Informal Science Education Policy: Issues and Opportunities

A CAISE Inquiry Group Report

August 2010

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.

For more information contact:
Center for Advancement of Informal Science Education
1025 Vermont Avenue NW, Suite 500
Washington, DC 20005-6310
202/783-7200
www.insci.org

Citation:
Brisson, L., Eisenkraft, A., Flatow, I., Friedman, A., Kirsch, J., Macdonald, M., Marshall, E., McCallie, E., Nesbit, T., Prosino, R., Petit, C., Schubel, J., Traill, S., Wharton, D., Williams, S., Witte, J., (2010). *Informal Science Education Policy: Issues and Opportunities*. A CAISE Inquiry Group Report. Washington, D.C.: Center for Advancement of Informal Science Education.

Informal Science Education Policy: Issues and Opportunities

Editors

Lisa Craig Brisson
Alan J. Friedman
Saskia Traill

Authors

Arthur Eisenkraft
Ira Flatow
Alan J. Friedman (co-leader)
Jeffrey W. Kirsch
Maritza Macdonald
Eric Marshall
Ellen McCallie
Trevor Nesbit
Rebecca Nesbitt Prosino
Charles Petit
Jerry R. Schubel
Saskia Traill (co-leader)
Dan Wharton
Steven H. Williams
Joe Witte

Center for Advancement of Informal Science Education (CAISE) Washington, D.C. August 2010

This Inquiry Group was supported by the Visitor Studies Association (VSA), one of the partner organizations in CAISE. The VSA Coordinator for the group was Lisa Craig Brisson. The National Science Foundation Liaison was Al DeSena.

This material is based upon work supported by the National Science Foundation under Grant No. DRL-0638981. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Contents

Part 1: Introduction ... 5

Part 2: ISE and Organizations ... 7

ISE and Science Research Institutions ... 7

ISE and Formal Science Education Institutions ... 10

ISE Institutions ... 14

Part 3: Everyday Science ... 17

Journalism, Media and Science Writing ... 17

Popular Culture ... 19

Linkages to Other Large-Scale Belief Systems ... 21

Part 4: ISE Cross-Sector Issues ... 23

Funding ... 23

Evaluation ... 24

Diversity ... 27

Part 5: Conclusion ... 29

Part 6: References and Further Reading ... 30

Part 7: Contributors ... 32

Part 1: Introduction

Policy: *"a high-level overall plan embracing the general goals and acceptable procedures"*
—Merriam-Webster Online Dictionary

The goal of the CAISE *Policy Study Inquiry Group* (PSIG) was to inventory and comment on policies (current or potential, organizational or governmental, explicit or implicit) which affect the capacity of informal science education to have an impact.

This group represented a cross-section of organizations and entities that touch upon or play a direct role in informal science education (ISE), including media, journalism, museums, science centers, aquariums, zoos, after-school programs, and academia. The group met via conference call several times and in person once, and used extensive e-mail correspondence and a web collaboration site.

Early in the study process, the group identified ten categories for further study. In each of our identified categories we asked the following questions:

- What are the overarching issues surrounding this topic?
- What are the current policies and their impacts related to this topic?
- What are the diversity implications?
- What policy changes in this area could facilitate greater ISE impact?

While we originally created a category to include policy issues in content authority and credentialing, early discussions recognized a host of complex issues which intertwined these issues with the other categories of policy concerns. Thus, we did not include a separate category for these issues in this report. Instead in a number of places we touch upon the need to address these issues of content authority and credentialing in more depth as they relate to a particular sector of ISE. For example, organizations that focus on informal science may find it difficult to determine what authoritative and accurate content should be, particularly in areas where the science is unclear and/or other belief systems may seem to conflict. The scientific community itself has long debated the wisdom and feasibility of establishing a "science court" to provide a process for articulating an authoritative view on issues and establishing the degree of certainty scientists have on them. Though this has never been implemented (http://www.piercelaw.edu/risk/vol4/spring/mazur.htm), it could be argued that the commissioned consensus studies from the National Academies provide one step towards a science court system. Such challenges as creationist museums raise the question of whether the ISE field should have a formal credentialing authority or ethical practice board. Further exploration and discussion by a new inquiry group is warranted for this large family of issues.

Understanding the impact of policies on diversity and accessibility of ISE is of great importance. Rather than separately discussing policy issues directly related to diversity, we chose to ask ourselves how each of the policies in our other categories affect diversity in ISE and accessibility of informal science resources and experiences. We summarize those discussions of diversity in Chapter IV. Please note that another CAISE inquiry group has looked at inclusion, disabilities and ISE, and their report can be found on the CAISE website (http://caise.insci.org/news/98/51/Inclusion-Disabilities-and-Informal-Science-Learning/d,resources-page-item-detail).

A constant temptation in this work has been to describe issues and opportunities in ISE, rather than focusing on the underlying policies which influence those issues and opportunities. We have tried to avoid these diversions, but in some cases readers will see that, particularly in the absence of articulated policy, we are describing practices and circumstances that we hope enlightened policies can positively affect.

We have not examined potential policy areas in emerging sectors of ISE, such as the rise of individual blogs and personal websites interpreting science for the public, or entrepreneurs who are establishing businesses to cater to a particular area of public interest in science, technology, engineering and mathematics (STEM). Policy can, or at least should, be reviewed as often as new goals and procedures are needed, so this report should be considered a snapshot inventory of policy concerns of a number of professionals in the field, rather than a document intended for long-term guidance or definition.

Each policy category area was initially written by a subset of the PSIG. All PSIG members were then able to critique and provide input for the entire report. The editors have tried to keep the writing styles of the subsets of authors intact, so that readers will note that the report has not been edited to sound like a single voice. We hope the variety will help keep the text lively, and remind readers of the personal-observation nature of this report.

The authors and editors would like to thank our "critical friends," who read the penultimate version of this report, and provided both broad assessments and specific recommendations: Al DeSena, Jenn DeWitt, Carol Inman, and Dennis Schatz. We studied all of their analyses. Any remaining errors or weaknesses are entirely the responsibility of the authors and editors, as always. We also thank Kirstin Jane Milks, originally a member of the PSIG and an early contributor, who had to excuse herself from the process due to the press of other duties.

Part 2: ISE and Organizations

This chapter on ISE and organizations discusses ISE policy in terms of four types of institutions that the group found were most strongly connected to ISE: those devoted to science research (e.g., research universities and agencies), those dedicated to science education (e.g., universities), those primarily devoted to public understanding of science (e.g., museums), and those engaged in broader pursuits but which also connect the public to science (e.g., mass media and news agencies).

1. Science research institutions include universities and federal research programs in such agencies as the NSF, National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA), and independent research and organizations such as the Institute for Learning Innovation.

2. Science education institutions include universities and K-12 schools, non-profit education centers, and organizations that run after-school programs.

3. Institutions engaged in public understanding of science include natural history museums and science centers, aquariums, other types of museums, and other free-choice learning institutions.

4. "Everyday Science." This fourth group of institutions and professionals we discussed were less explicitly connected to ISE but were seriously engaged nonetheless. This group includes journalism, media, film producers, and publishers. Professionals in these areas may not consider themselves "educators" (journalists, for example, often vigorously decline this categorization), but they generate much of the public's understanding and views of science. Part of the discussion here also involved ISE linkages to other issues in society. This included an understanding of climate change and evolution and is discussed in the section on linkages to other large-scale belief systems.

ISE and Science Research Institutions

Overview

ISE is often viewed as having a human resources role in relation to scientific research, that is, by recruiting and preparing new researchers and encouraging STEM-literate, supportive citizens. Sometimes, this role may be mediated by other systems or institutions. For example, informal science helps to prepare and train formal educators, who then help to create scientists and a STEM-literate populace. Viewed as a human infrastructure endeavor, ISE can serve as a community hub providing safe and trusted common ground among scientific researchers, informal science educators, and formal science educators. ISE human resources and staff at organizations and institutions that provide ISE serve as mediators and translators between disparate science, education, and public stakeholders.

Current Policies and their Impact

There are a range of federal agencies that have funding or other initiatives that indicate policy priorities for supporting ISE connections to science research institutions. A quick inventory demonstrates the breadth of agencies with policies supportive of these connections:

- NSF's research grants' criteria for Broader Impact (http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf)
- NOAA 2009-2029 Education Strategic Plan (http://www.education.noaa.gov/plan/09_NOAA_Educ_Strategic_Plan_Color.pdf)
- NASA Education programs (http://www.nasa.gov/offices/education/about/inf_overview.html)
- National Institutes of Health (NIH) Science Education Nation (http://science.education.nih.gov/nihsciednation)
- Department of Energy's Workforce Development for Teachers and Scientists (http://www.energy.gov/sciencetech/workforcedev.htm)

These initiatives create opportunities and potential challenges for the current ISE infrastructure. Mandates which require research scientists to connect with educators and the public have spawned a relatively nascent but growing field of informal science educators within research institutions (e.g., university research centers and professional organizations). Support of ISE from both public and private sources appears to be reaching a broader field beyond traditional ISE institutions such as museums, aquariums, and planetariums, to include universities and professional organizations of researchers. In many cases, research institutions often work to meet their ISE goals independent of, or in limited partnership with, institutions primarily devoted to ISE.

Perhaps as a result of these funding trends, we note a growing infrastructure within universities and professional organizations around informal science education, as demonstrated by the growing number of research education and outreach specialists (e.g., NSF Research Center Educators Network and the NSF Materials Research Science and Engineering Centers (MRSEC) Education Directors' Group) and the increasing activity of science professional organizations in ISE. University-led ISE efforts may have different scopes than efforts managed by institutions primarily devoted to public understanding of science, perhaps focusing more on formal science education (including K-12, teachers, and higher education) and also perhaps having different goals around accessibility and diversity.

Should these changes in ISE's connections to science researchers and their institutions be viewed as opportunities or threats? On one hand, it is natural for informal science educators to work more closely with the science and engineering education and outreach community, and these stronger partnerships can have benefits for ISE and science research. For example, achievement of diversity in the scientific workforce and equitable access for education and outreach efforts may be more readily achieved through partnerships between ISE institutions and diversity-focused science and engineering professional organizations. For example, the Nanoscale Informal Science Education Network's Diversity, Equity, and Access team partners with the Engineers Week Coalition Diversity Council, the National Society of Black Physicists (NSBP), the Society for Advancement of Chicanos and Native Americans in Science (SACNAS), and the Society of Women Engineers (http://www.nisenet.org/community/groups/dea).

On the other hand, smaller proportions of public and private ISE funding to traditional ISE institutions could threaten their unique role in building science interest and expertise. Informal science educators may become more likely to be employed directly by formal science institutions, which could change the way in which decisions about ISE are made and by whom, affect the professional development opportunities of informal science educators, and affect the way that they think about the larger context of their work.

A third option is to see the increased range of competitors for ISE funding as a call to action to formalize the supportive relationship of those primarily focused on ISE with formal science organizations and institutions. During recent years, a number of ISE-grounded, field-wide initiatives have begun to wrestle with these relationships (e.g., Volunteers Try Science, Portal to the Public, NISE Net, Communicating Ocean Sciences to Informal Audiences). They have found that relationships between science research institutions and ISE are widespread but usually not well-informed by previous practice and typically lacking adequate support. In many cases, there is a lack of understanding that creates a reluctance to engage with each other. Further, lack of buy-in at the highest institutional levels prevents full partnership. For example, in the Workshop on Sustainable Diversity at the 2009 Association of Science-Technology Centers Conference, when asked what participants needed to achieve sustainable diversity in their work, their overwhelming response was a need for high-level institutional support.

Connections between science research institutions and ISE, then, would be strengthened by sustainable funding scenarios for the partnerships themselves, and formalized, mutually beneficial agreements with dedicated human resources on both sides. Examples of where this is done well are the Center Of Science and Industry (COSI) Columbus partnership with the Ohio State University (www.cosi.org/about/partners/osu), and the Communicating Climate Change consortium of a dozen research universities and a dozen science museums (http://www.astc.org/blog/category/partners/page/3/).

Recommendations to the Field at Large for Next Steps

- ISE organizations (e.g., ASTC, Association of Zoos and Aquariums (AZA), California Association of Museums) should create policy statements regarding their relationship with the scientific community and generate activities to promote and support mutually beneficial partnerships between these communities. This may include expanded engagement of the scientific community at annual conferences and direct work with ISE institution leadership to raise the level of institutional support of these relationships, particularly with an eye towards sustainable diversity efforts.

- Public agencies, private philanthropy, and corporations that fund science and ISE should consider funding policies to prioritize sustainable partnerships between individuals or institutions primarily devoted to ISE and those dedicated to science.

- Scientific professional organizations and ISE organizations should create sustainable communication mechanisms to share knowledge and promote mutual understanding and partnerships between ISE and science communities. These partnerships could include mechanisms to support communication within institutions across departmental boundaries (e.g., informal educators and scientists within institutions, such as natural history museums and universities). Communication tools may also include online media to assist engagement of scientists with the full range of potential audiences.

- Evaluators should measure the strength of partnerships between science and ISE (e.g., sources, pathways to initiations, sustainability of efforts). Based upon findings, evaluators could make recommendations to funders on how best to promote and support partnerships utilizing the complementary strengths of the ISE and science communities

ISE and Formal Science Education Institutions

Overview

ISE connects to formal education systems in a number of ways, and some of the best connections blur the lines between "formal" and "informal." ISE can be an important part of science learning for students, in experiences that involve both "formal" and "informal" science, such as a class field trip to a science museum, a hands-on experiment after-school taught jointly by a certified science teacher and a youth development worker, or a service-learning project to study quality of nearby bodies of water. Institutions primarily devoted to ISE may play important and formal roles in science education, offering science learning to students or preparing their teachers. The CAISE Inquiry Group report *Making Science Matter: Collaborations Between Informal Science Education Organizations and Schools* (http://caise.insci.org/news/97/51/Making-Science-Matter-Collaborations-Between-Informal-Science-Education-Organizations-and-Schools/d,resources-page-item-detail), provides other examples and further discussion of the types of collaborations that would increase science learning.

Current Policies and their Impact

Perhaps the most detrimental policy affecting science education has been the 2002 Elementary and Secondary Education Act (ESEA), more commonly referred to as No Child Left Behind (NCLB), which did not initially call for science assessments as part of its accountability measures, even though the *National Science Education Standards* from the National Research Council had been available since 1996 and were in widespread use as models for state and local standards (http://www.nap.edu/catalog.php?record_id=4962). The absence of a requirement for NCLB-consequential science assessments resulted in a decrease in attention to science, including declining interest on the part of formal education leaders in taking advantage of ISE resources.

While governors and state commissioners of education from 48 states, 2 territories, and the District of Columbia are committed to developing a common core of state standards in English-language arts and mathematics for grades K-12, they have not yet committed to common core standards in science. The first steps of developing common core standards in science are taking place now at the National Academy of Sciences. Common core standards and the in-progress reshaping of ESEA could have profound effects not just on formal science education, but on ISE as well, providing a shared framework for science learning during school years. Currently, with some notable exceptions, ISE experiences are typically not described in terms of curriculum standards and learning objectives. This limits the ability of ISE institutions to demonstrate to teachers, schools, and districts how they support learning goals. If ISE providers are more aware of the experiences and challenges students have in school and the expectations of the curriculum, ISE institutions could tap into their visitors' school experiences. Similarly, if school teachers better understood the objectives of a museum exhibit, they could more effectively make use of the museum exhibit as part of their formal instruction.

President Obama's "Educate to Innovate" campaign is designed to increase students' science and math achievement over the next decade. The campaign is implementing "new and creative methods of generating and maintaining student interest and enthusiasm in science and math," many of which include collaborations between formal science systems and ISE. For example, Time Warner Cable, in partnership with FIRST Robotics and the Coalition for Science After School, is working to connect students to after-school science opportunities. Discovery Communications is launching a media campaign to promote science. National Lab Day and a national competition for video games are both natural places for connections between ISE and science education. Policies to implement and further the President's campaign could be designed to forge lasting partnerships between formal science institutions, science education, and ISE.

The National Assessment of Educational Progress (NAEP) science assessment presents a broad view of what students know and can do in science (http://www.nagb.org/publications/frameworks/science-09.pdf). The assessment covers earth, physical, and life sciences and the elements of knowing and doing science that each field requires. ISE that focuses on K-12 students should as a matter of policy describe how ISE activities will address gaps in science learning. Results from 2009's NAEP will be released in 2010, but are not available at the time of this report. NAEP also surveys teachers, students, and schools, offering background information about school policies and practices affecting science instruction. These may provide information for ISE about how partnerships with formal education may be most effective, and what policies need rewriting to facilitate effective use of ISE in reaching science learning goals. A new National Assessment on "Technology and Engineering Literacy" will begin in 2014, and could also have important information for policy on the role of ISE in these two components of STEM learning (http://www.nagb.org/publications/frameworks/prepub_naep_tel_framework_2014.pdf).

One area of intersection between formal and informal education is in science activities after-school, where strong curricula combines with youth-focused pedagogy to result in hands-on, inquiry-based science taught in after-school programs throughout the country. After-school programs serve large numbers of students, primarily low-income and minority, and a growing number of these programs recognize that after-school is an ideal venue for ISE learning through hands-on, inquiry-based activities. Common significant obstacles for ISE in after-school include lack of staff buy-in, lack of comfort or experience with science by staff and leadership, insufficient staff training, and a lack of materials. In addition, more high-level leaders in after-school and formal education need to recognize the role that after-school can play in science learning. Policies that improve professional development for after-school workers, especially in science curriculum and pedagogy, as well as efforts to heighten the importance of science after-school as an issue for high-level policymakers, will help support science after-school (http://afterschoolscience.org/pdf/conference/A%20watershed%20moment.pdf).

A number of school policies can prevent or facilitate partnerships with informal science: Policies that address field trip requirements and costs, Internet access in schools and use of computer labs by non-school staff, using volunteers in classrooms, use of classroom in out-of-school time, student use of handheld technology during the school day (such as using cell phones), class schedules that may only allow a 40-minute block for science, and transportation policy and regulations all affect access and quality of informal science experiences for students. These policies are strongly influenced by policies such as ESEA, as noted above.

Another policy area within formal and informal science education lies in the preparation of science teachers. A 1996 study found that ISE institutions work intensively with teachers throughout the US, and provide the majority of hours of in-service education for US teachers (Inverness Research Associates, 1996). The preparation of "highly qualified" teachers has been the goal of most reforms in teacher education in the last 12 years beginning with the National Commission on Teaching report *What Matters Most: Teaching for America's Future* (1997). Since then, a 2006 report has become one of the most salient documents about the identification, education, and retention of science teachers. The National Academies' *Rising Above the Gathering Storm: Energizing and Employing America* *for a Brighter Economic Future* called for recruiting and preparing many more scientists and science teachers, carrying out research in the field, focusing on recruiting the best and brightest, and creating economic incentives for innovation. The recommendations from the *Gathering Storm* report have been the foundation to commissions that followed, such as the National STEM Commission for 21st Century Education which identified institutions primarily devoted to ISE as one of the critical elements of STEM reform, and the need for their inclusion in reform efforts.

Over the past eight years, funding policies by NSF, NASA, and NOAA have forged partnerships between institutions primarily devoted to informal science and those devoted to teacher preparation. Among some of these, the Teacher Renewal for Urban Science Teachers (TRUST) initiative in New York City brought the resources of the American Museum of Natural History and two City University of New York (CUNY) campuses, Lehman and Brooklyn Colleges, who serve some of the neediest communities in the city into a collaborative to prepare Earth Science teachers. Most of these teachers went to work in high-need schools that had not been able to offer Earth Science and whose students were not able to take the high-stakes Regents exam in Earth Science which decreased their opportunities to graduate from high school.

Another example of collaborations resulting from funding policies is *Teachers for a New Era* (TNE) funded by Carnegie Corporation, Annenberg Foundation, and Ford Foundation to forge partnerships among the arts and sciences in teacher education programs. TNE has included ISE partnerships in its discussions (e.g., http://www.teachersforanewera.org/newsletters/newsletters/TNE%20Newsletter%20V4-N1.doc). Eleven universities were funded, and one of the most successful examples is The University of Virginia Curry School of Education which is now a model for replication in other contexts. Virginia faculty collaborate with ISE-based education projects, such as the Center for Informal Learning and Schools (http://cils.exploratorium.edu/cils/page.php?ID=23).

A new report on formal/informal science education partnerships appeared in the fall 2010 issue of *The New Educator* (http://www1.ccny.cuny.edu/prospective/education/theneweducator/volume6_3_4.cfm). Edited by Inquiry Group member Maritza MacDonald, the special issue is devoted to an examination of partnerships between teacher preparation programs and science cultural institutions. Together, the articles demonstrate how policies and funding have begun to acknowledge and institutionalize such partnerships.

Recommendations to the Field at Large for Next Steps

- The ISE field should continue to promote the importance of ISE in formal education as an issue for high-level local, regional, and national policymakers. One particular effort for organizations and institutions that provide ISE should be to inform the President's "Educate to Innovate" campaign about what ISE can offer to meet the President's goals for the initiative. And, those implementing the initiative should look for policies and practices that can create sustainable partnerships between formal science institutions, formal science education, and ISE, and use the campaign as a way to speak about the importance of these partnerships. In particular, the Administration may be able to encourage schools and school districts to address the policies that hamper effective partnerships with ISE providers. Allowing ISE institutions to be the leaders of these initiatives would further strengthen ISE participation.

- ISE and formal science education can support one another by framing their learning objectives in terms of a common document like the National Science Education Standards or state frameworks. Similarly, the ISE field should review NAEP results and offer solutions to formal educators about how ISE can help reduce gaps in science content and skills. School systems and schools should develop policies and practices to work with their local ISE institutions to integrate field trips into the school experience without being overly prescriptive in terms of standards or focusing exclusively on content information acquisition. The visit should promote curiosity and stimulate students to see and experience the wonders of science. ISE institutions can add value to these experiences by paying a visit to the school before the field trip.

- One approach to demonstrating the power of ISE and its unique niche might be for ISE institutions in local/regional areas and across the various sectors of ISE to form clusters that work together to develop programs on one or two timely scientific issues and deliver them to their different audiences during the same period.

- Higher education institutions and other organizations concerned with the system of professional development for after-school workers should prioritize ISE training for after-school staff.

- It is important to systematically identify policies that have created conditions of collaboration or partnership within the formal institutions and across formal and informal institutions to improve teacher preparation. To learn more about partnerships within and across institutions designed to increase access to science in different contexts, interaction with scientists, and authentic teaching that included investigations and methodologies that aim at differentiated teaching, four different groups could be invited to participate in a survey:
    - The list serve for the National Association of Research in Science Teaching (NARST);
    - New York State ISE and teacher preparation institutions, because of the State's recent efforts to develop policies that include science cultural institutions to broaden the path of certification for STEM teachers working in high-need schools. The CLUSTER project between the City College of New York and the New York Hall of Science is one good example of such inclusion (http://www.nysci.org/learn/research/cluster);
    - Formal higher education institutions that have innovative STEM teacher preparation programs incorporating partnerships;
    - The institutions primarily devoted to ISE and Institutions of Higher Education affected by the Center for Informal Learning Studies (CILS) program at the Exploratorium, such as the Fleet Inquiry Institute (FII) at the Reuben H. Fleet Science Center. FII worked with teachers and evaluators from a number of school districts in San Diego County. The Texas Center for Inquiry (TCI) at the Fort Worth Museum of Science and History, which has served thousands of teachers throughout Texas since its inception in 2000, is another example.

These surveys will help determine baseline information on the purpose of the innovation or partnership (funding, need, institutional leadership), the nature of the innovation or partnership (courses, internships, research experiences, for credit, certification, or elective), and the research and evaluation that have resulted from the work.

ISE Institutions

Overview

Institutions that are primarily devoted to ISE have special roles, responsibilities and opportunities in the nation's educational enterprise to engage and educate the public about science, the scientific process, and the lives of scientists. If these special roles, responsibilities, and existing accomplishments were more widely recognized and valued, the impacts of ISE institutions would be much greater.

Agencies, institutions, associations, and foundations responsible for the nation's educational enterprise have the opportunity to include leaders from ISE as partners in policy-making forums, in developing new curricula, in educational reform efforts, etc. Unfortunately, they often do not have significant representation from ISE organizations. The fact that the U.S. Department of Education does not include ISE institutions as being eligible to apply for most of their competitive grant programs illustrates the limited perceived value often accorded to ISE.

Part of the problem may be that ISE institutions themselves operate in a web of interrelated and sometimes conflicting policies—some written and some unwritten—some internal, some external. As noted in the introduction to this report, the four categories of participants in ISE are quite distinct, and don't always view or describe themselves as primarily educators since their key missions may involve preservation of artifacts, production of entertainment content, or reporting the news. Each category also has its own funding streams, primary audiences, policies about partnerships, and terminology (audiences may be "visitors," "guests," "viewers," "participants," listeners," "users," "players," etc.). This variety complicates the picture for a formal educator trying to understand where the ISE field might be involved more deeply in formal education's fundamental activities and policy development.

The culture of each ISE organization is also a major driver of informal, unwritten policies. These policies affect what ISE institutions do—their staffing and programming—and their effectiveness in carrying out their missions in informal science education. This chapter notes some potential common policies which could assist ISE organizations to advance the status of ISE and its impact on the public understanding of science.

Current Policies and their Impact

Many ISE institutions lack clear, concise, compelling policies describing their philosophies and codes of conduct with respect to fulfilling their missions in informal science education.

Professional associations of ISE institutions sometimes fail to provide the leadership in formulating and articulating policies on their commitment to and roles in enhancing the public understanding of science, and adherence by its members to core values of science and the scientific enterprise. An article in the *New York Times*, for example, described inconsistent behavior among science museums when faced with potential opposition from anti-evolution groups over an IMAX film that mentioned evolution (Dean, 2005). ASTC's Executive Committee created a strong statement on the presentation of evolution in science centers, but it was not positioned as an official statement for the community.

Most ISE institutions have staff with considerable experience and expertise in translating and packaging science stories into forms that engage, entertain, educate and even empower school groups and the general public. Many ISE institutions however, do not have great scientific depth on their staff, as measured for example by the number of individuals who read the primary scientific literature or are engaged with current research. This can pose problems, particularly when dealing with current and controversial issues in the news such as climate change or evolution. They may also lack currency in education theory or science communication strategies, which can hamper their abilities to connect with formal education or communicate with diverse audiences. This situation raises the question of whether, as a matter of policy, ISE organizations should have researchers on their staff, or have an ongoing deep relationship to science or education research organizations.

But evaluations of ISE programs and institutions should not be based entirely, or even primarily, on their contribution to conveying information and helping students and teachers meet state or national science standards. If ISE institutions are seen simply as an extension of the formal, K-12, educational system, they fail to take advantage of their most important contributions—engaging people of all ages in the excitement of scientific exploration and discovery, the importance of the scientific enterprise, and encouraging people of all ages, backgrounds, and capabilities to be involved in science in some way. ISE institutions can and often do play important roles in stimulating interest among young people in pursuing careers in STEM fields (Bell, et. al., 2009; Roper/Starch, 1998).

Formal school system policies often inhibit the use of ISE institutions or diminish their contributions. For example, future teachers are not allowed to fulfill their student teaching requirements at an ISE institution. Many local education agencies require that field trip experiences to ISE institutions be correlated to the curriculum and directly related to specific standards. Moreover, many school systems require that field trips to ISE institutions be paid for by individual schools, often putting the poorer schools at a disadvantage.

ISE institutions and ISE programs will play increasingly important roles in the nation's science education enterprise, but their potential will never be fully realized unless their special qualities and roles are explicitly acknowledged and embraced by those in leadership roles in setting educational goals, policies, and standards.

Recommendations to the Field at Large for Next Steps

- Each ISE institution should have a clear set of written policies that are widely known and embraced throughout the organization. Together these policies provide a "true north" in terms of how the institution sees its responsibilities in bringing timeless and timely science stories and experiences to its diverse audience, and that guide it through the roiling seas of the popular media that confound science with socio-political factors in the news. It is particularly in these cases that ISE institutions have a responsibility to examine issues through the lens of science to clarify what the science tells us, where the science community stands as a community, and how the scientific enterprise works to reduce uncertainty while affirming that uncertainties will always exist in science. These policies are especially needed as communities served by these institutions are called to grapple with controversial issues, such as climate change, evolution, and energy.

- Professional associations that ISE institutions belong to such as ASTC, American Association of Museums (AAM), AZA, Applied Science Accreditation Commission (ASAC), and Giant Screen Cinema Association (GSCA) should provide policy frameworks and codes of conduct for informal science education endorsed by the association and its member institutions. These encourage greater boldness in stating the responsibility of ISE institutions in dealing with controversial, value-laden scientific issues such as evolution and creationism, the role of humans in global climate change, stem cell research, climate intervention, genetically-modified crops, and many others. Association policies can provide an important buffering protection for individual institutions. This can help these organizations deal with pressures exerted by board members, political and advocacy organizations, and the fear of losing support from donors, members, and visitors, by underscoring the responsibility of dealing with these issues through a scientific lens and not through socio-political lenses. For association policies to be helpful, they must be clear, concise, and bold.

- To nurture the public understanding of science, it is important for science centers, science museums, aquariums, after-school providers, science theaters—all ISE institutions—to distinguish among: (1) the public understanding of science as a body of facts, information and knowledge, (2) the public understanding of science as an approach to deciphering nature and natural processes and phenomena—i.e. the processes of scientific inquiry, and (3) the public understanding of scientists as humans with all the foibles and strengths of other human beings. It is important for the public to understand that it is the community of scientists and the resulting scientific enterprise that approaches the ideal of producing an objective and unbiased picture of the state of scientific understanding. This is done through peer review, testable hypotheses, repetition of tests/experiments, etc. and that it is the community of scientists that protects against the biases and misjudgments of individual scientists. ISE institutions must be clear about these differences in their written and unwritten policies about how to promote public understanding of science.

- Individual ISE institutions and research institutions such as colleges, universities, government laboratories, private industries, and non-governmental organizations (NGOs), should form partnerships to add richness, depth, relevancy, and timeliness to the ISE's exhibits, productions, activities, and programs. Research funders could help promote this by being more assertive in recommending to researchers that they partner with ISE institutions in fulfilling the need for public outreach, such as the Broader Impacts criterion at NSF.

- In a climate of increasing demand for accountability, ISE institutions and funders of ISE programs must continue to work to develop more diagnostic evaluation tools. These methods must go beyond simple outcomes such as counting the number of people who see a particular exhibit or participate in a particular program, but should not fall into the trap of paying attention only to the most statistically rigorous tests, such as double-blind tests, that are inappropriate for most ISE activities. NSF's Impact Categories are a useful contribution to evaluation, but measuring these impacts is still the challenge. This remains an area for fruitful investigation. Longitudinal studies of ISE institution visitors will be required to document long-term impacts of ISE institutions on level of understanding, attitudes, and behaviors (see the section on Evaluation below).

Part 3: Everyday Science

Journalism, Media, and Science Writing

Overview

A staggering loss of revenue in traditional media has changed the landscape of journalism in just the last five years. Publishers, editors, networks, and station managers are sharply cutting back coverage of specialty beats. Heavy layoffs have included many science reporters. Even in better years, science and other technical topics got only a small share of time on the evening news or space in the morning newspaper. It is even less now.

Science journalism has never been more seriously threatened yet at the same time faced so many opportunities with new science and new communications media. Traditional media, such as newspapers, magazines, radio and TV news, continue to "down-size" or even totally cut coverage of science, which has never had the media attention it deserves. As a result, news coverage of science is at a low. Mooney and Kirshenbaum (2009) write: "For every 5 hours of cable news, one minute is devoted to science." A five-year study of local TV news indicates that only 3 percent of the stories are about technology or science (Rosenstiel, et al, 2007).

The gatekeepers of news are the editors and producers, including many who believe that the public is not interested in science. Can they be convinced by the findings of the Pew Research Center (http://people-press.org/report/528/) that "Americans like science"? Scientists rank with teachers as people who contribute "a lot" to society's well being. Actual journalists themselves may be sympathetic to the ideals of ISE; however they do not consider themselves as educators and should not be expected to be champions for ISE.

TV is still the main source of science information for a large majority of Americans (NSF, 2008, 2010). But while PBS, Discovery and others cover science and should be actively supported, these outlets are often "speaking to the choir." At the same time, the major TV news networks and newspapers continue to lose viewers and readership. Local TV might hold one answer. Close analysis indicates that local TV news continues to be a major source of science information, since viewership is nearly twice that of network TV (NSF, 2008, 2010). Outreach to community TV journalists and broadcasters should be an ISE goal.

Science stories and snippets on TV may help encourage the viewers to seek additional information via new media, which is offering hope for science journalism. Broadband wireless Internet is changing the world of news distribution and consumption at exponential speeds, especially for the youth of this country. Young people are not reading newspapers. While the Internet can be an excellent source of science information it is generally a "pull" device; the user has to know what particular topic to "Google." Well-designed ISE institutional websites can help answer these Google questions. Local ISE can help because the web can also be a powerful "push" communicator of science stories with the use of RSS, Twitter, Facebook, and other social networking systems. ISE policy needs to support these push opportunities.

Current Policies and their Impact

ISE institution and media partnership has yet to be perfected in a way that would deliver high-quality ISE, reliably and regularly, through most media. Some media channels make ISE a priority and most ISE institutions respond positively to many media requests for content and/or opinion, but this is overall lacking in strategy.

Recommendations to the Field at Large for Next Steps

- ISE policy can place considerable emphasis towards financial and technical support of new media outreach directly to journalists, bloggers, podcasters, and the public. Support can also include active feedback strategies between ISE and media reporters and editors. Not only can ISE museums and institutions have up-to-date and engaging websites, they also need to have very active new media outreach programs to journalists and interested public. Support for better understanding between journalists and ISE institutions is worth a concentrated effort, perhaps including experimentation with formal partnerships that support a process for regular, mutually beneficial collaboration. B. Ward (2008) has shown how daylong seminars have helped journalists and climate scientists see that in many ways they share a common work ethos. Feedback helps both ISE and media do better jobs at covering science.

- ISE media outreach should plan ahead to take advantage of breaking news stories: earthquakes, hurricanes, floods, scientific breakthroughs, etc. and offer timely assistance to journalists. Stories are very time dependent for reporters. News is about what is new. A breaking story has a short shelf life. Speed is important. News is also about headlines, and mostly very short stories. Even a story about the President may receive 30 to 60 seconds. However these headlines and short stories are attention-getters and should be used by ISE institutions as springboards to steer journalists, viewers and/or readers to ISE web resources for the in-depth science story. Depth is still desirable.

- There are a growing number of examples of new media outreach that might prove to be helpful. The NSF's "science360" News Service (http://news.science360.gov/files) and the Futurity organization's sites (www.futurity.org) have aggregated traditional press releases from numerous science research centers which "push" their science news via RSS, Twitter, Facebook and YouTube. These social media channels are becoming required in the competitive world of nearly real-time information. The NSF site very importantly includes short and long videos. Detailed discussions of astronomy outreach, especially the importance of video, are also discussed in various issues of the Communicating Astronomy with the Public Journal (www.capjournal.org). NASA's website (www.NASA.gov) and the new NOAA climate portal (www.climate.gov) are also well-designed.

- The new media is expanding the world of outreach to include individual journalists, bloggers, science schoolteachers, and members of the public. While there are quality control issues which must be addressed, these opportunities for increasing the variety and quantity of public understanding tools should be embraced and supported by ISE policy.

Popular Culture

Overview

Popular culture is the expression of society's ideas, attitudes and perspectives. Engaging the public with science through popular culture media like movies, video, theater, and social networks breaks the barriers of C.P. Snow's famous complaint that we have evolved into two separate cultures, one attentive to the humanities and one attentive to science (Snow, 1960). Popular culture can stimulate people to think about issues in science in a non-threatening, enjoyable environment. The potential gain in public understanding of science is great—the average American child spends 900 hours in school a year, but 1,500 hours watching TV (http://www.csun.edu/science/health/docs/tv&health.html). As informal science wades into this territory in search of relevance, policy questions arise such as how to guide practitioners from infringing on the field's core values of integrity, authenticity and trust.

There are at least two ISE policy orientations toward popular culture: 1) the policies that impact how institutions interact with popular culture through mechanisms that engage people with science, and; 2) polices that impact the delivery of science in popular culture by non-scientists. These perspectives arise from goals to informally educate and entertain. They converge to leverage television, movies, theater, and Internet media to reach children and adults as part of daily life.

Within this confluence lay a controversy and an opportunity for educators and entertainers. Dr. Leon Lederman, Noble Prize winner in physics, spent 25 years shuttling back and forth to Hollywood trying to convince studio moguls to create science oriented TV sitcoms. But despite hours spent with producer Norman Lear and his colleagues, Lederman was unsuccessful. The producers believed that you can't force science on to the public and it was not their jobs to educate but to entertain.

Yet, in recent years programs like *The Big Bang Theory (TBBT)*, *CSI*, and *Numb3rs* have emerged with science underpinnings. In some ways these programs actually attempt to explain STEM content using clever analogies and graphics in digestible 30-second sound bites. For motivational purposes, *TBBT*, *Numb3rs*, and *CSI* are all superb. The vast interest in forensics courses in schools in the past decade is a tribute to *CSI*. But for all of the success of these programs and others for attracting and retaining viewership, the science is being delivered by actors who are not real scientists or necessarily trained to provide ISE. Jack Lemmon knew nothing about nuclear reactors in *The China Syndrome* and how much did Russell Crowe know about mathematics as John Nash in *A Beautiful Mind*? Yet these characters have the power to change the attitudes and perceptions of society.

As a whole, such programs show science as a rich source of entertainment ideas that have learning impacts and motivate water cooler discussion among adults. Such conversations also occur publicly through Internet social networking sites (SNS). SNS users become fans, join causes and groups. Among their networks, users share information and misinformation. Within all of these settings, from SNS to television, popular culture breaks barriers and leads to rich opportunity for discussion. Informal educators interested in shaping the delivery of science within popular culture may find new sources of institutional relevancy. The entertainment industry interested in authentic content may find within science new sources of ideas. However, the policies that impact the delivery of accurate science within popular culture are limited.

Current Policies and their Impact

Few polices have direct application in this area. For the television entertainment industry, the Federal Communications Commission (FCC) has some bearing on children's programming. The FCC adopted rules to satisfy Congressional mandates in the 1990 Children's Television Act (CTA). Under the FCC's rules, television stations must: provide parents and consumers with advance information about core programs being aired; define the type of programs that qualify as core programs; and air at least three hours per week of programs designed to meet educational and informational needs of children. Under the FCC rules the display of website addresses during programs directed to children ages 12 and under is permitted only if the website offers a substantial amount of bona fide program-related or other noncommercial content and is not primarily intended for commercial purposes (http://www.fcc.gov/cgb/consumerfacts/childtv.html). To help accomplish this, the FCC's rules require commercial television stations to identify a core educational program by displaying throughout the program the "E/I" icon denoting that the program is "educational and/or informational." Commercial television stations must also provide information identifying these programs to publishers of program guides and TV listings.

ISE institutions have internal policies and review committees that approve exhibit and program content. Similar policies for content approval impact how institutions engage audiences using the Internet and SNS.

Recommendations to the Field at Large for Next Steps

- It is challenging to recommend directions for policy in this category, though opportunities for connecting ISE to popular culture abound. One suggestion is to use the celebrity of those involved in the venues listed above to promote ISE. The public loves to meet actors, musicians, and other entertainers and there is precedence for this in other public awareness campaigns. The challenges with this involve the risk of linking to the present popularity of the show and/or actors enlisted in STEM learning support. Popular media is a business and it may not be realistic that they would support ISE out of the goodness of their hearts.

- Using celebrities to promote ISE could be done by creating an advertising campaign celebrating science, creating a symposium about the success of the program at core ISE conventions, e.g. American Association for Advancement of Science (AAAS), National Science Teachers Association (NSTA), and the American Institute of Physics (AIP), featuring the producers, writers and stars of the program. When the awards are given out for science at various awards ceremonies, like the Intel science award, or at the White House with the President, the stars of the show can act as emcees and presenters.

- We also recommend that producers and writers consider STEM content stories and encourage the ongoing efforts of the National Academies and their alliance with Hollywood to have consultants with scientific expertise. As an example, the Alfred P. Sloan Foundation has a substantial program to encourage science in the theater realm.

Linkages to Other Large-Scale Belief Systems

Overview

There is an enormous awareness in ISE circles that some widely-held assumptions and beliefs about the world often play out in opposition to robust scientific theories. Some would argue that there is no inherent conflict between belief systems and products of the scientific method, but informal science educators must be aware of the potential conflict, underlying prejudices, and possible information gaps and take them into account while offering ISE. In an age when humanity is increasingly driven by the economic and political implications of scientific output, public understanding of scientific processes and the discipline of objective observation could become a higher priority on the ISE agenda than the current potpourri of scientific discovery.

Independent thinking is a prominent American value, one that is continuously reinforced by media, arts, and entertainment. Common sense vs. sophistication and complexity is a regular theme that permeates much of American culture, setting the perfect stage for energizing non-scientific challenges to misunderstood/unpopular scientific positions. Tennessee's Butler Act of 1925 (repealed 1967) embraced the position that the teaching of evolution was "dangerous" and threatened one of the linchpins of religious faith, and by extension, religion's associated moral codes. Made famous by the Scopes Trial, the Butler Act suggested that there was indeed a moral imperative in opposing science that challenged sacred traditions. More recently, scientific findings such as harvestable quotas of natural resources and human-induced climate change have not been universally welcomed as preambles to remedy but instead are seen by some as "philosophical" threats to economic prosperity. Combine this with popular images of scientists as overly obsessed with research agendas that work their way into policy, law, taxation, restrictions, and government spending, and the subtleties of objective science are easily lost.

Current Policies and their Impact

The perceived conflict between science and some belief systems has led to some written and unwritten policies about the public presentation of natural processes as described by scientific investigation.

For some organizations, those scientific theories and findings (e.g. evolution, climate change) perceived to be in conflict with community beliefs and belief-systems are being described in interpretive graphics without reference to the "hot button" words. Presentation of the phylogeny of a group of animals (not humans), minus the word "evolution," illustrate common ancestors and the chronology of non-controversial speciation events. Similarly, the recent history of polar ice cap melting may be presented in photographs without reference to "global warming" or "climate change."

Since belief systems are not, in fact, part of scientific debates, the common unwritten policy is to simply ignore belief systems and those systems' reactions to unpopular scientific theories. For example, most ISE institutions do not refer to "creationism" at all since it has no legitimate role in the interpretation of evolutionary biology. Some ISE institutions have made concessions to champions of "alternative views," the latter seeing opportunity for use of science exhibits to promote the non-scientific view, e.g. sanctioning creationism tours of exhibits presenting evolutionary theory and processes.

Pressure to withhold important scientific content and context, or to present alternative views in opposition to legitimate science, will affect some communities and geographical regions much more than others. To the extent that this is skewed toward communities already at socio-economic disadvantage, the distortion of science education will only compound this disadvantage.

There can be a perception that the challenges to scientific theory and findings require a direct response. This creates something of an “apples and oranges” kind of debate since the defense of belief systems and the defense of science operate in totally different realms of human experience. Science is not a belief system and requires no faith. In fact, it springs from methodical, accumulation of observable evidence and is pursued as falsifiable. This is not necessarily reassuring to many people who value certainty and view the inevitable caveats of scientific findings as more weakness than strength. Common statements such as “do you believe in evolution?” and “do you believe in global warming?” speak to a serious gap in public understanding of the scientific process.

Recommendations to the Field at Large for Next Steps

- The President’s “Educate to Innovate” campaign can advance understanding of the scientific method by promoting partnerships between corporations, communication outlets, schools, and other groups. The President and other political leaders can urge colleagues to maintain the distinction between the procedures which generate science understandings and belief systems in their public policy discussions.

- ISE institutions should include in their internal policies a focus on the scientific method and interpretation of scientific findings from a science standpoint. ISE institutions should discuss and document their policies about including non-scientific belief systems in their programs and exhibits.

- The ISE field should encourage common core standards in formal education to include continued, sequential understanding of the scientific method and interpretation of scientific findings. ISE institutions and after-school programs can then develop programs to augment school-day instruction.

- Language and use policies within media outlets could more deliberately prevent descriptions of “belief” in scientific evidence. Journalism schools could require science training as a requirement for graduation, and the National Association of Science Writers and other professional organizations in media and journalism can help journalists and editors to update their knowledge of scientific theory and methods.

Part 4: ISE Cross-Sector Issues

Funding

Overview

Funding for ISE is characterized by startling diversity. Sectors of support include philanthropic donations by individuals and businesses, government support at all levels and revenue programs that include admissions, birthday parties, camps, and paid outreach.

The National Academy report *Learning Science in Informal Environments* (Bell, et.al, 2009) finds that science education happens in numerous arenas, all of which interact to reinforce learning and engage learners. But most informal science education funding is distributed to individual sectors of institutions (school systems, media producers, museums, planetariums, and more) instead of coordinated across all institutions and delivery vehicles to effect certain outcomes.

Current Policies and their Impact

Within NSF, one of the major government funders of informal science education, several policies are at work that affect ISE. The inquiry group could not identify any policy that sets standards for dissemination of scientific research through informal channels and no institution exists to coordinate those efforts. Research institutions may obtain dissemination funding but may not want to subgrant it; moreover, no policy for accreditation of ISE institutions exists that will ensure that the desired outcomes can be achieved by these subgrantees. And finally, without national common core standards for science education, it is not clear when research falls within school content standards, making it more difficult to work with the formal school system as a potential audience.

Most ISE grants from both private and public funders are for short terms, between one and three years duration. This contrasts with grants for non-profits in social work or research, which are generally ongoing or for longer periods of time. Regarding work in education as a primarily shorter-term investment is a questionable assumption.

The U.S. Department of Education may provide some back-door funding to developers and deliverers of ISE, though this department is much more focused on the formal school system. Competitive grants in education at the federal, state, or local levels are often limited to Local Education Agencies (LEAs), excluding ISE institutions and after-school organizations that provide ISE from the competition for funding. Additionally, solicitations for after-school programming funded by the Department of Education's 21st Century Community Learning Center funds, which are currently administered by states, do not actively promote or require informal science as a prioritized activity in after-school.

In recent years much local and state government support for institutions of ISE has fallen away. ISE institutions are turning to two sources of revenue for cash flow: earned revenue and private grants. At many institutions, admission fees have skyrocketed, with implications for diversity of audience and programming. Parks and libraries have no admission fees and are therefore more accessible to a diverse audience. Museums require more substantial government funding then they currently receive if they are to be free to the public.

An additional source of funding is private foundations. Many of these organizations fund programming to meet specific goals or topics that are based on their philanthropic strategic plans. This drives the mission of the applicant institution and may have an impact on the public's trust and the institutions' authority, as in the case of energy companies funding energy programming. Additionally, some institutions use grant funding as a way to shore up lost operational funding, meaning that the institution becomes program-heavy and administration-poor, even while there are more and more demands to show a return on investment. This requires a great deal of evaluative and administrative overhead. Sometimes the best grants invest in the whole institution as operating support and not just a particular program.

Recommendations to the Field at Large for Next Steps

- Public agencies, private philanthropy, and corporations that fund ISE should consider funding policies to prioritize sustainable partnerships between individuals or institutions primarily devoted to ISE and those dedicated to science. These funders should also consider the merit of establishing policies that set standards for (and coordinate dissemination of research through) ISE institutions and partnerships.

- In funding those institutions primarily devoted to ISE, funders should consider the merits of granting operating support, rather than funding particular programming to meet specific goals or topics and fully support administrative costs. Funding policies that demand innovation or transformation outcomes should consider prioritization for underserved geographical areas.

- Competitions for 21st Century Community Learning Center funds through the Department of Education should allow efforts that incorporate STEM activities or prioritize those efforts as a mechanism to stimulate ISE in after-school. Other Department of Education funding competitions should allow non-profit agencies that offer ISE to directly compete, rather than allowing only Local Education Agencies to apply directly for funds.

- Local and state governments should work with ISE institutions to ensure that access is not hindered by admission prices. ISE institutions within jurisdictions should collectively assess impact of local and state government decreases in funding and strategies to build public will for public funding for ISE efforts.

Evaluation

Overview

Evaluation and assessment have long been a part of both formal and informal education, but the ways and reasons for which they are undertaken are largely unrelated across the formal-informal divide. What are the policies and expectations of funders and formal education partners for evaluation and assessment in the informal education realm? What collective efforts should be made within the informal sector to respond to those policies and expectations?

Based on informal discussions with leaders from ISE institutions as well as from funding agencies, evaluation in ISE seems to be performed primarily to differentiate and substantiate the value of individual projects, specifically the benefits of a program to its target audience. The overall rationale for evaluation is thus usually to justify the investment in the project and to document sound use of resources. To this summative evaluation has often been added front-end and formative evaluation, designed to help improve the effectiveness of individual projects in advance of summative evaluation.

In the current policy milieu, ISE is now also being called on to justify its value, not just on a project by project basis, but *as a field*. The overarching rationale is that if the ISE field is to receive funding, governmental or private, it needs to document that ISE as a tactic actually meets its intentions—that it contributes to public understanding of science, self-efficacy in terms of science, and positive science-related affect. This challenge is consistent with that which formal learning institutions (schools) are increasingly being held to, such as required assessments for formal education under the Elementary and Secondary School Act (known as No Child Left Behind).

If ISE communities and the overall ISE field do not proactively establish processes and practices for documenting the impacts of ISE, it is likely that ISE may be in the position that schools now find themselves—with requirements for specific assessments and standards being mandated by governmental and private-sector funders. Externally developed policies for evaluation run the risk of not assessing ISE-based pedagogies, values, and practices, that is, those measurable objectives which the field itself believes it can accomplish well.

Current Policies and their Impact

Evaluation and assessment policy has in general not been created from within the field of ISE, nor have such policies been designed or adopted by associations with the field. Instead, the impetus for much of the development of evaluation in ISE has been through funding agencies needing to document the impact of their investments. High-stakes testing has become the national norm for public schools. Typical large scale assessments in formal education, such as the NAEP, and most state-created assessments, seek to measure "what students know and can do" in a particular discipline, such as reading, math, or science. Although research shows interest, attitudes, and confidence in science are critical in developing a lifelong interest in science, these are not qualities that formal education assessments are typically designed to measure (see for example Tai, et al., 2006).

In contrast, most ISE programs are designed for the generation and maintenance of interest in a STEM topic, developing positive attitudes towards STEM pursuits, and affording opportunities for learners to become more practiced and confident in their abilities to learn about STEM. Thus applying assessments designed for formal education to ISE may show that ISE contributes little. During the early years of No Child Left Behind, as reported by many ISE practitioners, numerous school systems reduced their use of ISE resources because they felt there was little chance ISE could improve scores on a state's NCLB-mandated testing program. They were probably right.

Direct funding for ISE could be heading in that direction as well. The proposal by the Academic Competitiveness Council (2007, www.ed.gov/about/inits/ed/competitiveness/acc-mathscience/index.html) is an example. The ISE field is now in a critical period in which it can take hold and help shape its future through developing evaluation policies and practices. And, as the National Research Council (NRC) consensus report states, ISE practitioners must ensure that "assessments fit with the kind of participant experiences that make these environments attractive and engaging; that is, any assessment activities undertaken in informal settings should not undermine the features that make for effective learning there" (Bell et. al., 2009, p. 77).

An important practice—and therefore *de facto* policy—shaping evaluation in informal environments is an ethic of sharing resources and knowledge, often at no- or low-cost, with the wider community. These resources are available through www.informalscience.org, the Visitor Studies Association (www.visitorstudies.org), and AAM's Committee on Audience Research and Evaluation (www.care-aam.org). Included on these websites are lists of evaluators, archived journals and other publications, and career-ladder professional development resources. Thus, as ISE further develops the ability to assess impact, the dissemination tools and professional development networks are in place.

Recommendations to the Field at Large for Next Steps

- The recommendation consistently arising in discussions of ISE and evaluation is that ISE should be proactive in establishing what counts as effective ISE practices, as well as establishing how those ISE experiences can be evaluated for both individual projects and across many projects.

- If ISE wants to be at the table as an integral player and stakeholder in discussion of science education and/or of lifelong learning, value needs to be substantiated through data. This includes consistent, comparable sets of data that can be analyzed for cross-project impacts. ISE institutions have been conducting evaluation more frequently in the last decade or so. In the last several years, several efforts have raised the bar, challenging the field to consider field-wide categories by which to determine impact. The National Science Foundation's *Framework for Evaluating Impacts of Informal Science Education Projects* (http://informalscience.org/evaluations/eval_framework.pdf) is widely seen as a major encouragement in this direction.

- ISE has begun to move from merely claiming worthiness as a field to conducting more objective evaluation and research on individual experiences and intentionally designing frameworks and tools so that data is collected and can be analyzed across projects to determine field-wide impacts. Examples of new tools which can be used across projects, thus potentially supporting field-wide assessment, include the "Assessment Tools in Informal Science" project at Harvard (http://www.pearweb.org/atis) and instruments to measure public attitudes towards climate change (http://ec.europa.eu/public_opinion/archives/ebs/ebs_322_en.pdf).

- As next steps, leaders in the various ISE sectors can work together to examine what policies each sector might develop to encourage, if not require; that organizations involved in ISE agree to developing sector-wide, and then field-wide evaluations that make the case for ISE as a whole. For a start, the ISE field needs to inventory existing formal policies on evaluation in ISE, at federal agencies, major private foundations, state or local supporters of ISE activity, professional ISE associations, and leading individual ISE organizations and individuals.

- The inventory should start with leading major programs, such as those at NSF, Institute of Museum and Library Services (IMLS), NOAA, NIH, and NASA. Existing organizations that promote or support evaluation in ISE should also be surveyed to determine what policies they currently support, and what policies they believe would lead to field-wide encouragement of cross-sector impact data for ISE. These organizations include VSA, AES, National Association for Museum Exhibits, UPCLOSE, ASTC, GSCA, National Public Radio (NPR), and the National Association of Science Writers (NASW).

- As a matter of policy and priority, some individual ISE organizations already perform extensive impact evaluations and publish the results widely. Others perform evaluations, but rarely publish them externally. Yet others conduct extensive formative evaluation, but rarely perform summative evaluations. A measure of how these policies are distributed within and across the ISE sectors, such as museums, media, after-school, and community programs, would indicate where work is most needed and where common ground for policy is to be found.

- Based on these surveys, language should be drafted that could be adopted by individual ISE organizations, professional associations, and funders in order to encourage adoption of policies leading to improved sector-wide and ISE field-wide evaluation practice. Such instruments could potentially help make the case to funders for ISE support, and allow the field to indentify general principles to achieve the goals of ISE.

- The ISE field needs to develop the argument for why interest and motivation—and the measurement of it—is a primary need in both ISE and formal science education.

Diversity

Originally, the inquiry group discussed how to best include and address "diversity" in each chapter of the report, but then decided to treat diversity as a separate component. We would see how diversity issues were expressed or not in the individual discussions, and then describe how issues of representation, inclusion, equity, and other forms of "diversity" surfaced in the conversations overall.

In examining the notes and the policies reported here by the group, it became evident that "diversity" was not the term used. However, concerns for "access," "inclusion," and "representation" were at the core of many of the conversations. The following examples illustrate how policies may be examined with a broader lens in order to see how it is that they encourage or discourage opportunities for learning science "for all." The following questions and examples discussed by the group in other parts of this report illustrate how policy recommendations often addressed goals of access through issues concerning programming, people, practices, and funding.

- Are partnerships between formal and informal organizations, encouraged by funding policies, good ways to develop multi-sector strengths capable of reaching underserved audiences? Examples cited in the CAISE document "Making Science Matter" (http://caise.insci.org/uploads/docs/MakingScienceMatter.pdf) included 14 long-lasting partnerships. The work between the NY Hall of Science and City College (CLUSTER, page 46 of the PDF) demonstrated how the pre-service education of urban minority teachers could be beneficially mediated through teaching experiences in a context different from schools and informed by authentic science.

- Is it possible to develop a clearinghouse where research scientists can select informal learning organization partners and vice versa? This database could provide opportunities for scientists and the organizations to go beyond their own environments and include practices from different fields, backgrounds, geographical locations, and languages to better connect with diverse audiences.

- Goals for funding need to specify the problem they are solving and the applicants' capabilities to addresses it. For example, achievement goals for English Language Learner (ELL) students could require personnel and approaches with ELL expertise.

- How do science media decisions and practices influence who has access to the information? Key decisions involve whether to provide information in different languages, at different times of day, in more accessible forms, or on topics that are more inclusive of global communities. In practice, whether a weather report uses Fahrenheit, Celsius, or both will have an impact on the audiences reached and what they can learn.

- How do museum admission policies promote or diminish access to broader groups? This is becoming a widely studied topic because of its many dimensions of impact on funding and on access. Should admission be free, or cheap for those that only come once, or cheap for those who come often? Should there be admission policies that create or provide memberships to promote continued use and learning? How do "suggested" admission fees function for the institutions and for the visitors, as compared with free access or, pay-per-exhibit policies?

- How can institutions develop and identify programs suited for multi-cultural audiences and providing multiple points of entry? The recent exhibition "Traveling the Silk Road" (http://www.amnh.org/exhibitions/silkroad/) was explicitly promoted as focusing on the history of inventions, the interchanges of culture, musical traditions, and the story-telling nature of cultures from China to Baghdad. The result was extensive visitation from groups interested in the history of science, others in the development of writing and legends, on transportation by camels, on current lives in Silk Road communities, and on the cultivation of silkworms.

The various chapters of this report identify multiple areas of policy that could serve as starting points for further studies of policy issues affecting diversity in informal science learning. As an example, the ten partnerships between universities and informal science organizations are described in the Fall 2010 issue of *The New Educator*, cited earlier in this report (Part 2, page 12), could be examined to identify how these projects and their supporters assess the broader impacts of those partnerships on access, inclusion, and diversity (http://www1.ccny.cuny.edu/prospective/education/theneweducator/volume6_3_4.cfm).

Part 5: Conclusion

Informal science education as we know it today didn't begin from national mandates, the continuation of long-standing practices, or a coordinated effort of a large group. It arose at various places and times from the enthusiasms of individuals and small groups wanting to share a subject they loved and respected. Each science radio program, museum, community program, aquarium, and website has its unique origin story. Then partnerships were formed, professional organizations assembled, funders emerged, and popular practices became traditions.

Those traditions became policies, often without the kind of formal adoption and review one sees in formal education or other cultural schemes. As this report describes, various policies, internal and external, written and implicit, now encourage or constrain informal science education. It is time to review those policies, as this report attempts to begin, in order to understand their impacts and adjust them as needed. New policies may be useful to help the field attune to new challenges and to free up imaginations and passions by removing barriers and opening opportunities to share science in new ways, for new purposes, with new audiences.

The issues discussed in this CAISE Inquiry Group report are intended to spark conversation and awaken us to the policy contexts around us. We are part of the infrastructure of science and science education in this country and in the world. We hope that this document inspires ISE professionals to engage productively with the policy environment, in order to leverage our strengths into greater impacts for the individuals, organizations, communities, and societies we serve.

Part 6: References and Further Reading

Note that this list includes references not known to be directly available on-line. All on-line references are included in the text as clickable links, to assist readers in finding them quickly.

References

Bell, P., Lewenstein, B., Shouse, A. W., & Feder, M.A. (Eds). (2009). *Learning science in informal environments: People, places, and pursuits.* Washington, D.C.: The National Academies Press.

Dean, C. (2005). A new screen test for Imax: It's the Bible vs. the volcano. *New York Times*. (19 Mar). See also the related story, Dean, C. (2005). Challenged by creationists, museums answer back. *New York Times* (20 Sept).

Inverness Research Associates. (1996). *An Invisible Infrastructure: Institutions of Informal Science Education.* Washington, DC: Association of Science-Technology Centers.

Mooney, C., & Kirshenbaum, S. (2009). *Unscientific America: How science illiteracy threatens our future.* New York: Basic Books.

NSF. (2010, 2008 & 2006). Chapter 7: *Public attitudes and understanding: Science and engineering indicators.* Arlington, Virginia: National Science Foundation.

Roper/Starch (1998). *The Bayer Facts of Science Education IV.* [online] URL: http://bayerfactsofscience.online-pressroom.com/

Rosensteil, T., Just, M., Belt, T., Pertilla, A., Dean, W., & Chinni, D. (2007). *We interrupt this newscast: How to improve local news and win ratings, too.* New York, NY: Cambridge University Press.

Tai, R., Liu, C., Maltese, A., Fan, X. (2006). Planning Early for Careers in Science. *Science*, 312, 1143-1144 (2006).

Snow, C. (1960). *The Two Cultures.* Cambridge, UK: Cambridge University Press.

Ward, B. (2008). *Communicating on climate change: An essential resource for journalists, scientists, and educators.* Metcalf Institute for Marine and Environmental Reporting. Narragansett, RI: University of Rhode Island.

Further Reading

Allmon, W. (2005). *Evolution and Creationism: A Guide for Museum Docents.* Ithaca, NY: Museum of the Earth.

Briggs, M. (2007). *Journalism 2.0, How to survive and thrive. A digital literacy guide for the information age.* Knight Foundation. Knight Citizen News Network. [online] URL: http://www.j-lab.org/Journalism_20.pdf

Goodman, A., Heath, D., Lindee , M. (Eds). (2003). *Genetic nature/culture: Anthropology and science beyond the two-culture divide.* Berkeley, CA: University of California Press.

Helper, D., & Potter, D. (2008). *Advancing the story: Broadcast journalism in a multimedia world.* Washington, D.C: CQ Press.

McCall, R. (1988). Science and the press: Like oil and water? *American Psychologist*, (43), 87-94.

Part 7: Contributors

Policy Study Inquiry Group Members

- Arthur Eisenkraft, Ph.D., Distinguished Professor of Science Education, University of Massachusetts, Boston
- Ira Flatow, Executive Producer/Host, *Science Friday*
- Alan J. Friedman, Ph.D., Consultant and CAISE co-PI. *Co-leader of PSIG*
- Jeffrey W. Kirsch, Ph.D., Executive Director, Reuben H. Fleet Science Center
- Dr. Maritza Macdonald, Senior Director of Education and Policy, American Museum of Natural History
- Eric Marshall, Ph.D., Principal, Resonant Partnerships
- Ellen McCallie, Ph.D., Deputy Director, Carnegie Museum of Natural History
- Trevor Nesbit, Independent Researcher, ECHO Leahy Center MSMIIT Candidate, Champlain College. *CAISE Fellow*
- Rebecca Nesbitt Prosino, Director of Marketing and Strategic Projects, Sci-Port: Louisiana's Science Center. *CAISE Fellow*
- Charles Petit, MIT Knight Science Journalism Tracker
- Jerry R. Schubel, Ph.D., President and CEO, Aquarium of the Pacific
- Saskia Traill, Ph.D., Director of Policy, The After-School Corporation. *Co-leader of PSIG*
- Dan Wharton, Ph.D., Senior VP Animal Programs, Chicago Zoological Society
- Steven H. Williams, Ph.D., Chief of Education Initiatives, National Air and Space Museum. *CAISE Fellow*
- Joe Witte, TV Meteorologist and Ph.D. Candidate, Center for Climate Change Communication, George Mason University

Ex-Officio

- NSF: Alphonse DeSena, Ph.D. Program Officer, Lifelong Learning Cluster, National Science Foundation
- VSA: Lisa Craig Brisson, Consultant for VSA/CAISE

Critical Friends

- Alphonse DeSena, Ph.D. Program Officer, Lifelong Learning Cluster, National Science Foundation
- Jennifer DeWitt, Research Associate, King's College London
- Carol Inman, National Grant Writer
- Dennis Schatz, Senior Vice President for Strategic Programs, Pacific Science Center