Informal STEM Education 101: What We Know and Don't: The State of the Art on Research on Outcomes in Informal STEM Education

April 28, 2016
STEM LEARNING AND OST

@BronwynBevan, University Of Washington
Lifelong and Lifewide Learning

16 Waking Hours

- 0-5K
- GR 1-12
- UG GRAD
- WORK
- RETIREMENT

Formal Learning Environments:
- 9.25%
- 18.5%

Informal Learning Environments:
- 7.7%
- 5.1%
Learning Ecology

- school
- neighbors and friends
- afterschool
- family
- library
- museum
- career role models and possibilities
- home
- faith-based institution
- cultural values
- summer camp
- mass media
- parks
- job

Research+Practice Collaboratory. 2015
## WHAT IS OUT-OF-SCHOOL TIME STEM LEARNING?

<table>
<thead>
<tr>
<th>Everyday Learning</th>
<th>Self-Directed Learning</th>
<th>Structured, Supervised Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home/Family</td>
<td>On-Line</td>
<td>Afterschool Programs</td>
</tr>
<tr>
<td>Community</td>
<td>Radio, TV, Film Museums</td>
<td>Weekend Classes</td>
</tr>
<tr>
<td>School Yard</td>
<td>Books/Libraries</td>
<td>Summer Camps</td>
</tr>
<tr>
<td>Social Media</td>
<td>Hobbies, Clubs</td>
<td>Internships</td>
</tr>
<tr>
<td>On-the-Job</td>
<td></td>
<td>Clubs</td>
</tr>
</tbody>
</table>
**WHAT IS OUT-OF-SCHOOL TIME STEM LEARNING?**

<table>
<thead>
<tr>
<th>Everyday Learning</th>
<th>Self-Directed Learning</th>
<th>Structured, Supervised Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home/Family</td>
<td>On-Line</td>
<td>Afterschool Programs</td>
</tr>
<tr>
<td>Community</td>
<td>Radio, TV, Film</td>
<td>Weekend Classes</td>
</tr>
<tr>
<td>School Yard</td>
<td>Museums</td>
<td>Summer Camps</td>
</tr>
<tr>
<td>Social Media</td>
<td>Books/Libraries</td>
<td>Internships</td>
</tr>
<tr>
<td>On-the-Job</td>
<td>Hobbies, Clubs</td>
<td>Clubs</td>
</tr>
</tbody>
</table>

**SOCIAL AND INTEREST-DRIVEN**
**WHAT IS OUT-OF-SCHOOL TIME STEM LEARNING?**

<table>
<thead>
<tr>
<th>Everyday Learning</th>
<th>Self-Directed Learning</th>
<th>Structured, Supervised Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home/Family</td>
<td>On-Line</td>
<td>Afterschool Programs</td>
</tr>
<tr>
<td>Community</td>
<td>Radio, TV, Film</td>
<td>Weekend Classes</td>
</tr>
<tr>
<td>School Yard</td>
<td>Museums</td>
<td>Summer Camps</td>
</tr>
<tr>
<td>Social Media</td>
<td>Books</td>
<td>Internships</td>
</tr>
<tr>
<td>On-the-Job</td>
<td>Hobbies, Clubs</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>50M PK-12 Youth</th>
<th>50M PK-12 Youth</th>
<th>20M? Youth</th>
</tr>
</thead>
<tbody>
<tr>
<td>50M PK-12 Youth</td>
<td>50M PK-12 Youth</td>
<td>20M? Youth</td>
</tr>
<tr>
<td>10M=6M 4-H, 4M B&amp;G Clubs</td>
<td>10M=9M the Y, 1.6M 21CCLC</td>
<td>10M?=Museums, Libraries, Nature Centers, Community Programs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social Policies</th>
<th>Cultural Policies</th>
<th>Educational Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FIG. 4. Family enrichment expenditures on children

Annual expenditures per child

<table>
<thead>
<tr>
<th>Year</th>
<th>Poorest 20% of families</th>
<th>Richest 20% of families</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972-73</td>
<td>$883</td>
<td>$3,740</td>
</tr>
<tr>
<td>2005-06</td>
<td>$1,391</td>
<td>$9,384</td>
</tr>
</tbody>
</table>

Author’s calculations are based on data from the Consumer Expenditure Surveys. Expenditure patterns vary across families and include child care. Books, fees for sports activities and equipment, and summer camp enrollment fees are examples of common “child enrichment” expenditures. Amounts are in 2012 dollars. Reprinted with permission from Whither Opportunity? © 2011 Russell Sage Foundation.
RESEARCH JOURNALS AND SYNTHESSES

National Research Council Consensus Studies

Peer-Reviewed Journals
• Learning develops across settings and over time
  (National Research Council, 2002)

• STEM learning is best accomplished through firsthand
  engagement in STEM practices
  (National Research Council, 2012a)

• 21st c skills promote deeper learning
  (National Research Council, 2012b)
HIGH QUALITY STEM LEARNING IN AFTERSCHOOL (NRC, 2015)

• Provides first-hand experiences with phenomena, concepts, and practices that are both intellectually and socio-emotionally engaging.

• Recognizes and leverages/builds on young people’s interests, prior experiences, and cultural resources (which vary across communities).

• Actively makes connections to STEM ideas and experiences in school, at home, and in future learning and work opportunities (which vary across communities).
GET City (Boys & Girls Club)
Calabrese Barton & Tan, 2010
IMPLICATIONS OF RESEARCH

• OST sector is a powerful resource waiting to be tapped, serving 10-15M youth/year, and primed to expand STEM education.

• Robust STEM learning ecologies contain multiple, varied, and locally adapted programs that can address all students’ interest and needs as they change, evolve, and fluctuate over time.

• To broaden participation in STEM, communities need to actively ensure that students from low income communities have access to responsive, engaging OST STEM. And there is a need to actively broker/connect youth to additional ongoing learning opportunities.
REFERENCES


Contact: bronwynb@uw.edu

Bronwyn Bevan, University of Washington
STEM EDUCATION COALITION
POLICY • FORUM
Science Technology Engineering Mathematics
Informal STEM Education 101: Connecting Research & Practice in Informal STEM Education

James Bell
Project Director
Center for Advancement of Informal Science Education (CAISE)

This material is based upon work supported by the National Science Foundation (Award Nos. DRL-0638981 / DRL-1212803). 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.
Convene

Connect

Characterize

Communicate

CAISE
InformalScience.org is a central portal to project, research and evaluation resources designed to support and connect the informal STEM education community in museums, media, out-of-school and a growing variety of learning environments.
6,622 Free Resources

- Research Resources: 4,054
- Project Descriptions: 1,982
- Evaluation Reports: 848
STAR LIBRARY EDUCATION NETWORK: A HANDS-ON LEARNING PROGRAM FOR LIBRARIES AND THEIR COMMUNITIES

Date: Wednesday, September 15, 2010 to Saturday, August 21, 2011

Resource Type: Project Descriptions

Environment Type: Public Programs, Library Programs, Professional Development, Conferences, and Networks, Professional Development and Workshops, Resource Centers and Networks, Exhibitions, Library Exhibits

Audience: Elementary School Children (6-10) | Middle School Children (11-12) | Families | Museum/ISE Professionals

discipline: Engineering | Geoscience and geography | Technology

Organization: Space Science Institute

Description of Abstract: The STAR Library Education Network, a hands-on learning program for libraries and their communities, (STAR, Not for short) is led by the National Center for Interactive Learning (NCI) at the Space Science Institute (FSI: Paul Dusenbrey), STAR stands for Science-Technology. Activities and Resources. Team members include NCI staff, the American Library Association (ALA), Lunar and Planetary Institute (LPI), and the National Geos Collaborative Project (NSCP). STAR, Net is developing two comprehensive, informal education programs: Discover Earth and Discover Tech. The project also includes a comprehensive evaluation plan and a research component that explores how public libraries can serve as a STEM learning center in rural, underserved communities. STAR, Net is supported through a grant from the National Science Foundation. The STAR, Net project includes two traveling library exhibits: Discover Earth: A Century of Change and Discover Tech: Engineers Make a World of Difference. The Discover Earth exhibition features interactive, multimedia displays that allow exhibit visitors to interact with digital information in a dynamic way, encouraging new perspectives on our planet. Discover Tech introduces the many extraordinary ways that engineers solve problems to help people and societies around the world. Similar to a science center experience, visitors and families will be able to explore and interact with their own engineering solutions. A number of STEM activities and resources will be developed by project staff and by other organizations to help librarians and community partners offer a wide variety of programs for their patrons. Besides the traveling exhibits and programs, STAR, Net also includes library staff training (online and in person) and a Community of Practice (CoP) for libraries (including non-host librarians) to interact and partner with STEM professionals and organizations. NCT’s Kate Haley Goldman and staff from Evaluation and Research /Associates are conducting the project’s evaluation.

Project Website: http://community.starlibrarynetwork.org/

Funder(s): NSF

Award Number: 1010844

Funding Amount: 2495335

PROJECT PRODUCTS

• Poster - STAR Library Education Network (STAR_Net)

• Public Libraries as Places for STEM Learning: An Exploratory Interview Study with Eight Librarians

• STAR_Net Summative Evaluation Report

• Spotlight: Star_Net

• Star_Network Presentation
<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
<th>Audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Youth Access &amp; Equity in ISL</td>
<td>How can researchers and practitioners work collaboratively with youth to create more equitable ISE environments and settings?</td>
<td>Youth from Underrepresented Groups, Researchers, Practitioners</td>
</tr>
<tr>
<td>STAR Library Network</td>
<td>In what ways do libraries serve as an environment for STEM learning?</td>
<td>Youth, especially rural regions</td>
</tr>
<tr>
<td>Synergies</td>
<td>How do a variety of informal STEM experiences influence urban youth over time?</td>
<td>Urban youth</td>
</tr>
<tr>
<td>Activation Lab</td>
<td>What interests, skills, and knowledge do children need to succeed and persist in future STEM experiences?</td>
<td>Youth</td>
</tr>
<tr>
<td>California Tinkering Afterschool Network</td>
<td>What does STEM-rich, equity-oriented tinkering look like in out-of-school settings, and what kinds of professional learning is needed to support it?</td>
<td>Youth, Practitioners</td>
</tr>
</tbody>
</table>
Documentation from the NSF AISEL PI Meeting 2016

February 29 - March 2, 2016
CISE hosted the 2016 NSF AISEL Principal Investigator Meeting on February 29th - March 2nd, 2016. Slides and documentation are now available...

Access Peer-Reviewed Literature

Available Free to Site Members
Access peer-reviewed articles from thousands of learning research journals through EBSCO's Education Research Complete database, available to logged-in members of InformalScience.org...

Scientists and Public Engagement

Resources for Broader Impacts
Informal STEM Education networks and organizations have developed resources and expertise to help the STEM research community design and evaluate outreach, engagement and broader impacts activities.
RESEARCH AGendas

Across the field of informal STEM education, agendas are emerging to guide research, support innovative interventions, and to understand, share, and scale successful practice. These agendas are often roadmaps to identify and prioritize possible research directions and questions, and reflect the field’s ongoing evolution to connect research and practice. Agendas are typically developed through intensive and inclusive processes involving reviewing current literature, convening experts, summarizing current findings, identifying gaps in evidence, and iteratively vetting the agenda with the broader field.

Current Research Agendas

21st Century Natural History Learning

Institutions that support natural history learning are mobilizing internationally to explore how they can support learning for the “21st Century naturalist”. In the US, the Smithsonian led the development of a learning research agenda with input from educators, scientists, evaluators, and learning researchers. The Natural History Museum London and Kings College London have also launched a series of meetings to develop a research agenda for the UK. The US and US agenda converged on highly similar themes to guide the field into the 21st century.

Priority Areas for Research and Practice

- Understanding and facilitating stronger two-way communication between experts and the public. (Identified in both the US + UK processes)
- Understanding the affordances and value of collections and authentic objects for learning. (US + UK)
- Domains of knowledge that are core to natural history learning: evolution, biodiversity, sustainability, and science process skills such as observation, comparison, modeling, visualization, etc. (US + UK)
- Developing and deploying innovative facilitation and mediation of natural history learning that leverage social practices, collections, social media, digital technology and more. (US + UK)
- Helping to create a broader field of natural history learning by exploring connections between learning, organizational change, and the broader learning ecologies in which our institutions exist. (US only)
- Understanding the needs, resources, and interests of the wide variety of audiences who come to natural history settings. (UK only)

Related documents:

- Summary of the US Agenda Process: A Research Agenda for Learning in Natural History Settings

Zoos and Aquaria

This evolving framework provides an opportunity for all AZA-accredited institutions and independent researchers to become involved in social science research and to work collaboratively in order to enhance the impact of zoos and aquariums and the conservation field as a whole. It also provides a structure for individual institution and multi-institutional studies to be interpreted in the larger picture of what is known about zoos and aquariums, their visitors, and their community relationships.

The overarching questions below are designed to facilitate the synthesis of information that is useful for end accessible to researchers, educators, marketers, administrators, and other stakeholders:

- What Role do Zoos and Aquariums Play in Lifelong Learning Experiences?
KNOWLEDGE BASE

The Knowledge Base (formerly the ISE Evidence Wiki) is a collaboratively generated resource designed to streamline access to and share evidence about the impacts of informal STEM learning on a range of audiences in a variety of settings. Articles in the Knowledge Base are intended to be evidence-supported claims that can be referenced when developing proposals or "making the case" for a strategy or approach to funders and stakeholders, as well as to see what is known and emerging in the field.

Are you interesting in contributing to the Knowledge Base? Contact caise@informalscience.org in order to edit existing articles or to create new ones.

Search our knowledge base. Select from one of three categories below.

SUBJECTS | AUDIENCES | EXPERIENCES & SETTINGS

Results

Adult Informal Science Education Programs

There are a variety of informal science education programs that target adult learners. These programs exist along a continuum from casual drop-in programs (e.g., 1-2 hour workshops or lectures on...

ISE 101, Ecosystems of STEM Learning

Affective experiences are an important part of informal science education

Fun, excitement, pleasure, enjoyment, delight, laughter, wonder, joy are all emotional states that many informal science educators desire learners to associate with science learning. Yet in formal...

Broadcast Media & Film

Broadcast Television and STEM Learning

Broadcast television offers a variety of ways to present STEM-content and informal science education programming to public audiences. The educational program "Watch Mr. Wizard" (NBC 1951-1965)...

Children (5-12) | Broadcast Media & Film, Games & Cyberlearning, Online & Mobile Technology | Ecosystems of STEM Learning

Children learn more across multiple types of media and ISE experiences

Numerous research studies have demonstrated that educational media can produce significant STEM learning among children. Viewing of educational television has been found to contribute to children's...
EVALUATION

Evaluation is a set of approaches and tools that gather evidence about the effectiveness or worthiness of a program or project. Evaluation generally provides information and evidence to demonstrate whether or not this initiative is meeting its goals, needs, and support the decision of a larger group. Evaluation can inform decisions about its design, development, and implementation. Many groups or individuals engage with evaluation and need to understand how it can be used.

When evaluating informal STEM educational programs, three types of evaluation are often considered: formative, summative, and summative. Formative evaluation occurs during the project planning process. It often takes the form of audience research as it gathers data about the knowledge, interests, needs, and experiences of the intended audience. Summative evaluation occurs during the development process by gathering data about a project’s strengths and weaknesses that can be used to make improvements. Summative evaluation occurs during the project planning process. It often takes the form of audience research as it gathers data about the knowledge, interests, needs, and experiences of the intended audience. Formative evaluation guides project improvement during the development process by gathering data about a project’s strengths and weaknesses that can be used to make improvements. Remedial evaluation is carried out when a finished exhibition or program first opens to see how all the individual components work together as a whole. The purpose is to see if any small changes need to be made before beginning summative evaluation, which focuses on a project’s overall effectiveness and impact. Summative evaluation is particularly important in making decisions about continuing, replicating, or terminating a project.

How is evaluation different from research?

The primary purpose of evaluation is to assess or improve the merit, worth, value, or effectiveness of a program or project and to advance the field (in this case, informal STEM education) by deriving lessons for funders, policymakers, or practitioners. Evaluation studies are typically conducted for clients and in collaboration with various stakeholders who are invested in improving or assessing a particular program, project, or activity. In contrast, educational research is typically designed to study a characteristic of learning grounded in an academic discipline such as psychology or sociology, or to study a particular theoretical framework. Research traditionally is geared toward knowledge generation for the larger field.

Want to learn more about evaluation?

You’ve come to the right place! This site includes a wide range of resources that will help individuals learning about evaluation as well as those with many years of evaluation experience under their belts. To start, check out Chapters 1 and 2 of the Principal Investigator’s Guide to Managing Evaluation in Informal STEM Education Projects for a more detailed introduction to evaluation and stories from practitioners about the interplay between evaluation and project implementation. We’ve also gathered a collection of some great guides and handbooks that provide overviews of evaluation as well as detailed guidance for carrying out an evaluation. Other links on this page will take you to information on choosing and working with an evaluator, developing an evaluation plan, locating evaluation tools and instruments, reporting and disseminating evaluation findings, and understanding where the informal STEM evaluation field is headed. See what we have learned from evaluation and research in these summaries.
What are we studying?

competency  peer-relationships  aspirations  efficacy
knowledge-of-nature-of-science  behavior
interest
engagement
values  beliefs
opportunity
expertise  sense-making
adult-relationships  stewardship
critical-thinking  encouragement
participation  fascination
inquiry-skills  perseverance
motivation

JBell@ASTC.org
@InformalScience
From 2015-2016

Session Visits: 100,042
Users: 66,040
Newsletter Subscribers: 6,704
InformalScience.org Rated Highly by NSF AISL PIs

- Uniqueness of resource offered: 91%
- Quality of content: 91%
- Usefulness of to me or my work: 87%
- Comprehensiveness of content: 86%