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The Learning Science in Informal Environments Study in Context

David A. Ucko

Abstract

The National Science Foundation (NSF) funded the National Research Council report *Learning Science in Informal Environments* to synthesize the growing body of diverse research underlying informal science learning. Intended outcomes were to establish a base for future research, to provide evidence-based guidance for those developing and delivering informal learning experiences, to broaden the definition of “learning” beyond that typically used in formal education, to encourage knowledge sharing across the heterogeneous informal science education field, and to provide a measure of external validation for the value of learning in informal settings. NSF investment in this study is part of a larger ongoing effort by the Informal Science Education Program to advance knowledge and practice and build capacity in the field.

David A. Ucko (ducko@nsf.gov) is division director (acting) of the Division of Research on Learning in Formal and Informal Settings, Directorate for Education and Human Resources, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230.

Background

The National Science Foundation (NSF)-funded report *Learning Science in Informal Environments: People, Places, and Pursuits (LSIE)* was triggered by a chance meeting in March 2004 with Dr. Jean Moon, then-director of the Board on Science Education (BOSE) within the National Academies. Familiar with the role of its National Research Council (NRC) in convening independent committees of experts, the author encouraged BOSE to consider submitting a proposal to generate a synthesis study of the research literature underlying informal science education. A proposal, *The Status of Research on Learning Science within Informal Education Settings—A Planning Grant* (0448163), was subsequently submitted, reviewed, and funded. It made possible an invitational planning conference involving 15 experts (National Academies 2005) that helped frame the subsequent study (National Academies 2006), which was supported through a second NSF competitive award, *Learning Science within Informal Environments* (0545947). This article presents the context and intended outcomes for that study.

The informal science education field has expanded greatly over the past 40 years. One indicator is the growth of the Association of Science-Technology Centers (ASTC) from 16 founding organizations in 1971 to 583 institutional members in 45 countries today. With the creation of the Public Understanding of Science (PUOS) program in 1957 and its successor, the Informal Science Education (ISE) program in 1983, NSF has played a major role in supporting the emerging field. For example, it provided initial support for the nascent ASTC organization; helped to establish television, radio, and giant-screen

film as media for science, technology, engineering, and mathematics learning; and funded a large number of traveling and permanent exhibitions (National Science Foundation 1982, Cosmos Corporation 1998).

Expansion and maturation of the field have been accompanied by growth in knowledge, encouraged in part by NSF investment and emphasis on evaluation. Awards in the 1970s through 1980s supported such research as a study of the effect of field trips¹ and an investigation of the influence of museum exhibit design on naïve knowledge of science.² By the early 1990s, NSF funded a review of the existing literature on informal learning³ that focused primarily on evaluation studies based on television and radio, community projects, and science museums (Crane, Nicholson, Chen, and Bitgood 1994). In 1996, the Museum Learning Collaborative was formed with funding from four federal agencies, including NSF, to generate a research base to guide the study of learning in informal contexts. By the time funding ended five years later, it had assembled a searchable database on museum learning with approximately 2,300 research literature citations.⁴ To build on this work, supplemental funding was awarded by NSF in 2003 to create the website www.informalscience.org. That site now contains over 5,000 literature citations.

Study Objectives

The purpose of the *LSIE* study was to synthesize the growing body of work from research and evaluation on informal learning of science from many diverse sources. Ultimately, the study would draw from science education research, cognitive science research, psychology research, youth development research, media research and evaluation, after/summer school science programming, adult programming investigations, sociology research, anthropology research, visitor studies, exhibit studies, serious leisure research, adult learning/development research, and other domains.⁵ A synthesis would make this dispersed published literature more accessible to researchers and others, along with evidence-based findings from the “gray” literature of formal evaluations, not typically published in peer-reviewed journals.

One key objective of conducting and disseminating this synthesis was to provide a foundation for future research. In this sense, it could serve as a preliminary step towards ultimately developing a “science” of informal science education, building on more general efforts (National Research Council 2002). The report provides recommendations for fruitful areas for further study, including tools and practices that contribute to learning; learning strands; cumulative effects; learning by groups, organizations, and communities; supporting learning by diverse groups; and media (National Research Council 2009a, 310-314).

A second objective was to help practitioners develop learning experiences in informal settings that would enhance the educational impact of exhibitions, media, and programs. The young field has been guided by a large body of practical experience that is shared within organizations and across institutions through various professional organizations, publications, listservs, websites, and conferences. Aspects of that experience are captured and disseminated in published “best practices” (see, for instance, McLean and McEwen 2004). The *LSIE* study could provide a research-based foundation to help design and program the most effective educational experiences.

The report, in fact, makes specific recommendations for exhibit and program designers and for front-line educators (National Research Council 2009a, 307-309). The companion publication *Surrounded by Science* (funded by NSF, the Institute of Museum and Library Services, and the Burroughs Wellcome Fund) provides case studies and guidance for applying the report findings (National Research Council 2009b). The goal of improving practice based on research faces many challenges, however. One is the assessment of learning in informal settings, which can be more complex in the “wild” than in the classroom and is less developed in terms of common instruments. In addition, “conventional academic achievement measures (e.g., standardized tests of science achievement) are too narrow and not well aligned to the goals of informal providers” (National Research Council 2009a, 303). There are other critical underlying questions as well, such as whether greater educational impact can actually enhance an organization’s financial “bottom line.”

A third objective was to broaden the definition of “learning” beyond those aspects typically considered in formal education, enabling the field to define success on its own terms that are more appropriate to the setting. An earlier study, *Taking Science to School: Learning and Teaching Science in Grades K-8*, identified four “strands” of scientific proficiency for students: knowing, using, and interpreting scientific explanations; generating and evaluating scientific evidence and explanations; understanding the nature and development of scientific knowledge; and participating in scientific practices and discourse (National Research Council 2007, 36). *LSIE* adapted these four strands, but crucially added two others fostered especially through informal learning:

Strand 1: Experience excitement, interest, and motivation to learn about phenomena in the natural and physical world.

Strand 6: Think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science.

The report notes that “informal environments can be particularly important for developing and validating learners’ positive science-specific interests, skills, emotions, and identities” (National Research Council 2009a, 294).

Another objective was to help bridge the heterogeneous informal science education field through knowledge sharing by means of an NRC process that was broadly inclusive. A recent “landscape” study by Falk, Randol, and Dierking (2008) disaggregated the ISE community space along two dimensions: “practicing informal education” and “promoting public understanding.” The authors found that science centers, natural history museums, zoos and aquariums, and to a somewhat lesser degree, children’s museum communities, perceived themselves tightly committed to the central tenets of an informal science education community of practice, while the broadcast media, film makers, extension, after-school science, parks and gardens, libraries, health education, and environmental education communities were less so. Others, such as science writers, science societies, new media researchers, and adult and youth communities, viewed them as more ancillary to their work. Promisingly, although the diverse sub-communities have their own professional societies, publications, and practices, they used “similar evidence and arguments for making the case for the value of

what they do” (Falk, Randol, and Dierking 2008, 15). *LSIE* may help to further foster a community of practice that cuts across these domains.

The final objective for the study was to provide a measure of external validation for informal learning. The NRC is widely recognized for the rigor of its study process, which includes very limited involvement of the project funder; careful vetting of committee members, who serve as volunteers, to ensure appropriate range of expertise and diverse perspectives; intensive information gathering and deliberations by the committee to refine the scope and reach conclusions; external review of the draft report; committee response to reviews and agreement on a final report (National Academies n.d.). For this reason, the NRC is frequently tasked by federal agencies, Congress, and the administration to carry out non-partisan studies on complex and often controversial topics.

The report confirmed what most practitioners would assume: “The committee found abundant evidence that across all venues—everyday experiences, designed settings, and programs—individuals of all ages learn science” (National Research Council 2009a, 2). This finding may not appear surprising, but there have skeptics, especially from among those who view informal learning experiences through the more narrow cognitive lens of formal education, or question whether “real” education can be entertaining (Thompson 1991). The report’s affirmation represents a major step towards enabling the field to establish broader credibility.

Related NSF Efforts

LSIE is part of a larger strategy by NSF in recent years to advance the field of informal science education, an effort that has included a wide range of investments. For example, the aforementioned website www.informalscience.org, a project (0610348) of the Learning Research and Development Center of the University of Pittsburgh's Center for Learning in Out-of-School Environments (UPCLOSE), offers more than a searchable database of research articles on informal learning. It also provides information about ISE-funded projects, summative and formative evaluations of NSF-funded projects, and additional resources designed to support knowledge-sharing, collaboration, and innovation. Other web portals include www.ExhibitFiles.org, a site developed by ASTC (0540261) to preserve and share science museum exhibit information and images. As well as serving archival and dissemination functions, ExhibitFiles seeks to stimulate discussion within the community of exhibit designers and developers by means of a blog and exhibit reviews. The site’s membership of more than 1,300 offers one indication of value to the field.

The Center for Advancement of Informal Science Education (CAISE), a partnership of ASTC, UPCLOSE, Oregon State University, and the Visitor Studies Association (0638981), was created to support a community of practice across the diverse informal science education field. Its Inquiry Groups synthesize research and practice around issues and topics of current concern in an effort to catalyze cross-cutting dialogue. Recent topics include public engagement with science, public participation in research, and sustaining access for persons with disabilities. CAISE also offers a website, www.insci.org, with access to the findings of these groups, along with additional resources.

In an effort to bring greater coherence and rigor to project evaluations, NSF convened leaders in the field to write a Framework for Evaluating Impacts of Informal Science Education Projects: Report from a National Science Foundation Workshop (Friedman 2008). This document is designed to guide aspects of the planning and implementation of summative evaluations based on a common set of impact categories (awareness, knowledge, or understanding; engagement; attitude; behavior; skills; other).

The ISE program, along with NSF's research directorates, funded the Nanoscale Informal Science Education Network (NISE Net) to create a national infrastructure of science museums linked with researchers to increase public awareness of, knowledge of, and engagement with nanotechnology through exhibits, programs, media, and other resources (0532536). Initiated by a collaboration of the Museum of Science, the Exploratorium, and the Science Museum of Minnesota, NISE Net (www.nisenet.org) now has 14 organizational partners and more than 100 members. This five-year, \$20 million investment has stimulated collaborative open-source product development (reducing the tendency to "reinvent the wheel" in multiple institutions), created national programming through NanoDays activities in more than 200 sites in 2009, and devised new forms of programming such as public forums for adults on societal impacts.

Discussion

The *LSIE* study and these types of related NSF efforts may be moving the field of informal science education towards a "tipping point" in terms of greater recognition of educational value and impact. A wide range of indicators is suggestive of such a trend. The Academic Competitiveness Council, which reviewed science education programs across the federal government, included Informal Education and Outreach as one of its three working groups, along with K-12 Education and Post-secondary Education (U.S. Department of Education 2007). Journals such as *Science Education* have placed increased attention on informal learning through special editions and ongoing series of articles, as has a recent monograph focused on formal education (Ucko and Ellenbogen 2008). The National Science Teachers Association now holds an Informal Science Day in conjunction with its annual meeting. Community organizations and after-school providers are focusing to a greater extent on this area; 4-H's Science, Engineering and Technology program and the formation of the Coalition for Science After School are illustrations. Several major philanthropic organizations, such as the Noyce Foundation, have increased funding emphasis on informal science education. In Congress, a House subcommittee held a hearing specifically on the topic Beyond the Classroom: Informal STEM Education (U.S. Congress 2009), including testimony on the recently released *LSIE* report. Other factors are contributing to this growing recognition as well, such as the realization that learning is increasingly possible outside the classroom at any time and any place through nearly ubiquitous computers and mobile technology.

In conclusion, *LSIE* represents an important step for the informal learning community. Museums should especially benefit from the report and its companion volume, which offer an evidence base for guiding exhibit design, program development, and professional development for floor staff, in addition to fruitful directions for future museum research studies. Although the study focus was informal learning of science, it is likely that aspects of the findings and recommendations will apply to other content areas

to varying degrees as well. It is hoped that the report will stimulate new research and evaluation studies that will add to the expanding knowledge base and further improve the field's capacity to provide engaging and increasingly effective learning experiences.

Acknowledgment

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Notes

1. J. Falk, 1977. *An Investigation of the Effect of Field Trips on Science Learning*. National Science Foundation grant 7718913.
2. M. Borun, 1987. *Naïve Knowledge and the Design of Science Museum Exhibits*. National Science Foundation grant 871396.
3. V. Crane, 1992. *A Review of the Informal Learning Research Literature in Science, Mathematics and Technology*. National Science Foundation grant 9254384.
4. Annotated Literature. Accessed Nov. 9, 2009 at <http://mlc.lrdc.pitt.edu/Annotatedlit.html>.
5. Michael A. Feder, personal communication.

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