Evidence for the Impact of Informal Science Learning

Alan J. Friedman, 1/2011
This essay is an ongoing project with periodic updates.

- Evidence that Informal Science Education really works
- How it complements rather than replaces or just continues formal education

Evidence that Informal Science Education really works

1. The most comprehensive single study to date is the one released in 2009 from the National Research Council (NRC), the operating arm of the National Academy of Science: *Learning Science in Informal Environments: People, Places, and Pursuits.* Here's a concise summary from their website:

> "Learning is broader than schooling, and informal science environments and experiences play a crucial role," said Philip Bell, co-chair of the committee that wrote the report, and associate professor of learning sciences at the University of Washington, Seattle. "These experiences can kick-start and sustain long-term interests that involve sophisticated learning. Think of the child who sees dinosaur skeletons for the first time on a family trip to a natural history museum, and then goes on to buy dinosaur models and books, do Web searches about dinosaurs, write school reports on the subject, and on and on."
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> The report notes that experiences in informal settings can significantly improve science learning outcomes for individuals from groups which are historically underrepresented in science, such as women and minorities. Evaluations of museum-based and after-school programs suggest that these programs may also support academic gains for children and youth in these groups.
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> http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12190

The Executive Summary, available as a free download, http://www.nap.edu/nap-cgi/report.cgi?record_id=12190&type=pdfxsum, for a good idea of everything in the report. The first and last chapters are the next most useful. A practitioners' guide to the NRC findings was published in 2010: *Surrounded by Science: Learning Science in Informal Environments* and is available at http://www.nap.edu/openbook.php?record_id=12614&page=1.

Among the sources for the NRC report are a web site for reporting studies on informal science learning. It is still being populated, but is already quite useful: www.informalscience.org. The Visitor Studies Association is a partner in this project. Its entire archive of studies has been digitized and is available in free, searchable form through www.informalscience.org or through www.visitorstudies.org.

2. "The 95 Percent Solution," Falk, J.H. and Dierking, L. D., American Scientist (2010), v. 98, pp. 486-493. This article from the November-December 2010 issue of the peer-reviewed journal *American Scientist* is the closest thing we have to a manifesto declaring the importance, even the necessity, of informal science education. It cites numerous references, like the National Research Council reports described above, but is not constrained by the highly cautious concensus nature of NRC publications. Falk and Dierking have looked at the broadest implications for "free-choice" learning, and make a compelling case for ISE in all of its forms. http://www.americanscientist.org/issues/feature/2010/6/the-95-percent-solution.

3. A very interesting study was published in 1998 by the Roper/Starch Organization with support from the National Science Foundation and the Bayer Foundation. It interviewed 1,400 scientists to find out the early sources of their interest in science. Visiting a science museum as a child came high on the list. The detailed summary is no longer on their web site, but a short version and ordering information for the full report is available at: http://www.bayerus.com/MSMS/web_docs/Science_Facts_I-XII_internet.pdf

3. The Center for the Advancement of Informal Science Education, CAISE, is another NSF supported resource. Part of its mission is to collect and disseminate evidence for the impacts of informal science education programs and organizations. Subscriptions to its newsletter are free, and announcements of publications, conferences, services, and invitations to contribute may be found at www.insci.org.

4. I also find very useful the research by Robert Tai and his associates, published in the May 26, 2006 issue of *Science.* They found that young adolescents' *expectations* that they would have a career in science were an excellent predictor of graduating college with a science or engineering degree. "Young adolescents who expected to have a career in science were more likely to graduate from college with a science degree, emphasizing the importance of early encouragement." The study found that 8th grade students with expectations for a science related career were 3.4 times more likely to earn college physical science and engineering degrees than students without similar expectations.

> "An *average* mathematics achiever with a science-related career expectation has a higher probability of earning a baccalaureate degree in the physical sciences or engineering than a *high* mathematics achiever with a nonscience career expectation, 34% versus 19%" [emphasis added]. So career expectation as an adolescent had more value than mathematics achievement in school as a predictor of winning a college degree in STEM disciplines.

Since science centers and other informal science activities are designed to encourage interest in STEM disciplines and to encourage students to pursue careers in these fields, Tai's work suggests that engagement in science centers and museums may be a major factor in students' becoming STEM college graduates.

5. Jon D. Miller has been measuring public science literacy in the US for decades. His recent work on US science literacy shows substantial increases, particularly through the 1990's. Use of informal science education resources came in second only to having taken college-level science courses as a significant predictor of science literacy. See www.fas.org/faspir/2002/v55n1/scilit.htm. Google "Jon D. Miller" to find more studies.

6. With knowledge of these arguments, the highly respected international science journal *Nature* published an editorial on the value of informal science learning in 2010. It is a passionate call for paying more attention, and spending more money, on informal science education. The title and heading: "Learning in the Wild / Much of what people know about science is learned informally. Education policy-makers should take note**.**" http://www.nature.com/nature/journal/v464/n7290/full/464813b.html .

7. The Programme for International Student Assessment (PISA) has done background variable studies of what factors correlate with 15-year olds' test scores in science, world-wide. Visiting science museums is one significant positive factor. This data has not yet been fully analyzed or published (Dr. Andreas Schleicher, private communication), unfortunately, but I'm working on getting that to happen.

How Informal Science Education complements, rather than replaces or simply continues formal education

Informal Science Education (ISE) does not DELIVER education, like a school. We are more like a gym than a school. We have the equipment, the settings, which individual people can use to exercise their minds and spirits. The mere exposure to the equipment in a gym does not make anyone fit or flexible. But people who choose to use that equipment, can make themselves fit, at whatever pace they individually choose. Similarly, visiting a science museum does not deliver science knowledge. But people who do visit, and who become fascinated with something they experience, will find themselves learning and becoming even more interested in whatever it was that caught their imagination. That's why ISE is also called "free-choice learning."

ISE can be a source for inspiration and wonder, and reinforcement of these qualities. But ISE can not have a standardized cuuriculum to make this happen. We do work very hard to increase the chances that each person using the museum will find something which will be his or her personal springboard to wonder and learning. A science museum has hundreds of exhibit units and thousands (if not tens of thousands) of objects on display. The museum staff doesn't know precisely which objects will appeal to which visitors. A thousand visitors on a given day may each find a *different* exhibit or experience which fires their individual imaginations and learning. Many scientists describe just such an individual experience as their pathway to a career in science (see the study mentioned earlier, http://www.bayerus.com/MSMS/web_docs/Science_Facts_I-XII_internet.pdf).

There is supporting evidence in studies of what works in formal education—practices which seem even more familiar in informal education than they do in most science classrooms. The National Research Council has published lots of reports on what works in formal education. One study by the Educational Testing Service, however, seems to me to articulate most clearly practices where formal and informal organizations could collaborate closely. "Exploring What Works in Science Instruction: A Look at the Eight-Grade Science Classroom," by Henry Braun, Richard Coley, Yue Jai, and Catherine Trapani, can be downloaded free at http://www.ets.org/Media/Research/pdf/PICSCIENCE.pdf.

Increases in NAEP 8th grade science test scores are significantly associated with increases in use of the following instructional strategies:

- Students reading a science textbook
- Students doing hands-on science activities
- Students writing long answers to science tests and assessments
- Students talking about measurements and results from hands-on activities
- Students working with others on a science activity or project

It is interesting that some other common strategies are *negatively* associated with achievement, such as students giving frequent oral science reports. Especially important is that the strategies for increasing test scores were effective *across all racial/ethnic and school disadvantage groups.* The study shows that Black and Hispanic students are less likely to experience these effective strategies, a finding which provides a possible explanation (and remedy) for at least some of the gaps in achievement.

For decades informal science organizations have been providing in-service teacher professional development concentrating heavily on three of the five effective strategies: hands-on science activities, measurement and analysis of hands-on activities, and team projects. These practices are still easier to do, and more common, in informal science organizations than they are in the vast majority of the nation's school systems.

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