anything like it in their original or ongoing evaluations. However, we believe that our rubric represents an important step in bringing cohesion to the emerging PPSR field. It can be used not only as a guide to project assessment, but also as a tool for project planning and development.

Awareness, knowledge, and/or understanding

All PPSR projects seem to contribute to awareness, knowledge, and/or understanding of key scientific concepts related to the study at hand. This conceptual understanding ranges from purely scientific information to environmental issues and regulations. Participants in many PPSR projects also gain knowledge of the process of science. Indeed, this is one area where PPSR projects have the potential to yield major impacts, particularly Collaborative and Co-created projects, which engage participants in project design and data interpretation to a significant degree. Participants in most of the Collaborative and Co-created projects also seem to have gained knowledge of community structure and environmental regulation.

Engagement or interest

Increasing public engagement in scientific activities is an area at which PPSR projects excel. Participants who take part in a project's full range of activities are deeply engaged in conducting science. Indeed, enlisting people into PPSR projects is probably one of the most expedient methods for informal science educators to engage people in science in a fun and meaningful way. PPSR projects provide opportunities for people to develop interest and engagement by either trying something new or by expanding previously existing interests. The different PPSR models allow varied levels and types of engagement so that individuals with varying levels of expertise can develop a new interest or take deeper steps in their practice or engagement.

Skills

PPSR projects are excellent for developing science-related skills. Participants in most projects increase their ability to identify organisms, to use measurement instruments, to collect field data following specific protocols, and to sample consistently over time. Thousands of individuals have submitted data on nesting birds, the distribution and abundance of monarch butterflies, patterns of water quality, and the distribution and abundance of invasive plants. Furthermore, these data have been of sufficient quality to allow scientific analyses and to be published in peer-reviewed scientific publications. Participants in data analysis workshops gain additional skills in reading and interpreting graphs, drawing conclusions from evidence, and raising new questions as a basis for new study designs. Participants in Collaborative and Co-created projects also increase their ability to identify and distinguish habitats, to identify and select study sites, to weigh the pros and cons of various research design and data collection methods, and to communicate their results to the public.

Attitudes and behaviors

Few instances where PPSR project participation has affected attitudes toward science have been documented. Nevertheless, individuals who learn to function as scientists, or at least to understand how scientists work, could be expected to increase their already positive attitudes toward science. We do see evidence that Co-created projects that are initiated to meet specific community needs can

draw concerned citizens into the scientific process who might not otherwise be involved in science-related activities. In addition, participation in PPSR projects can change behaviors. First of all, the projects cause people to take part in scientific research, which is a huge behavior change for many! Participation also can lead to other types of behavior change such as improving habitat for wildlife or noticing invasive species in the environment. And some PPSR participants become more engaged in community politics and more confident about asking for a place at the table in making decisions about community planning.

Opportunities for the Field

We suggest that projects focusing on PPSR represent an emerging field of informal science education that is ripe for further development, and we urge developers of ISE programs to consider four PPSR approaches in their work.

Creating new PPSR projects

Although hundreds of PPSR projects are now under way, both large and small, room for new projects exists in three areas:

1) Projects designed to study new scientific questions

2) Projects designed to engage new audiences

3) Projects designed to test new or enhanced PPSR models.

Many new projects could be created that will appeal to the increasing numbers of amateur naturalists and stargazers who are interested in lending their brains to science. Developers should be aware, though, that coming up with questions that are appropriate for PPSR is not a simple task, especially if the project desires to reach a wide audience.

And from an educational perspective, developing projects to answer new scientific questions may not be the most strategic approach for the ISE field unless new projects strive to enhance existing PPSR strategies or reach truly new audiences. But to reach new audiences, significant research into motivations for members of the public to understand and participate in research will be needed. Also required is research into the ways in which individuals perceive themselves or can develop identities as scientists, potential scientists, and critical thinkers. We suggest that new projects, especially if they desire to engage diverse audiences, test Collaborative and Co-created approaches to PPSR.

Enhancing PPSR projects already underway

We believe there is tremendous potential to enhance projects that are already underway. In particular, we suggest that many projects could be expanded to involve more individuals in more aspects of science inquiry. For instance, Contributory projects can be expanded into Collaborative models, at least for some project participants. At the same time, Collaborative and Co-created projects can learn many lessons from successful Contributory projects. For example, water quality monitoring projects could work together to design and develop regional and national databases that would allow participants to compare data and findings across larger regions or over long spans of time.

Add PPSR to other types of ISE projects

Examination of the NSF portfolio shows that relatively few full-fledged PPSR projects have been funded to date, although several have started in the last few years. More common in the portfolio are PPSR "add-ons," that is, citizen science projects that are associated with other projects such as films or exhibitions. We suggest that more closely integrating PPSR efforts into other types of ISE projects

would represent strategic investment by the field. ISE projects seeking to deepen their impact through inclusion of PPSR techniques should consider partnering with PPSR projects already under way.

Enhancing research and evaluation surrounding models of PPSR and their impacts

Many questions remain to be answered about the potential for PPSR projects to contribute significantly to the ISE field. These include questions about personal and extrinsic motivators, altruistic intentions, and the notion that projects may be tiered or might serve as gateways for other projects to embrace participants who join projects for different reasons. Questions also remain about the learning implications of various types of PPSR projects. What is the nature of questions that enable participants to not only collect data but also to reflect on their experiences? Do participants, or potential participants, prefer to become involved with questions that deal with basic science, that resolve issues, that are simply fun, or all of the above? To what extent do participants gain from projects because they help to shape them? Yet other questions relate to the overall impacts of PPSR participation, including participation in areas of inquiry that have not been well studied such as modeling, data visualization, and data dissemination. Finally, we need to better understand the behavioral impacts of PPSR, which could push the boundaries of what we currently define as learning in the realm of science, including learning that affects participants' lives in a very broad sense.