Learning Science In Informal Environments: People, Places, and Pursuits

Final Report of the NRC Committee on Learning Science in Informal Environments

Summary slides

Report formally released 14 January 2009

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Advisers to the Nation on Science, Engineering, and Medicine

National Academy of Sciences
National Academy of Engineering
Institute of Medicine
National Research Council

DISCLAIMER!!

- This talk is a summary, necessarily abbreviated. The formal consensus findings and recommendations are those in the NRC report, available at

- http://www7.nationalacademies.org/bose/Learning%20Science%20in%20Informal%20Environment.html

Presentation Outline

- Context
- Study overview
- Fact finding
- Report structure
- Conclusions
- Recommendations

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Context

- 100+ years of science comm
- 50+ years of "science literacy" studies, NSF-funded outreach, "public understanding of science" (largely) "deficit model" activities
- 40+ years of science centers
- 1985, "Bodmer Report" in UK
- 1990s, development of "public engagement" model
- 1990s, development of "learning sciences"

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Study basics

- NSF funded
- 30-month NRC consensus study
- 5 committee meetings
- Related NRC studies:
  - *How People Learn (2000),* and *Taking Science to School (2007)*

Committee areas of expertise

- Research and evaluation of learning in informal settings
- Educational design and curriculum development
- Cognition and development
- Science & science education
- Science media and technology
- Youth development / Out-of-school time
- Cross-institutional connections:
  - Schools and informal
  - Community development and informal
  - Career development and informal

Committee members

Philip Bell, Co-Chair
University of Washington

Bruce Lewenstein, Co-Chair
Cornell University

Sue Allen
Exploratorium

B. Bradford Brown
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Maureen Callanan
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The Franklin Institute

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Northwestern University

Vera Michalchik
SRI International

Gil Noam
Harvard University

Brian K. Smith
Penn State University

Study charge

- Theoretical perspectives, assumptions, and outcomes

- Evidence of learning outcomes for participants of all ages and cumulatively over time

- Features of effective environments; Commitments that are shared between formal and informal environments

Study charge, cont'd

- Unique features of informal environments (e.g., potential to reach populations that have been poorly served by schooling)

- Guidance to policy and practice

- Research agenda

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Fact finding

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Meeting topics and presenters (slides available online)

Where is the field now:

Jon Miller - Sheila Grinell -George Hein - Lynn D. Dierking

Previous informal science learning initiatives

Kirsten Ellenbogen - John Falk - Shalom Fisch - Laura Martin

Perspectives on LSIE

Maureen Callanan - Ann Renninger - Karen Knutson - Kevin Dunbar

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Meeting topics and presenters (cont.)

Diverse Learners
Margaret Eisenhart - Kris Gutierrez - Vera Michalchik - Leslie Goodyear

Venues and configurations for LSIE
Deborah Perry - Bonnie Sachatello-Sawyer - Saul Rockman

Informal-science policy
Christine Klein - Bronwyn Bevan - Elizabeth Reisner
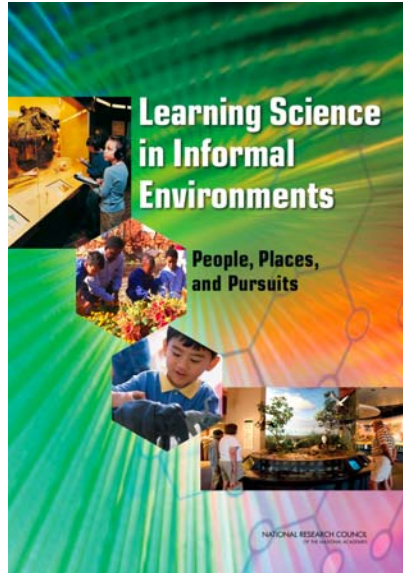
Evaluation of LSIE
Martin Storksdieck - Lynn D. Dierking

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Commissioned papers (online)

- **Evaluations of LSIE** - *Institute for Learning Innovation*
- **Interest and Motivation** - *K. Ann Renninger*
- **Native Science and LSIE** - *Bryan Brayboy and Angelina Castagno*
- **Diverse Learning and Learner Diversity** - *Shirley Brice Heath*
- **Assessing Learning in LSIE** - *Michael Brody, Arthur Bangert, Justin Dillon*
- **Older Learners and LSIE** - *Casey Lindberg, Edwin Carstensen, and Laura Carstensen*
- **Media and LSIE** - *Saul Rockman, Kristen Bass, Jennifer Borse*
- **After School and Adult Programs** - *Sarah Schwartz and Gil Noam*

Reflections on the literature base

- 1200+ citations
- Several distinct bodies of literature
- "Gray" literature
- Varied standards of evidence

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Learning Science in Informal Environments

People, Places, and Pursuits

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Report structure

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Report outline

- Introduction
- Theories
- Assessment
- Evidence Across Venues
  - Everyday Learning Environments
  - Designed Environments
  - Programs for Children and Adults
- Cross-Cutting Themes
  - Media
  - Diversity
- Conclusions and Recommendations

6 "strands" of science learning

Learners in informal environments. . .

1: Experience excitement, interest, and motivation to learn about phenomena in the natural and physical world.

2: Come to generate, understand, remember, and use concepts, explanations, arguments, models and facts related to science.

3: Manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world

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6 strands, continued

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.

5: Participate in scientific activities and learning practices with others, using scientific language and tools.

6: Think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science.

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Link w/K-8 school science learning strands

1. Experience excitement, interest, motivation
2. Understanding scientific explanations
3. Generating scientific evidence, explanations and arguments
4. Reflecting on how science knowledge is produced and used in society
5. Participating in the practices of science — specialized talk, disciplinary tool use, representations
6. Develop identity in science

Important ideas in the strands

- Connection to learning in formal environments
- Unique affordances of informal environments & complementarities
- Broad learning → Broad assessments

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Conclusions

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Topics

- Learners and learning
- Informal environments
- Promoting learning
- Informal environments & K-12 schools
- Advancing the field

Learners and learning

Conclusion 1: Across the life span, from infancy to late adulthood, individuals learn about the natural world and develop important skills for science learning.

Conclusion 2: A great deal of science learning, often unacknowledged, takes place outside school in informal environments—including *everyday activity*, *designed spaces*, and *programs*—as individuals navigate across a range of social settings.

Conclusion 3: Six strands of learning science in informal environments

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LIFELONG AND LIFEWIDE LEARNING
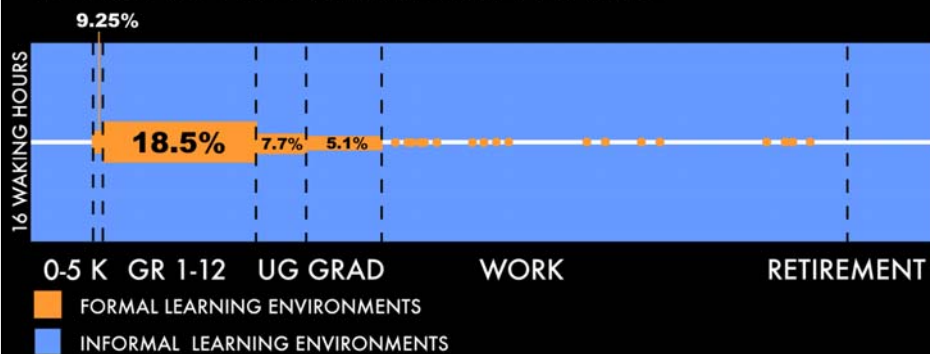
Life-Deep Learning embraces religious, moral, ethnical, and social values that guide what people believe, how they act, and how they judge themselves and others. Learning, development, and education are deeply grounded in value systems operating in society—frequently in implicit ways.

Stevens & Bransford in Banks, et al., *Learning In and Out of School in Diverse Environments*, 2007

Conclusion 4: Members of cultural groups develop systematic knowledge of the natural world through participation in informal learning experiences and forms of exploration that are shaped by their cultural-historical backgrounds and the demands of particular environments and settings. Such knowledge and ways of approaching nature reflect a diversity of perspectives that should be recognized in designing science learning experiences.

Conclusion 5: Learners' prior knowledge, interest, and identity—long understood as integral to the learning process—are especially important in informal environments.

Informal environments

Conclusion 6: Informal environments share common commitments: engage participants in multiple ways; encourage direct interactions with phenomena; provide multifaceted and dynamic portrayals of science; build on learners' prior knowledge and interests.

Conclusion 7: Media can play an important role in facilitating science learning across settings. However, the evidence base is uneven.

Informal environments, cont'd

Conclusion 8: Designers and educators can make science more accessible to learners when they portray science as a social, lived experience, in contexts that are relevant to learners and when they are mindful of diverse learners' existing relationships with science and institutions of science learning.

Conclusion 9: Informal environments can have a significant impact for individuals from nondominant groups who are historically underrepresented in science.

Conclusion 10: Partnerships between science-rich institutions and local communities show great promise for fostering inclusive science learning.

Promoting learning

Conclusion 11: Parents, adult caregivers, peers, educators, facilitators, and mentors play critical roles in supporting science learning.

Conclusion 12: Programs for school-age children and youth (including after school) are a significant, widespread, and growing phenomenon in which an increasing emphasis is placed on science.

Informal environments & schools

Conclusion 13: Currently there are not good outcome measures for assessing the science learning goals of informal settings. Conventional academic achievement measures (e.g., standardized tests of science achievement) are too narrow and not well aligned to the goals of informal providers.

Conclusion 14: Learning experiences across informal environments may positively influence: science learning in school, attitudes toward science, and pursuit of science-related occupations, engagement in lifelong science learning

Advancing LSIE

Conclusion 15: LSIE literature is vast, but the quality of the research is uneven, in part due to limited publication outlets and incentives to publish.

Conclusion 16: Evaluation reports on particular programs provide an important source of evidence that can inform practice and the field more generally. Other kinds of research and data are needed.

Conclusion 17: An interdisciplinary community of scholars and educators share an interest in developing coherent theory and practice of LSIE. There are barriers to reaching this goal.

Conclusion 18: Ecological perspectives on informal environments can facilitate important insights about science learning experiences across venues.

**Recommendations
for practice and research**

Audiences

- Exhibit and program designers
- Front-line educators
- Researchers and evaluators

Exhibit and program designers

- **Recommendation 1**: We propose a set of design principles for informal learning environments. They should:
  - Be designed with specific learning goals in mind (e.g., the learning strands).
  - Be interactive.
  - Provide multiple ways for learners to engage with concepts, practices, and phenomena within a particular setting.
  - Facilitate science learning across multiple settings.
  - Prompt and support participants to interpret their learning experiences in light of relevant prior knowledge, experiences, and interests.
  - Support and encourage learners to extend their learning over time.

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Recommendation 2: From their inception, informal environments for science learning should be developed through community-educator partnerships and whenever possible should be rooted in scientific problems and ideas that are consequential for community members.

Recommendation 3: Educational tools and materials should be developed through iterative processes involving learners, educators, designers, and experts in science, including the sciences of human learning and development.

Front-line educators

Recommendation 4: . . . should actively integrate into science learning experiences, questions, everyday language, ideas, concerns, world views, and histories, both their own and those of diverse learners.

Researchers and evaluators

Recommendation 5: Broaden opportunities for publication of peer-reviewed research and evaluation, and provide incentives for studies to be published.

Recommendation 6: Integrate bodies of research on learning science in informal environments.

Recommendation 7: Researchers and evaluators should use assessment methods that do not violate participants' expectations about learning in informal settings . . . address the science strands . . . provide valid evidence across topics and venues . . . allow educators and learners alike to reflect on the learning taking place in these environments.

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Areas for future research

- Tools and practices that contribute to learning
- Learning strands
- Cumulative effects
- Learning by groups, organizations, and communities
- Supporting learning for diverse groups
- Media