Measuring the Ephemeral

Effective Evaluation of Informal STEM Learning

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caise | center for advancement of informal science education

The mission of the Center for Advancement of Informal Science Education (CAISE) is to support and strengthen the informal science education (ISE) field.

- Leverage NSF's investments in ISE
- Catalyze interactions between NSF and the field
- Facilitate online and in-person connections
- Integrate education infrastructure
- Generate and disseminate resources.

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CAISE core audiences include principal investigators, evaluators and learning researchers, NSF program officers, and researchers, educators, and outreach professionals in the STEM disciplines.

Your centers represent a wonderfully diverse range of informal science education programming

Performances

Summer camp

Themed program days

Afterschool clubs

Cart demonstrations

Holiday lectures

And if we look at the broader field, there's an even greater diversity of informal science education environments. From demonstrations, to field trips, to citizen science, television, radio and blogs, as well as the the massive sectors of 4H and afterschool

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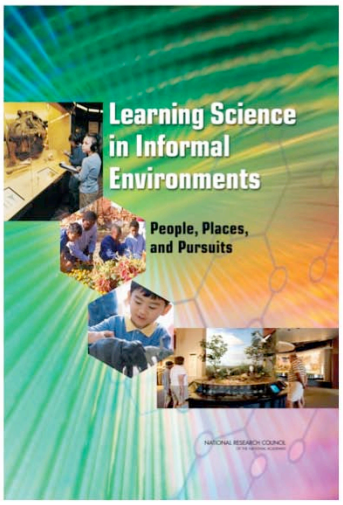
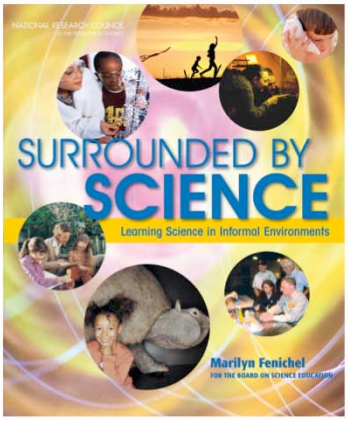
Report





We are a relatively young field. An important resource, among the many discussed today, is that National Academies of Science report on learning in informal science education (also practitioner volume: Surrounded by Science).

Addresses “What counts as learning?” in ISE.

Presents STRONG evidence for six interwoven dimensions of science learning.

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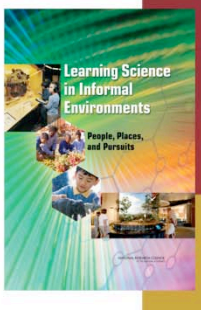
Learning Science in Informal Environments

1. Developing interest
2. Understanding scientific knowledge
3. Engaging in scientific reasoning
4. Reflecting on science
5. Engaging in scientific practices
6. Identifying with the scientific enterprise



Important ideas in the strands:

- Connection to learning in formal environments
- Unique affordances of informal environments
- Broad learning requires broad assessments

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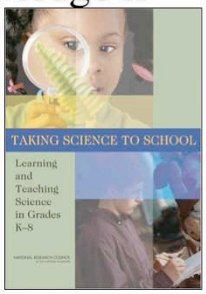
K-8 School science learning strands

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



- Connection to learning in formal environments

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Strand 1: Interest, Motivation

- Dominates conversations
- Dominates descriptions
- Types of play
- Fun AND learning

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

Assumption: exciting experiences→ intrinsically motivated learning

Affective experiences, including excitement, pleasure, awe, delight. They dominate the conversation of museum experiences.

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

Note that "content" is only 1 of the 6 strands.

Some evidence of learning after one visit and of generalizing experiences.

Interpretive labels and environmental cues help.

Evidence that sensory, investigatory activity supports learning.

Conceptual change over time needs more study.

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Strand 3: Reasoning

- Doing and seeing is a pattern
- Pointing out relevant features
- Questioning & predicting; concluding & generalizing

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

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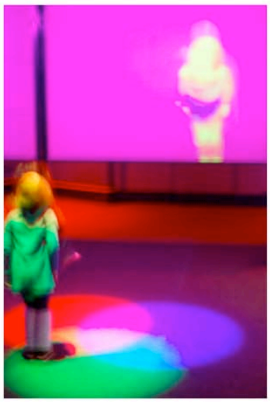
Strand 4: Reflecting



- Encouraging self reflection
- What happens if …
- Try it again, but this time try …

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

Exhibits have focused on content of experience itself; interviews show appreciation and thought.

Self-reflections: many interview studies (cued) show new appreciation following exhibits.

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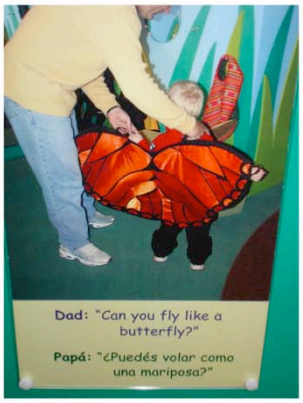
Strand 5: Practices

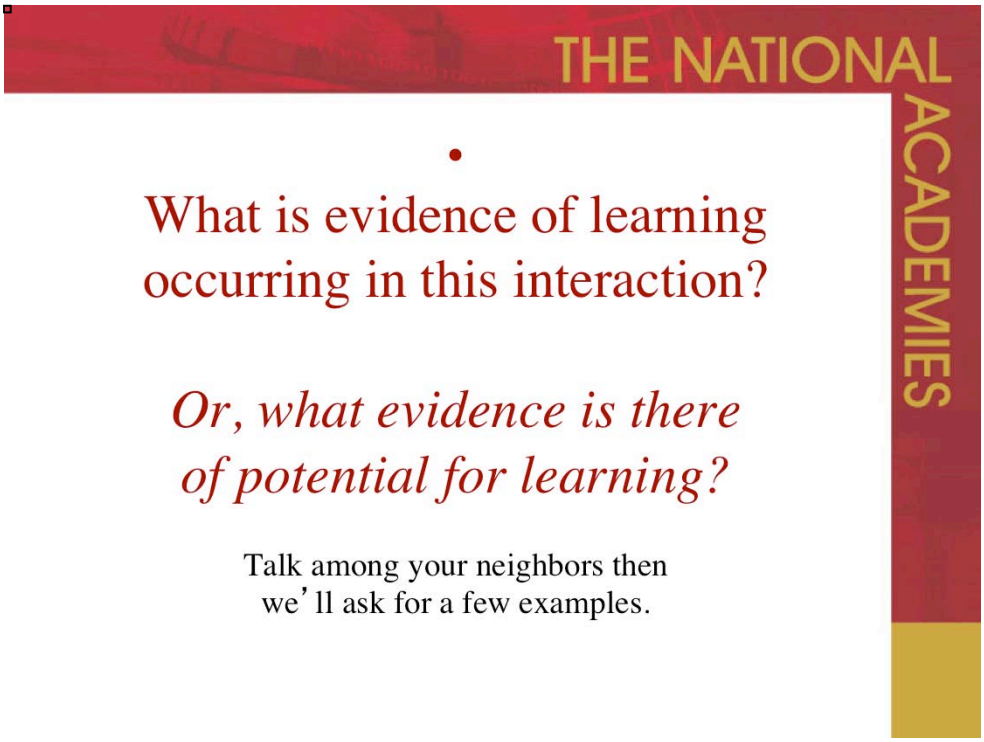


- Language more than other tools
- Specialized talk:
- Social group influences
  - gender
  - level of expertise
  - modeling

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

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

Through experiences in informal environments, people may come to see themselves as capable of doing science, and for young people, considering careers in the STEM fields. For those who do not become professional scientists, it is important that they identify themselves as being comfortable with, knowledgeable about, or interested in science, in order to pursue hobbies, take informed policy positions, or draw on science when it seems to be appropriate.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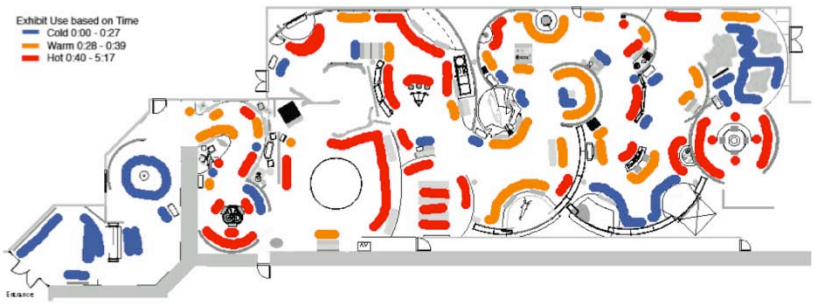
What is evidence of learning occurring in this interaction?
Or, what evidence is there of potential for learning?
Talk among your neighbors then we'll ask for a few examples.

Watch video.

Complex



Challenges

- Cannot separate single experience
- Experimental design is impractical

Opportunities

- Allow wide range of outcomes
- Naturally learner-driven
- Inspires new methods and approaches

Informal learning environments and experiences are complex.

Many are short, isolated, free choice, and self-directed. Often they target heterogeneous public audiences whose members come to the project with unique prior knowledge, interests, and experiences, and individual audience members learn different things, not just different amounts (Friedman 2008).

Challenges:

Separating the effects of a single experience from a variety of other factors that could contribute to positive learning outcomes can be challenging (National Research Council 2009, 2010). This is true with many education interventions but particularly so with informal learning environments.

Establishing uniform evaluation activities, approaches, and methods that do not sacrifice a participant's freedom of choice and spontaneity can be difficult (National Research Council 2009, 2010).

Experimental designs, where participants are studied in both treatment and control groups, may not be practical or the most appropriate method for evaluating many ISE projects. Therefore, conclusively attributing specific outcomes to a set of specific experiences or interventions is a difficult, often inappropriate, task for evaluation in the ISE context (Friedman 2008).

Collaborative & Social

Challenges

- Individual assessment can be difficult

Opportunities

- Helps us better understand how people learn

Many informal learning experiences are collaborative and social.

"Doing well" in informal settings often means acting in concert with others (National Research Council 2010). Participants may be motivated to engage in ISE with the primary goal of having a social experience, considering learning goals secondarily or not at all.

Challenge:

Teasing apart individual assessment from group process and accomplishments, especially in light of unanticipated outcomes, can be difficult (National Research Council 2009, 2010).

Opportunity:

Evaluation in the ISE context helps us better understand socially mediated experiences across family and multi-age groups. These insights add richness and depth to our understanding of how people learn through interaction and conversation, which subsequently helps us to design experiences that better support social interaction.

Diverse Environments & Experiences

Challenges

- Self-articulation is difficult
- Context limits cross-field generalization

Opportunities

- Many flexible evaluation settings
- Invites diverse disciplinary foundations

Informal Science Education environments and experiences are exceptionally diverse.

Audiences, settings, delivery methods, depth, expected outcomes, and other dimensions vary, and experiences may include exhibits in museum environments, television and radio programs, casual investigations at home, or afterschool programs.

Challenges:

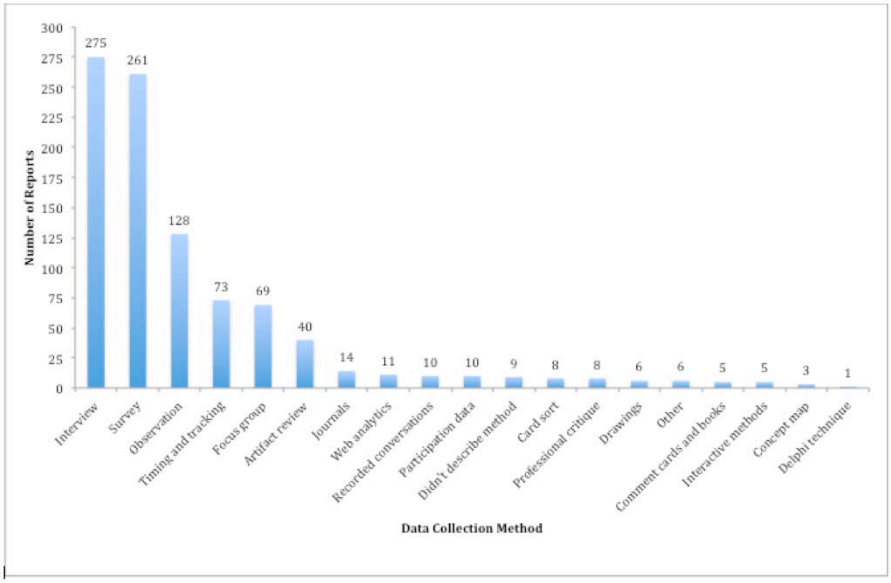
Participants may or may not be able to articulate personal changes in skill, attitude, behavior, or other outcomes at any stage of an informal learning experience. Therefore, evaluators may need to design instruments or other evaluation techniques that do not require or solely depend on self-articulation (Allen in Friedman, 2008).

Connecting the dots between various evaluations to make generalizations about learning or best practices is complicated because of multiple unique contextual factors.

Opportunities:

Many ISE environments allow for nimble and flexible evaluation settings. Especially at museums, visitors are abundant, and most are willing study participants.

Because of the diverse contexts that surround informal learning, ISE evaluation is well positioned to draw on and contribute to theory, knowledge, and methods from a broad array of academic disciplines including psychology, learning sciences, cognitive



Frequency of data collection methods used in the BISE synthesis reports (*n* = 427)

Building ISE project

Analysis of almost 500 evaluation reports posted on informalscience.org

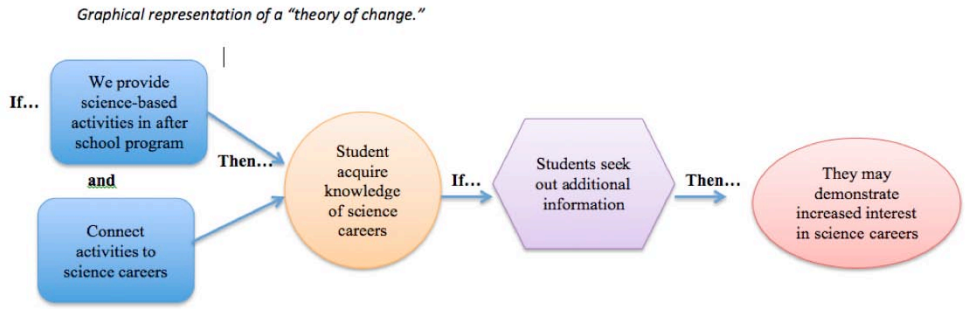
Not surprisingly interviews, surveys dominated methods, but there is quite a diversity

This is appropriate given that method should only be discussed and determined after there is agreement on goals and outcomes. Since ISE outcomes are broad, methods should be too.

Work with your evaluator to make these connections

Targeted Outcome	Evaluation Question	Indicator (include audience)	Data Collection Method	Timeline, Personnel
High school visitors will increase their interest in nanoscience	To what extent does the experience change high school students' interest in nanoscience?	During their visit, high school students will engage their parents in conversation about specific phenomena featured in the program	Observational tracking studies	Three days; Lead evaluator
		High school students in the program will indicate that the experience increased their interest in learning more about nanoscience and/or a related topic.	Interviews with students after the program	Three days; Lead evaluator

A common pitfall when designing evaluations is the instinct to start by identifying preferred evaluation methods, for example, "What I want is a series of focus groups conducted with youth in the science afterschool program" (Diamond 2009). Evaluation planning should begin not by choosing methods but by defining questions that frame what you want to know from the overall study (not questions that might be asked of participants) (Diamond 2009). Then your evaluation questions can guide the choice of data collection methods.



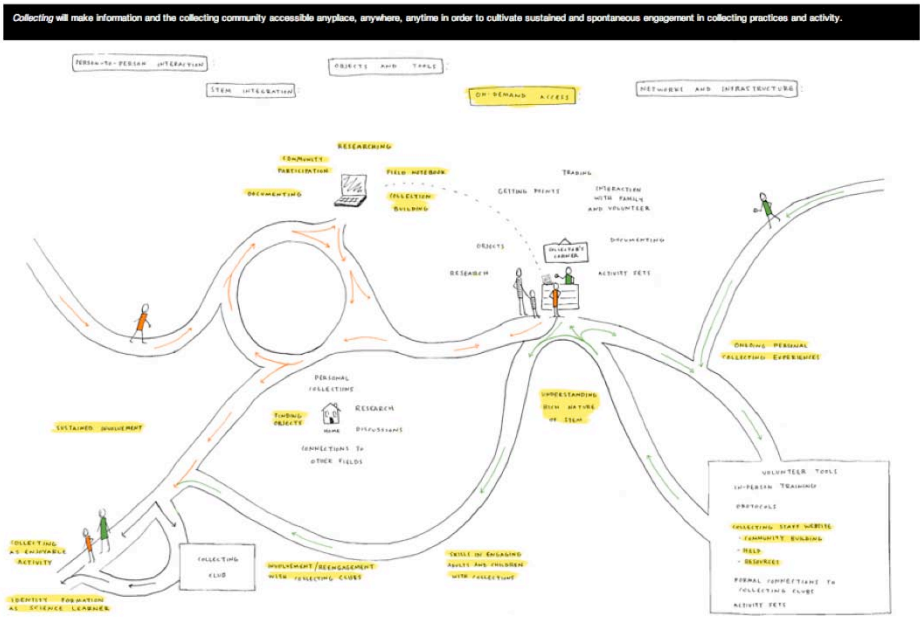
So how do we get better at identifying the outcomes we intend (and don't intend)? Logic models are important, but sometimes difficult to use for broad and varied programming like the MRSEC educational outreach. Look at theory of action (theory of change) as an alternative way to get at this. A theory of action is a statement that describes why the programming or intervention you are offering is likely to lead to the intended outcomes. Typically stated in If-then statements, but does not have to be. They are often illustrated or diagrammed to be sure that the interconnections of the activities are identified.

A formal ed example (admittedly longer than many)

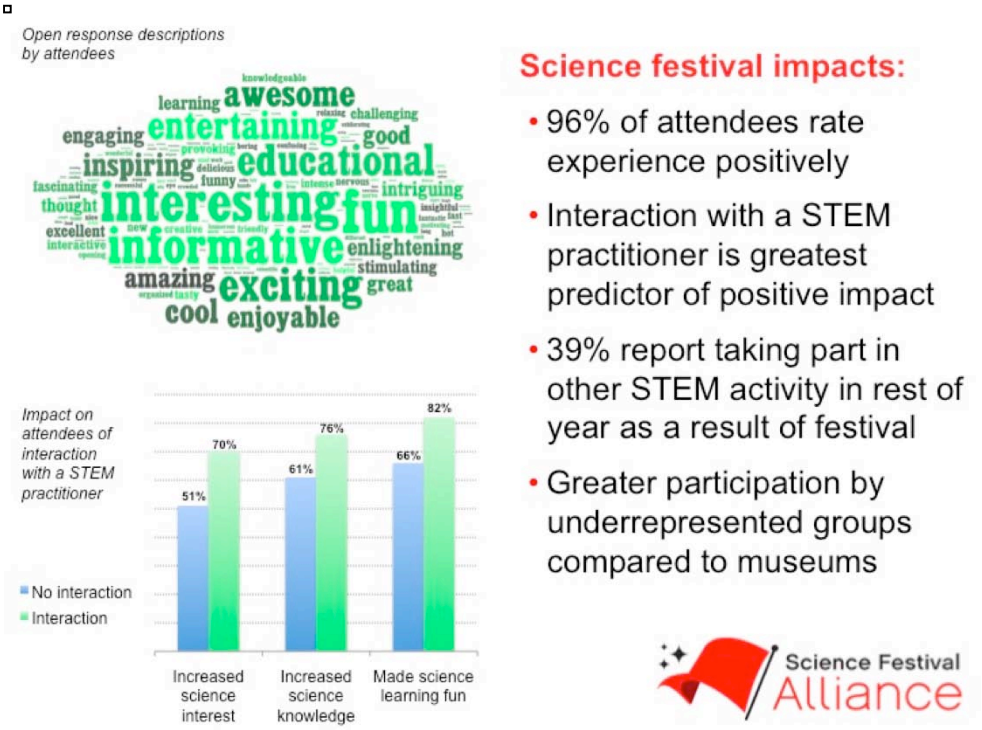
IF we have professional learning communities, THEN we will have a scheduled time for teachers to discuss their work and the work students produce.

And IF teachers share their work and the results with each other, THEN they will be able to learn from each other's successes and draw upon the expertise of their colleagues around common challenges.

And IF teachers draw upon the expertise and successes of their colleagues around common challenges, THEN teachers will be able to incorporate new and successful strategies into their practice with support from their colleagues.



Illustrated example – this is actually a dynamic website – as you click on the concept, the supporting program elements are highlighted.

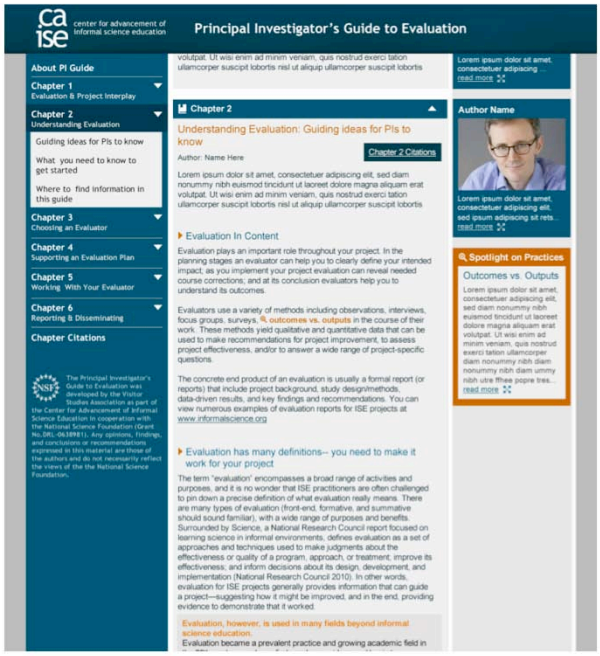


Look to evaluation of Science Festivals as a good example of how to capture the impact of broad ISE programming.

[Ben Wiehe] In the early years of the Science Festival Alliance, a common critique that we heard was "we don't need a once a year party, we need a sustained effort."

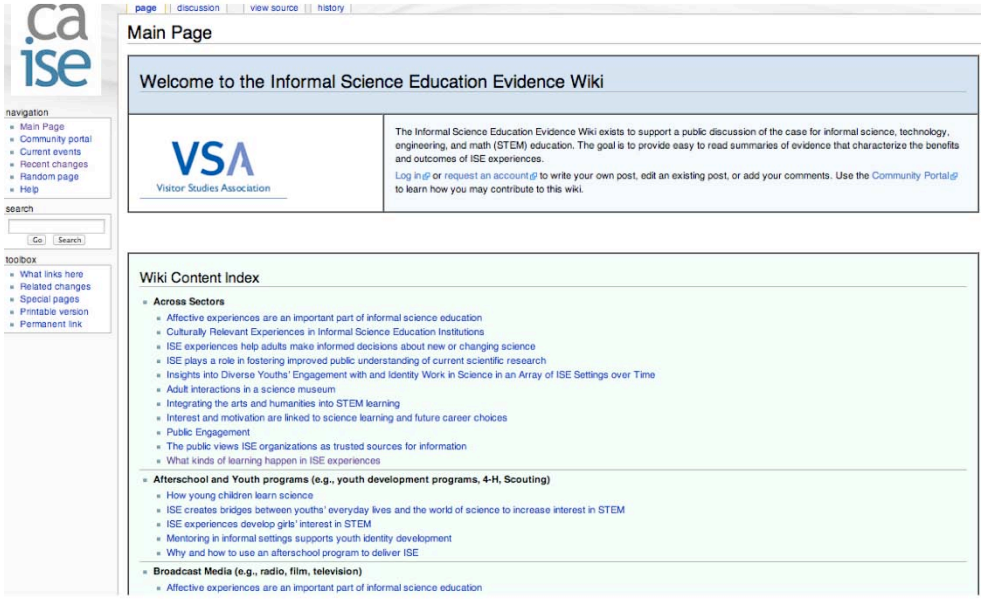
Top image: Close to 2,500 attendees were asked to write three words describing their festival experience. This is word cloud shows the replies, with the size of each word representing the frequency with which it was used.

Bottom image: Survey data from attendees at 46 different science festival events allowed a regression analysis showing that "interaction with a science professional" (described as someone working or studying in a STEM field) was the greatest predictor of learning reported by attendees. Experiencing a hands-on activity was also found to be important, but less so. Other factors, such as race, education, gender, etc. had little to no correlation.



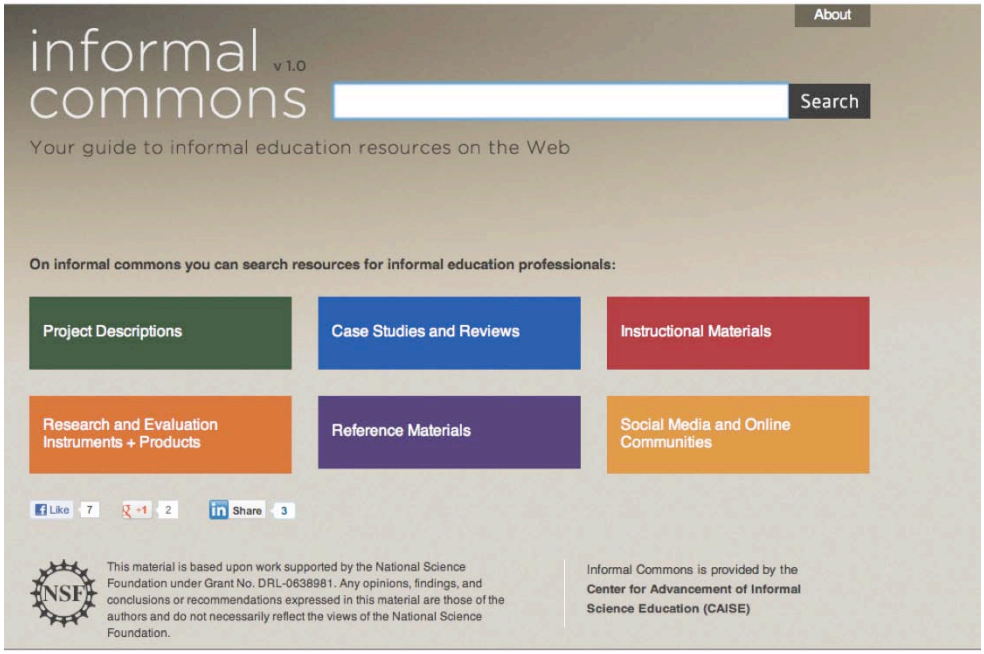
Many new resources created in just the past year

The PIs Guide to Managing Evaluation in ISE Projects (a website) will be launched in mid October. It will be part of caise.insci.org



The ISE Evidence Wiki www.iseevidencewiki.org

The Informal Science Education Evidence Wiki exists to support a public discussion of the case for informal science, technology, engineering, and math (STEM) education. The goal is to provide easy to read summaries of evidence that characterize the benefits and outcomes of ISE experiences.



Informal Commons: informalcommons.org

Searches across all of the informal science websites – great way to make sure you are considering all possible resources, related projects, etc.

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