

LEARNING RESEARCH IN SCIENCE MUSEUMS: A CURRENT FRAMEWORK, TRENDS, AND TOOLS

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Overview: In this presentation I will use the recent LSIE report as a framework for considering current research and development in science museums. I share several examples, drawn from the Exploratorium's active program in Visitor Research, and highlight current trends, tools, and possible areas for future work.

Learning Framework: In 2009, the National Research Council (NRC) of the United States' National Academy of Sciences conducted a landmark synthesis study that attempted to bring together evidence of learning in science in informal environments, that is, outside formal schooling. Most of the research considered was U.S.-based, though studies from other countries was included where known. The committee considered learning in everyday settings such as homes or gardens, designed settings such as museums, and programs that have some kind of curricular goal. Happily, the report cited extensive evidence that learning does occur in such environments, across cultures, ages, and settings. The final report was entitled *Learning Science in Informal Environments: People, Places, and Pursuits* (henceforth LSIE), and is available free online through the National Academies Press.

A major contribution of this report was the creation of a Framework of 6 strands of learning, that emphasized the special value of informal learning environments such as museums:

Learners in informal environments:

Strand 1:

- experience excitement, interest, and motivation to learn about phenomena in the natural and physical world.

Strand 2:

- come to generate, understand, remember, and use concepts, explanations, arguments, models, and facts related to science.

Strand 3:

- manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world.

Strand 4:

- reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena.

Strand 5:

- participate in scientific activities and learning practices with others, using scientific language and tools.

Strand 6:

- think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science.

(NRC, p.4)

In particular, Strands 1 and 6 were seen as aspects of learning that are strongly supported in informal environments, but that are seldom even included in most (school-based) lists of proficiencies. In other words, the LSIE report significantly broadened the definition of learning to include the strengths of museums and other informal settings. Another significant feature of the strands is that they are process-focused, emphasizing the kinds of activities that learners engage in rather than their final knowledge state; this has the advantage that they are both an outcome and a mechanism, so that museum professionals may get a sense of how well their educational designs are supporting a strand, by watching learners during their process (i.e. useful for formative evaluation purposes).

The strands are not intended to be hierarchical or sequential, but they provide researchers as well as exhibit-designers and educators opportunities for considering possible aspects of learning that might be supported and assessed.

While these 6 strands were designed with science in mind, the framework could be adapted to other domains such as history or social science – or any domain with a corpus of canonical knowledge, skills and techniques for making inferences, and communities of practicing professionals.

Examples of studies focusing on a specific strand:

During the presentation I will share the motivation, methods, and results of several studies conducted at the Exploratorium. These studies all involved attempts to both assess and enhance learning, as measured by one of the strands. In brief:

Strand 2: understand science content

At the Exploratorium, we conducted a number of studies to explore ways to enhance visitors' understanding of canonical science.

In one study, we found that visitors were more likely to correctly identify "energy" as the unifying concept connecting a series of 6 exhibits, if the exhibits were surrounded by a wall that separated them from other exhibits on different topics.

In another study, we found that visitors drew and annotated more detailed and accurate representations of *C. Elegans* worms when they had interacted with a live exhibit rather than a non-interactive version.

Strand 3: investigate the natural world

In another project, Exploratorium staff created a genre of exhibits that emphasized certain aspects of Strand 3. Specifically, the goal of the project was to extend visitors' engagement time significantly beyond that of a typical interactive exhibit, and to support them in asking their own questions at exhibits, and answering them using the exhibit rather than reading a label. This research showed that it was possible to change the nature of visitors' investigations (Strand 3) through exhibit design, and also generated a list of assessment techniques and design principles for achieving this.

The changing roles of museums

In the U.S., science museums have been heavily funded by the National Science Foundation (NSF) to create and study innovative practices. This has led to decades of experimental approaches, combined with a mandate to share lessons learned with other professionals in the museum field. As a result, there is substantial infrastructure for viewing, discussing, and reviewing the impacts of innovative museum learning materials (see some of the websites listed below).

In addition, the explosion of technologies related to communication, social and mobile media, has led to a partial transformation of the activities of museums. The following are some current trends I would argue are particularly worthy of study:

a) Extended learning experiences beyond the single interaction with an object: Museums are exploring ways to provide visitors with a longer engagement, even including beyond the museum walls to the home or school environment, or to mobile technologies for users in motion.

b) More participatory modes of interaction: Museums are experimenting with greater degrees of participation by visitors, including scientific inquiry (asking their own questions, conducting their own investigations), comments and curation, and even generation of exhibit content or entire exhibits. The Maker Movement is one example of this.

c) Greater personalization of experience: Museums are offering visitors choices such as language, theme, personal recording of experience, level of engagement.

d) Blurring of boundaries between museums and other parts of the learning ecosystem: Museums are becoming less isolated, with offerings for schools, home-schools, and virtual visitors; and serving as conduits and hubs for community concerns and forums, science bloggers, and current science issues.

e) Increasing professionalization and connection to researchers: Increasingly, research and practice are becoming integrated in creative ways. Again, the NSF has invested heavily in capacity-building and community-building efforts that encourage museum researchers and practitioners to learn from each other in reflective communities (e.g. CAISE, Exhibitfiles, informalscience.org, research2practice).

Future research questions

These trends are exciting, but much is still experimental and untested. For example, research questions about the changing role of museums might include:

- How can museums personalize learning in a way that is still cost-effective and doesn't undermine the social nature of the learning experience?
- What is an effective balance of structure and choice to help a broad range of learners use museum resources effectively?

- How can museums support greater participation by learners and yet keep high standards of communication or content?
- How can museums effectively interface with schools (e.g. with a national agenda related to standards, learning trajectories, careers)?
- How can museums link effectively with other parts of a learning ecosystem (including libraries, websites, science blogs, social media) while not assuming that every learner has prior experience or access to these? How do learners navigate among these resources and how do they generate appropriate media literacy to be able to synthesize, apply, and evaluate what they learn?
- How do exhibit-designers and museum educators learn and grow in their professional trajectories, and how can they find and use research results effectively?

The LSIE report identifies a number of additional areas for future research about the learning experience in more depth. Among these are:

- Creating valid assessments of the strands (especially 1 and 6), especially across settings and time
- Longitudinal tracking of learners across settings and experiences
- Supporting learners from non-dominant groups
- Identifying specific tools and practices that contribute to learning

In all cases, the report emphasizes the importance of using ecologically valid assessments, i.e., those that do not undermine the fundamental nature of the museum as a free-choice, contingent, social leisure experience.

Contemporary research tools

One of the current drivers of research on learning in museums is the increasing availability of tools and technologies to gather, synthesize, and analyze new forms of data. These include:

- Data streams: mobile eye-tracking, facial expressions, tracking software
- Analysis: web analytics, semantic analysis, qualitative analysis, social network analysis
- Video: wide-angle or targeted, recording and analysis tools

In particular, I would argue that the pervasive use of video data has been transformative in the Exploratorium's visitor research. While the main challenges (technical issues, especially audio quality, and ethical issues regarding protection of human subjects) are complex and challenging, the rewards are substantial. Video has supported very detailed analysis of learning processes at short timeframes, as well as the creation of new assessments (such as measures of collaboration or coherence in group activity). Even more powerfully, it has the capacity to serve as a powerful bridge between research and practice: Viewing video in the context of exhibit development forces different members of a design team to align meaning as they identify desirable and less desirable learning behaviors.

References and Resources

Friedman, A. (Ed.). (2008). *Framework for Evaluating Impacts of Informal Science Education Projects*. Washington D.C.: National Science Foundation.

National Research Council (2009). *Learning Science in Informal Environments: People, Places, and Pursuits*. Committee on Learning Science in Informal Environments. Washington, DC: The National Academies Press.

Simon, N. (2010). *The Participatory Museum*. Santa Cruz, CA: Museum 2.0.

For Exploratorium Visitor Research studies and projects

www.exploratorium.edu/partner/evaluation.html

For resources related to informal science education research & evaluation

www.informalscience.org

For museum visitor studies

www.visitorstudies.org

For informal science education resources, community discussions and white papers

www.caise.insci.org

For exhibit community discussions

www.exhibitfiles.org

For brief summaries of current peer-reviewed research relevant to informal science education

www.research2practice.info

For contemporary work in online museum communities and resources

www.museumsandtheweb.com