PROJECT REPORT

SENCER-ISE

Establishing Connections between Formal and Informal Science Educators to Advance STEM Learning through Civic Engagement

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Introduction

On Sunday afternoon, March 6, 2011, more than fifty educators from the formal education (or higher education) and informal science education worlds gathered at the Liberty Science Center in Jersey City, New Jersey, to engage in two days of discussion about how both communities could work together to advance STEM learning through the broad focus of civic engagement. The SENCER-ISE conference* was funded by grants from the National Science Foundation (NSF) and the Noyce Foundation to the National Center for Science and Civic Engagement (NCSCE), the home of SENCER (Science Education for New Civic Engagements and Responsibilities). Two NSF divisions, Research in Learning in Formal and Informal Settings, where the Informal Science Education (ISE) program is housed, and Undergraduate Education, combined efforts to support the initiative.

Although unable to attend the conference, ISE's Program Director Al DeSena sent remarks that were read at the opening of the conference. In them, he noted his personal view that "I don't think there is work more important in informal science education and in higher education than creating meaningful opportunities for learners of all ages to engage in activities at the interface of science and civic engagement." He also commented that the conference attendees had the opportunity to build on the work of previous collaborations among professionals in higher education and informal science education (DeSena 2011). DeSena's comments are included in SENCER (2011). Along with an Executive Summary and the authors' recollections, these proceedings provide a source of information for this review article about the activities of the conference.

The informal science educators who attended SENCER-ISE came primarily from science and natural history museums, science centers, science media and communication outlets, and science organizations such as the National Geographic

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Society and the Association of Science-Technology Centers. The world of formal science higher education was represented by SENCER faculty, primarily by those who are co-directors of the SENCER Centers for Innovation located at two- and four-year institutions of higher education. The participants came from 19 states and the District of Columbia and also from Canada, Chile, and Israel.

How the individuals in the room found themselves together, what their discussions entailed, and how the connections between both communities can be strengthened will be the prime focus on this preliminary project report.

The Path to SENCER-ISE

SENCER focuses on teaching and learning through real-world problems and provides an approach for faculty to teach science and mathematics courses through complex, capacious, and often unsolved problems of civic consequence. SENCER pedagogical strategies include learning that is active, inquiry-based, collaborative, and connected to research. SENCER courses can also include academically based service-learning projects and community-based research.

For a number of years before the conference, SENCER scholars had been exploring the relationship between the work of its faculty as formal science educators and the work of those involved in informal science education. Programs at regional meetings in 2008 and 2009 and at the 2010 D.C. Symposium saw presentations by Alan Friedman, nationally known expert in museum development and science communication, David Ucko, then Deputy Division Director of the NSF's Division of Research and Learning and now president of Museums+*and more*, and Al DeSena. All provided SENCER faculty overviews of the role of informal science educators in STEM learning. At the 2010 symposium, two Noyce Fellows (Phelan Fretz, Executive Director of the Echo Lake Aquarium and Science Center in Burlington, Vermont, and Stephanie Radcliffe, Executive Director of The Wild Center in Tupper Lake, New York), whose attendance was sponsored by the Noyce Foundation, met with SENCER faculty and undergraduate students about activities and career in informal science education venues. SENCER faculty also participated in a colloquium at the 2009 SENCER Summer Institute to explore the differences and commonalities between formal and informal science education.

The idea to bring together a working group of individuals from both communities grew during this time period. With Alan Friedman's involvement, the National Center received the NSF grant and a supplementary grant from the Noyce Foundation to hold an invitational conference that would give both communities an opportunity to share methods and outcomes that each sector employs to implement the civic engagement approach to STEM learning. The conference was also seen as an important step in creating possible partnerships between formal and informal science educators and strengthening those that already exist.

The Connection between SENCER and Informal Science Education

At first glance, the formal and informal science education worlds seem far apart. Alan Friedman notes that "Informal Science Education (ISE) does not *deliver* education, like a school" but rather it provides opportunities for people to become fascinated with something they experience, and to then find themselves learning and becoming even more interested in whatever it was that caught their imagination. That is why ISE is also called *free-choice learning* that "complements rather than replaces or just continues formal education" (Friedman 2011). The website of the Center for Advancement of Informal Science Education (CAISE) notes that "informal science education supports people of all ages and all walks of life in exploring science, technology, engineering and mathematics" (CAISE 2009).

At the 2009 regional meeting at Franklin & Marshall College, which focused on how informal science education experiences could improve college readiness, David Ucko provided a succinct comparison of key aspects of formal and informal education, focusing on K–12 education for his comparison. His analysis is applicable to higher education as well. Table 1 (next page highlights some of the differences he addressed. Ucko presented data from the Center for Informal Learning and Schools showing the extent to which informal science education complements the formal side through out-of-school enrichment such as after-school programs, museums, the media and cyber learning and by providing classroom and teacher programs and resources. He also indicated that formal education can complement the informal side in part through developing assessment tools and providing professional development activities.

TABLE 1 The Modes of Learning: Formal and Informal Education

Formal Education	Informal Education
Compulsory	Voluntary
Curriculum-based	Personal Interest
Teacher-directed	Self-directed
Set Times	Anytime
Ages 5- 18	All ages, lifelong
Classrooms	Ubiquitous
Assessment	No tests or grades

The 2009 NRC report, *Learning Science in Informal Environments: People, Places, and Pursuits*, reinforces the belief that there are commonalities in learning goals between formal and informal science education. The report indicates that:

> Learning science in informal environments is a diverse enterprise and serves a broad range of intended outcomes. These include inspiring emotional reaction, reframing ideas, introducing new concepts, communicating the social and personal value of science, promoting deep experiences of natural phenomena, and showcasing cutting-edge scientific developments (Bell et al. 2009, 41).

The report also provided strands of learning or learning goals for informal science learning that include experiencing excitement, interest and motivation to learn about phenomena in the material and physical world; generating, understanding, and using concepts related to science; reflecting on science as a way of knowing and on the process of learning about science; participating in scientific activities or practices; and having participants think of themselves as both science learners and individuals who use science (Bell et al. 2009, 43). The six informal science education strands can be seen to follow from the four strands of scientific proficiency that were introduced in *Taking Science to School* (Duschl et al. 2007, 37).

The strands of learning for informal science education can be related to SENCER theory and practice, providing a justification for the idea that the two communities can join together to improve science learning. Although the fit is not seamless, the SENCER Ideals offer a framework for teaching and learning science that connects unresolved public issues with basic science. Thus learning can, for example:

- Start with matters of interest to students allowing them to put scientific knowledge and the scientific method to use;
- Begin with an intellectual project that is practical and engaged;
- Extract from immediate issues the larger lessons about scientific processes and methods; and
- Locate the responsibility of discovery in the work of the student (SENCER 2009).

The SENCER-ISE Conference

Through facilitated, interactive problem-solving discussions, participants were able to build upon mutual learning goals and interests. They began to theorize that partnerships between formal and informal science educators could, through a shared focus on issues of civic consequence, lead to greater civic engagement and the continued development of a science-enabled citizenry that can make science-based decisions about these issues.

The problem-solving process included discussions on both potential obstacles and possible strategies to address these obstacles. The question "What can we do together to advance our shared vision?" was central to the proceedings as participants worked in teams to learn more about each other's strengths and goals. It became apparent that most of the higher education participants saw civic engagement as a means towards achieving science learning and most of the informal science education participants looked at civic engagement as a valuable end in itself. Still, the commonality of interest in using civic issues to engage audiences (whether students in and out of school or adults in the community) was the glue that held the discussions together.

For part of the final morning, participants again worked in teams to develop ideas for potential collaborations. One "mock" project postulated the formation of a Climate Change Corps (CCC) that would develop science content through a partnership between formal and informal institutions. This project would involve creating toolkits and providing training and would include a student leadership component, based upon the National Center's GLISTEN (Great Lakes Innovative Stewardship through Education Network) project. The CCC would provide sub-grants to develop the toolkits and also

involve community members from different regions who could share their personal experiences related to climate change.

Next Steps

By the end of the conference, an interconnected and parallel set of strategies emerged from the first step of listening to the communities to be served as displayed in Figure 1. (An expanded version of this diagram can be found in (SENCER 2011) and is based upon the diagram developed during the conference by Jonathan Bucki, the conference facilitator.

Participants agreed that this meeting was just the first step for the SENCER-ISE initiative and suggested further meetings with prematched partnerships at the regional level (i.e., informal and formal science educators who attend as already formed teams), either with some participants from the March conference or with new participants. The purpose of the follow-up meetings would be to develop workable structures for a diverse range of informal and higher education partnerships.

In the meantime, a document is being completed that is a synthesis of the discussions and is meant to serve as a resource for those who attended and for others in the field. This document, along with an Executive Summary, will be available both on line on the SENCER website and other locations and in hard copy, which can be ordered through the National Center's office. An evaluation report is also being completed.

A "Passport to Networking," which included information about the backgrounds and existing partnerships of the participants, enabled individuals to go beyond the usual formal introductions that occur at meetings. The "Passport" will be available on line so that participants can share their ongoing activities, along with an opportunity for participants and others to join a LinkedIn network about collaboration between informal and formal science educators.

Conclusion

A recent *Education Week* report, "Science Learning Outside the Classroom," noted, "as concern mounts that U.S. students lack sufficient understanding of science and related fields, it has become increasingly clear that schools can't tackle the challenge alone. This special report explores the field often called "informal science education," which is gaining broader recognition for its role in helping young people acquire scientific knowledge and skills. Opportunities abound outside the classroom to learn about science, and to inspire a passion for it. Zoos and science museums, robotics clubs, science competitions, and online games are just a few of the options to engage American youths. Education Week reporters examine what informal science education looks like in practice, and what we know about its impact, its potential, and the challenges it faces" (*Education Week* 2011). (The report contains articles on the role of science learning outside of school, NSF, and informal learning, and assessment.) Falk and Dierking (2010) state that "average Americans spend less than 5 percent of their life in classroom," and offer arguments and citations to support their conclusion that "most science is learned outside of school." The *Learning Science in Informal Environments* report (Bell et al. 2009), along with a companion volume, *Surrounded by Science* (Fenichel and Schweingruber 2010), are now widely referenced and have given informal science education a more solid framework than the field has ever had.

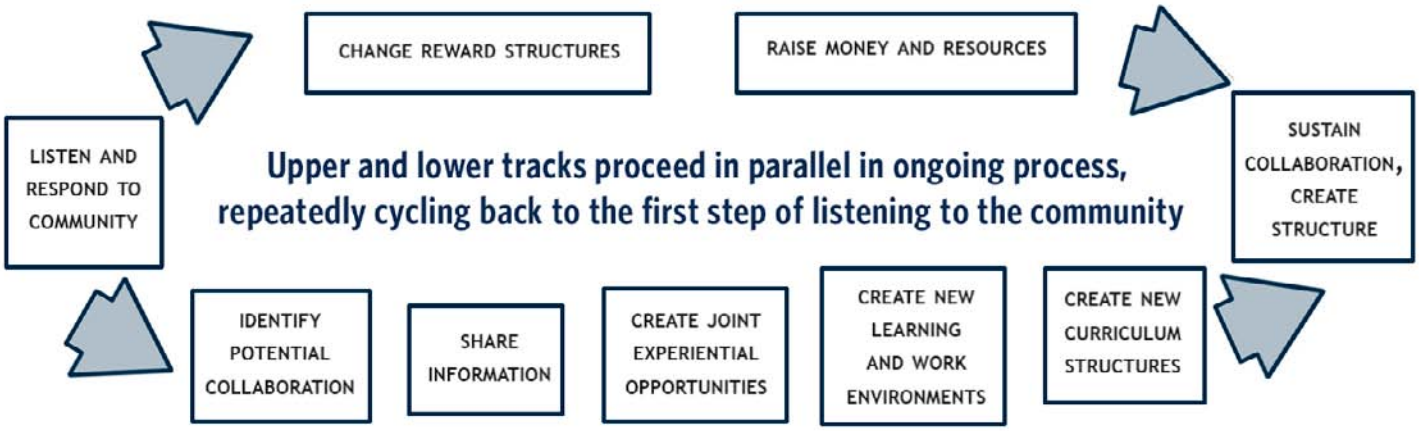

FIGURE 1. Emerging strategies for civic engagement (SENCER 2011, 2)

Given this growing body of evidence, it is important that both communities work together as equals to develop opportunities for all ages to understand and engage in science practices. Whether it is offering issue-based exhibits at a science museum or providing opportunities for individuals to participate in data collection as a citizen scientist, both communities have much to offer each other in educating students of all ages. SENCER-ISE is a crucial step in connecting initiatives between these communities.

Brief Interview with Alan Friedman

As this report is being published in a SENCER journal, we thought it would be interesting to pose some questions to Alan Friedman about informal science education.

Mappen: You have been involved with science museums for a good part of your career. How have these museums changed over that time period?

Friedman: When I started working in a science museum (the Lawrence Hall of Science at the University of California, Berkeley) in 1973, there were about twenty institutions like the Hall that called themselves "science-technology centers." They differed from traditional museums in that they had few if any permanent collections of artifacts that they studied, and instead they had hands-on interactive exhibitions. They were focused as much on the visitor experience as they were on the science they offered. Today there are over 350 such institutions in the US alone, and over 500 in other countries. Most of these institutions have, in the last couple of decades, become very serious about evaluating their impacts, and looking for more ways to engage visitors than the traditional exhibitions and theater presentations. Citizen Science Citizen Science (www.citizenscience.org) is an example of these new mechanisms for engagement, and the technique is becoming popular in both formal and informal science education. I've written about these trends recently (Friedman 2010).

Mappen: A 2008 CAISE study looked at the informal science education "landscape." How would you describe this landscape?

Friedman: I would estimate that informal science education is a billion dollar a year industry in the U.S., and that tens of thousands of people work in it. But they do not see themselves as a common body (Falk et al. 2008). Science journalists relate to other journalists, not to museum educators. TV producers feel that they are part of the media, not in the same business as zoos. Even in the museum field, for the most part the natural history museums do not have a lot to do with the science centers, living collections (zoos, aquaria, botanical gardens) have their own networks, and aerospace museums keep to themselves professionally. So there has not been nearly as much synergy as there could be if the various parts of this landscape could somehow be brought into closer contact. That is one of the goals of the Center for Advancement of Informal Science Education project (www.insci.org).

Mappen: What opportunities are there in science museums or other areas of informal science education for undergraduate students to complement their studies in science or mathematics courses?

Friedman: Most of us who have taught science at any level agree that when you try to teach a concept to others your own understanding is really tested and improved. So I think undergraduates who learn to communicate science to informal audiences, like museum visitors of all ages and backgrounds, have a unique experience that sharpens their own knowledge and communication skills. This is certainly the case for the hundreds of undergraduates who have served as paid floor staff at the New York Hall of Science, as supported by several longitudinal studies of program alumni.

Mappen: We know that some connection with formal science education has always been a feature with informal science education. Has this typically been at the K–12 level and how might that change?

Friedman: Museums have for decades worked closely with K–12 education, and the school field trip has become a nearly universal practice in museums worldwide. No such tradition exists for higher education and museums. Science museums often have university researchers on advisory boards, and in the past twenty years science museums

have employed a modest number of undergraduates to serve as part-time floor staff (often called Explainers, a term coined at the Exploratorium in San Francisco). There are sometimes connections with university faculty in schools of education, because museums do a lot of in-service teacher professional development. But connections to undergraduate education are much rarer: The New York Hall of Science and the City College of New York have a joint program called CLUSTER, in which both the science center and the college are involved with pre-service teacher training (NYSCI 2011). But the SENCER-ISE project is looking to connect undergraduate higher education and informal science learning in a very different fashion. Engagement with practical, local, civic issues is equally distant from both the traditional higher education classroom and from the traditional informal science education modes of operation. The potential SENCER and ISE partners are both venturing into new territory, and each has significant, complementary resources to facilitate that engagement.

Mappen: On a more personal level, what first drew you to the science museum field?

Friedman: I was a visiting assistant professor in 1973 at the University of California, Berkeley, when I wandered into the Lawrence Hall of Science, one of the pioneering public science-technology centers. As a solid-state physicist, I was in a field with thousands of other researchers, hundreds of university and industry labs, and my chances of contributing in a big way seemed limited. But at the Lawrence Hall I discovered this other field, informal science education, where there were only a few dozen institutions, and a handful of recognized leaders. I also found that research and development into communicating science to the public was in its early stages, and there were many opportunities to influence the advancement of this nascent enterprise. So I convinced the Lawrence Hall to hire me part time for nine months. It quickly became full-time, stretched to twelve years, and I never looked back.

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