Hot Topics in Informal Science Education

This is one of a series of documents covering the ISE Summit 2010. For more visit **insci.org**

Sparks!

These illustrated, online posts about informal science education projects appear on the CAISE Web site, contributing to a picture of the field.

http://insci.org/sparks

http://www.nsf.gov

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Documentation
Catherine McEver
The Bureau of Common Sense

This document is intended to be a faithful synthesis of one session that took place at the Informal Science Education Summit 2010, *Surrounded by Science*, In Washington, D.C. March 3-5. It is meant to serve as a resource for those who attended and for others in the field.

Participant comments have been paraphrased and reordered. These are not exact quotes, rather they are an attempt to capture the content and meaning of the ideas presented. The contents of this document do not necessarily reflect the views of CAISE, the National Science Foundation, or individual meeting participants.

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Hot Topics in ISE

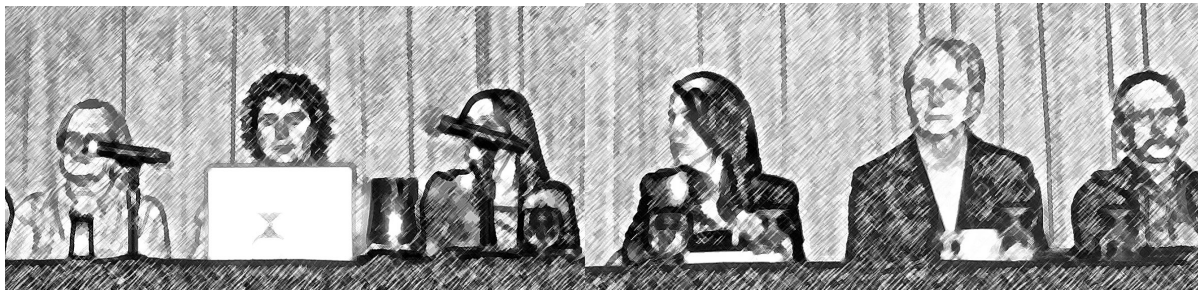
Introduction

Al DeSena
Program Director, Informal Science Education, Division of Research and Learning, National Science Foundation

I'd like to continue in my role of offering a transition from one part of the summit program to another. In my earlier comments I mentioned something about the diversity of the NSF staff in the Informal Science Education program. That diversity reflects the range of skills that we need because of the diversity of what we deal with, which is what you bring to us. There are so many kinds of projects that this program is involved with that it has to call on the deep and wide experience of a wide range of folks. I also mentioned that the proposals that we are getting now are mixing and matching in ways such that there is no one of us who has the expertise to be able to handle all of the facets of the notions that you present to us. That means that among our fourteen program officers there is quite a bit of collaborating that has to occur. So again, we both reflect the field as well as prod the field, and this conference is part of that prodding process.

One of the things that occurs to me is that in the proposals we are seeing that are mixing and matching, so many different dimensions are being driven by the things that you consider important. The drivers of those are so numerous that we won't have time to get into all of them, though we will be hearing examples of some of them. There is a tremendous amount of convergence that we see, some of it driven by digital media. There is also a blurring of the boundaries going on, some of which has been happening for a long time in terms of formal and informal education. We know the story is not done there. Other blurring of the boundaries has occurred between education and information and communication, as we heard in Bruce Lewenstein's presentation, or between the boundaries of education, communication and entertainment.

Al DeSena (at podium) and Edward Maibach



From left:
Sue Ellen McCann, Robert Hone, Christine Reich, Bronwyn Bevan, Kali Lightfoot, Rick Bonney

That has been the nature of the field for a long time, and many of the proposals that we see embody those kinds of ideas as they converge, but I think, as many of us know, there is quite a bit more work to do. CAISE provides a way to bring us together more formally, and in a sense pushes us together to have the wonderful kinds of conversations that have been happening at this summit.

I have had the opportunity over the years to look at the literature having to do with creativity and innovation, and there are two critical ideas I'd like to share. One is that to have a good creative idea you need to have a lot of smaller ideas first. You don't have just the one great inspiration, you have many ideas that come together. You also need to have the skills to be able to take that large number of ideas and hone them down to ones that you think are the best.

Related to that, having a lot of ideas is often stimulated by diversity. Diversity is actually a catalyst for generating a number of ideas. That helps create those intellectual connections that we have been talking about throughout the conference, but we have to remember that we are not just in the business of generating ideas, we are in the business of changing the world, right? The impact that we have through new ideas and the collaborative efforts that we are trying to foster here are really important.

This summit is an opportunity to present to you things that you might already have had some glimmer of—through the sessions, the Sparks materials that you have been posting, and particularly through this upcoming session. This session offers a fairly broad representation of projects that will hopefully make concrete many of the ideas that we have been expressing and the state of the field as we see it today.

So think of diversity, think of creative ideas, think of collaboration, think of the challenge and opportunity. Think of bringing new players to the table in terms of infrastructure and learning and policy.

From left: Rick Bonney, Ellen McCallie, Robert Reitherman, Dennis Schatz, Jon D. Miller

Pathways to STEM careers

Jon D. Miller
John A. Hannah Professor of Integrative Studies and Director of the International Center for the Advancement of Scientific Literacy, Michigan State University, East Lansing, Michigan

Informal Science Learning by Young Adults: A Report from the Longitudinal Study of American Youth

http://lsay.msu.edu

My assignment this morning is to introduce to you a study that I have been conducting for the last twenty-two years, following a group of young people who were tenth graders and seventh graders in 1987, and who we have been keeping tabs on and interviewing and getting data from regularly. It is, I think, one of the longest running longitudinal studies of its kind. There have been other, longer ones in medical and other fields, but for people who are looking at the kinds of things we are looking at—education and learning about science—I think it is the longest. It is an NSF-funded project, and NSF has been supporting this since 1986, so we have been at it for a while. Sue Allen, our NSF Program Officer, has been extremely helpful.

We started with a group of seventh graders and tenth graders in 1987, about 3,000 of each from public schools across the country. We followed them initially for a period of seven years very intensively, getting data from them, their parents, their teachers and their principals. We then took a data break and did a number of years of analysis and enrichment of the data set by doing things like geocoding. These students are now 34 to 38 years old. We have been following them for the last twenty years and actually have about 9,000 variables per student, so we know a fair amount about them.

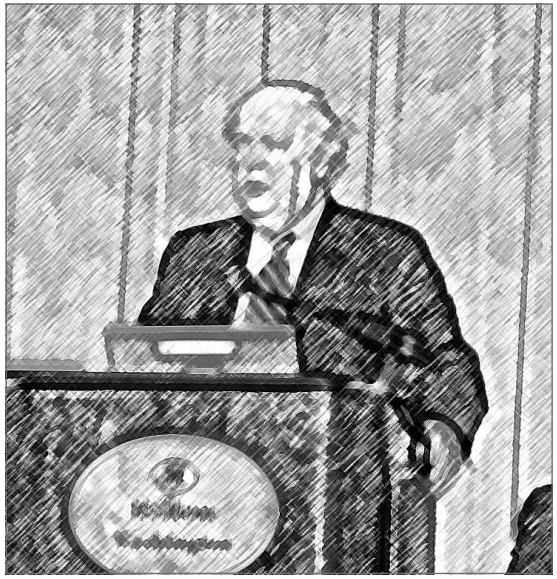
Funded by the NSF, the LSAY is a national longitudinal study of two cohorts of public school students:

- Cohort 1 includes approximately 3,000 10th grade students who were selected in the fall of 1987.
- Cohort 2 includes approximately 3,000 7th grade students who were selected in the fall of 1987.
- Both cohorts were followed for an initial period of 7 years and data were collected from students, parents, teachers, and school principals.
- Data collection was resumed in 2007 and now continues on an annual basis. The original students are now 34-38.

In this last cycle, what we have been focusing on is how they learn through informal science: who goes to Web sites, who goes to museums, and a variety of other venues. What I would like to offer is a preliminary picture of that cycle. There will be much more detail coming in the months ahead, and I'm going to go through this very quickly.

The LSAY was designed to look at attitudes, at achievement scores, at career plans and

Jon D. Miller



The LSAY was designed to study:

- The growth of student attitudes toward and interest in science, mathematics, and technology.
- The growth of student competence in science and mathematics.
- The development of career plans and interests, including interest in careers in science, mathematics, engineering, and related fields.
- And the development of civic scientific literacy and the citizenship skills necessary to understand and participate in the formulation of public policy on issues involving science or technology.

During each of the years that an LSAY student was in middle school or high school, he or she was asked to complete:

- A mathematics achievement test and a science achievement test each fall (usually late September or early October) based on the NAEP item pools.
- A fall and a spring questionnaire that collected information about life goals and plans, courses taken, school activities, out of school activities, and interactions with peers and parents.
- A reading test in the spring of the 3rd year (grade 9 for Cohort 2) using reading items from HSB and NELS88.

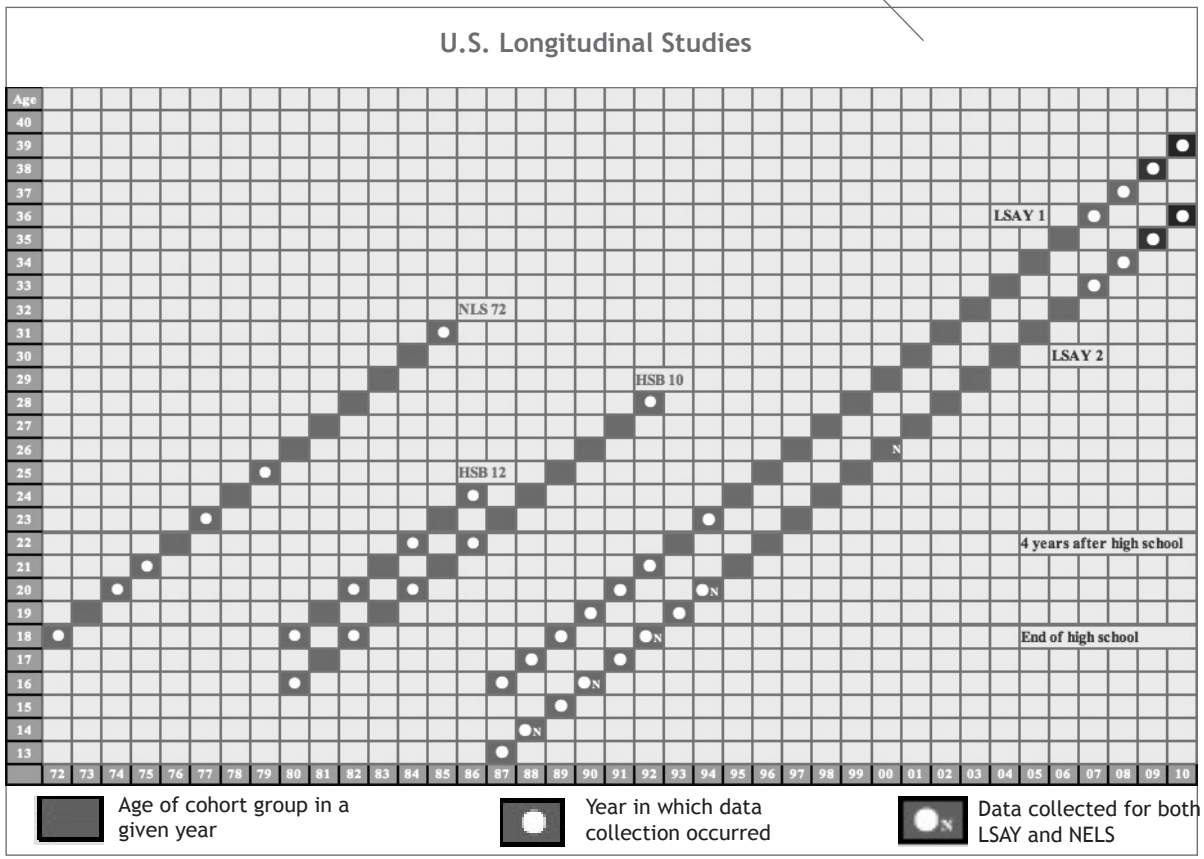
In addition, supplemental data were collected from parents, teachers, and principals.

- One parent of each LSAY student was interviewed by telephone annually during the years that the students were in grades 7 through 11.
- Each mathematics and science teacher who served one or more LSAY students (in the original sample schools) was asked to complete a background questionnaire and a separate questionnaire for each science or mathematics course that included one or more LSAY students.
- A set of questionnaires were completed by the principal of each school periodically and detailed curriculum guides were collected from each school to help classify courses.

interests. We have actually been doing a lot on the latter, and now know who becomes a scientist and who becomes an engineer out of those six thousand kids. It was also designed to look at the development of civic scientific literacy. How do citizens who need to know what a stem cell is figure out what it is and what they ought to do about it?

We also have gotten a good deal of achievement data. We know how well they did in school science and mathematics, we know their attitudes, their life goals, their in-school activities, their out-of-school activities. We also interviewed their parents—one parent a year through their pre-college years. We supplemented that with parent interviews and teacher interviews. We know every textbook they saw in middle school and high school in science and mathematics. We also have a set of data from the principals about the schools. As you can see, it is a comprehensive set of data.

If you look at the right side of the graph below you will see two very long diagonal lines. Those start back in 1987 at seventh and tenth grades



and continue up to the last two dots on the end, which is where we are this year and next year. This year we asked all of our young adults, ages 34 to 38, about how they get information both formally and informally about a whole range of science issues and just generally learn about science questions. About two-thirds of our young adults now have children of their own. In 2010 we will go back again and ask them how they work with their own children in learning about science. The beauty of that is that back in 1987 and 1988, we asked their parents the same question, so we will have essentially three generations of those who go to museums and other kinds of informal science education settings.

We hope to keep following these people for a good many years because there are a number of intriguing questions. For example, who has stayed in the work force and who has not?

I now want to quickly show you two things. This is the number of museum visits per 100 people. We have to do it this way because otherwise, for example, the number of visits per individual to a botanical garden would be .45. The results would be mind boggling and we would be talking about how people do two-tenths of a visit to a museum. Another way of saying the same number is that 45 out of every 100 people would have visited that museum or activity.

What we have is a range of things that look at this by the education level of our young people and as you can see, the more education you have the more likely you are to find your way into a zoo, an aquarium, a botanical garden, a science center and the like. I also put in art and children's museums. Some children's museums are highly scientific, some are not, but art museums also represent the phenomena of simply museum going. This probably doesn't surprise you, but it is what we have seen for a number of years in the adult population also.

I also looked at it by scientific literacy. I have been measuring what people know about science for about twenty-some years: Who knows what a molecule is, who knows if the earth goes around the sun, and other central questions like that. We think it roughly equates to the ability to read the Tuesday *New York Times*. It is meant to identify those who can make sense of first-rate science journalism or a news report, or first rate *NOVA* shows, or first-

Number of Informal Science Visits by Level of Civic Scientific Literacy

Education	Number of visits per year per 100 adults (2009)								N
	Zoo/ Aquarium	Botanical Garden	Natural History	Science Mus/Cent	Planetar' m	Science Total	Children's Museum	Art Museum	
Less than HS	127	45	41	22	14	250	112	36	78
HS Diploma	161	52	47	42	24	316	70	43	1,028
AA/AS	176	60	70	60	26	378	73	76	148
Baccalaureate	194	81	69	62	22	422	111	77	650
Grad/Prof	191	138	85	78	27	506	120	120	395
LSAY Total	180	75	63	55	24	397	93	68	2,040

rate museum exhibits. If you look at that, in fact what you see is that the people who come to science museums are primarily people who already know a lot of science. Some of you have seen other manuscripts in which I have reported the same kind of thing.

Number of Informal Science Visits by Level of Civic Scientific Literacy

CSL Score	Number of Hours per Month						N
	Work and Commute	Read Newspaper	Total Reading	Use Internet at Home	Watch TV	Exercise	
Less than 50	145	7	15	25	46	15	160
50-69	159	7	16	28	50	14	585
70-89	166	7	20	34	48	16	730
90 +	176	9	22	38	44	15	565
LSAY Total	161	7	18	30	48	15	2,040

Time Use by Level of Civic Scientific Literacy

CSL Score	Number of Hours per Month						N
	Work and Commute	Read Newspaper	Total Reading	Use Internet at Home	Watch TV	Exercise	
Less than 50	145	7	15	25	46	15	160
50-69	159	7	16	28	50	14	585
70-89	166	7	20	34	48	16	730
90 +	176	9	22	38	44	15	565
LSAY Total	161	7	18	30	48	15	2,040

I know, having worked with the museum community for some time, that some of you will take that as a disappointment. I think you should take it as an encouragement because there are many functions to be fulfilled. One function is to help people who don't understand science come to understand it. Another important function is to sustain people who already have some understanding of science in the years after they leave formal schooling.

For example, almost none of us in this room would have said that we studied stem cells as students because they weren't in our textbooks when we were in school—certainly not in my case, and I'm sure not in most of your cases—and yet we have learned about stem cells in a whole range of informal ways.

I should note that these data are almost identical for the total adult population. One of the tasks to think about is the function of helping people make sense of this emerging science as it occurs. I think these numbers suggest to you that you have at least a portion of your audience coming to your doors who actually bring some science knowledge with them, but who need some enrichment and some enhancement.

These young people are also very busy and the point I want to make to you is that they do spend a lot of time on the Internet. They spend a fair amount of time reading. Oftentimes we hear that reading has died as an activity in the new generation. That's not true. They don't necessarily read paper newspapers, but they

read a lot of online newspapers. The thing I draw to your attention is simply the left-hand column of the chart at the bottom of page 8: how much time they spend working and commuting. These are very busy young people and you have to compete for their time. There is a marketplace competing for their time that you should all be aware of.

From these preliminary results from the 2009 LSAY survey of young adults, we conclude that:

- The primary users of informal science learning resources are individuals who are already scientifically literate and who are either seeking to maintain their own level of scientific understanding or seeking to provide an enriched science experience for their children.
- This is an important audience in need of accurate and timely information about emerging scientific constructs and issues. Some of these needs will be met online from various sources, but one of those sources could be museums and other informal science learning resources.
- I do not suggest that you cease trying to serve the underserved, but it is important to recognize the markets that you now serve as well as the markets that you may aspire to serve.

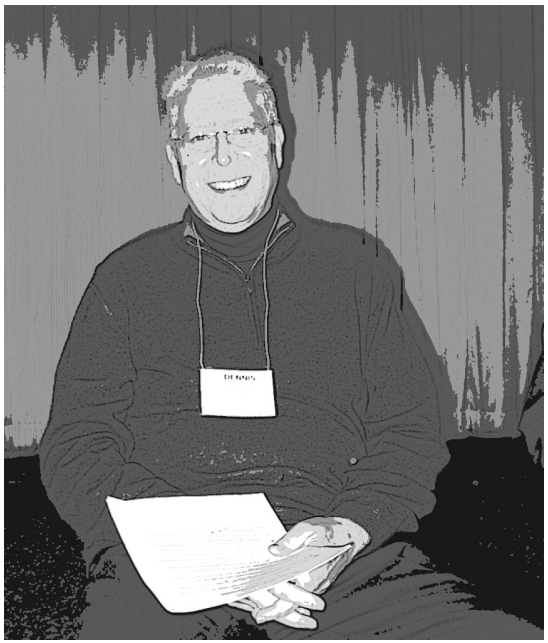
In summary, individuals who are scientifically literate are actually the major users. That doesn't mean that it is the only audience you can reach, but it is one audience you can reach, and I think you should pay some heed to that. I think that as new issues emerge, people need to find places that they have trust in, and I think science centers and science museums can be one of those places. I do not mean to suggest by this that you cease serving underserved populations, but that you do recognize what the distribution of your current market is.

Jon D. Miller

For more information go to:

http://lsay.msu.edu

Dennis Schatz



Connecting the Public with the Research Community

Dennis Schatz
Senior Vice President for Strategic Programs,
Pacific Science Center, Seattle, Washington

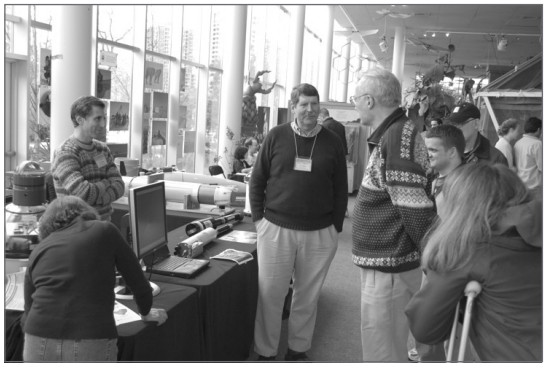
I'm here to talk about some of the results that have come out of our Portal to the Public effort, which bring scientists and research-based professionals into face-to-face interactions with public audiences—a project working with Explora in New Mexico, the North Museum of Natural History and Science in Lancaster, Pennsylvania, and the Institute of Learning Innovation. We have also worked and talked with a number of other science centers. There are a lot of discussions and questions that come out of bringing research-based professionals into the institution to help with our activities communicating with the public.

PORTAL to the Public

DISCOVER | PACIFIC SCIENCE CENTER

Always a place for basic science and a fun time for families

Connect to current science and technology

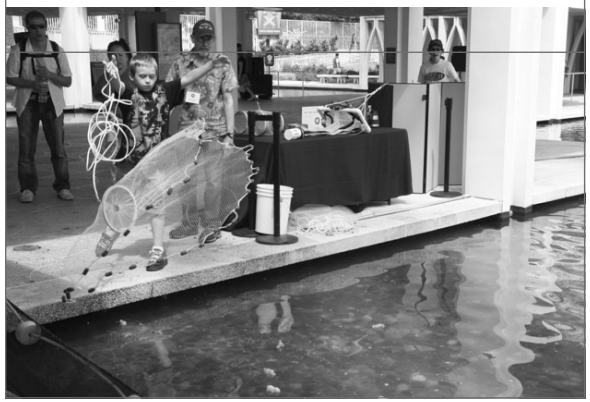


If you've been in the field as long as I have, you know that to a large extent we are institutions that do a great job of working with families on basic science. One of the things that is happening as we move forward is thinking about what science centers should be doing and how we make ourselves more relevant. How do we broaden our role as a place where people come and engage in dialogue about current science and technology and their impact on society?

When you do this, it requires greater understanding of scientific content areas than we have probably required in the past. Some institutions have staff with a deep understanding of content, but you can only cover some areas, you can't really do it all. This requires bringing in people who have that kind of content expertise to interact with the public or at least to give your staff the background.

So some questions come up as we try to engage the research-based community more often. One thing that comes to mind is, how do we broaden our sense of the term "scientist"?

How do we broaden the image of what we mean by scientists?



Every time someone says "scientist" to me, what I think of, and what the public thinks of, is the research scientist at the university, or maybe some other institution like a national lab. We need to start broadening our definition to include people who are from the technical level such as technicians in labs. If we are trying to get students interested in STEM, and they all think they are going to become a research scientist, that's not going to work very well. There aren't enough jobs out there. We need to be thinking about those individuals who work as technicians in labs, especially in the health industry, etc.

The other question is, how do we broaden the image that goes beyond the university? How do we think about other institutions such as businesses, government agencies and even city planners? We recently had a program in which a city planner was talking about sustainable energy design. I think it's important that we think about other organizations to connect with, other than the traditional.

Another issue is, how should we think about translators of science? We do a lot of translating. How much translation should be done by us and our staff and how much should be done by the research-based professionals in the community? I think that's an important question to bring up. What is the right balance?

Also, if we are going to be working with research-based professionals, how do we help

Should we be the translator of current science and technology?

Should the scientist be the translator of current science and technology?

How do we help science-based professionals become effective science communicators?

How do we help science-based professionals become effective science communicators?

http://www.pacsci.org/portal

Puts a human face on science

them become effective communicators? Too often you hear from many people—and it's not just scientists—"I went to school, so I know how to educate people. I know how to teach. I know how to connect."

I often wonder how many scientists would say, "Well, I went out in the snow so I know about climate change. Let me tell you how to do your research on climate change."

There is this real need to have training and professional development to help science-based professionals become effective science communicators. In these photos you see some of the scientists that we have been working with to accomplish this.

While we work with a large number of non-scientist volunteers, which involves having to provide them both with the training in content and communication skills, why not pursue (I often think "exploit") the science-based professionals who come with the content and at the same time allow us to put a human face on science?

How do we provide role models for what it means to be a scientist? There are great ways to see what scientists are like. They don't all wear white lab coats!

These are some of the questions I think we need to be wrestling with as we move to include the research-based community in our programs.

Provides a role model

ISE Opportunities in Civil Engineering

Robert Reitherman
Executive Director, Consortium of Universities for Research in Earthquake Engineering; PI of Building Bridges Between Civil Engineers and Science Museums

Two weeks ago I was in the supermarket buying an avocado for dinner and as I was standing at the avocado bin I looked up at the sign and it said "Avocados fifty cents, two for a dollar."

As another fellow walked up I kind of chuckled and said, "Look at the sign: Avocados fifty cents, two for a dollar."

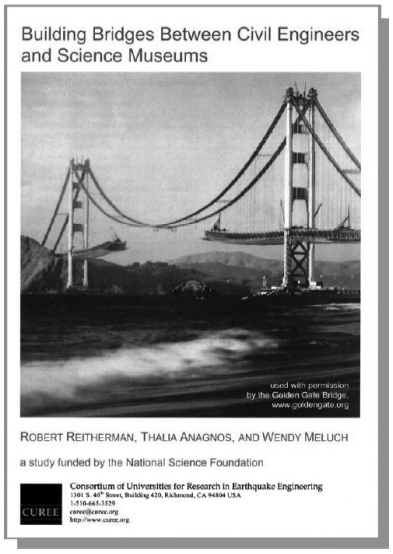
And he said, "I guess they're on sale this week." So all of you for whom STEM literacy is a cause have more work to do.

I will talk briefly about one project that has been completed in the informal science education or informal engineering education area. The report is available at the URL below. The cast of characters was composed of about half engineering folk (although they were selected so that they had previous experience communicating with the public) and about half science centers, science museums and educators.

Where did this come from? Our organization was interested in how civil engineers and science center or science museum professionals could

Building Bridges Between Civil Engineers and Science Museums

www.curee.org



free PDF at: www.curee.org
completed 2008

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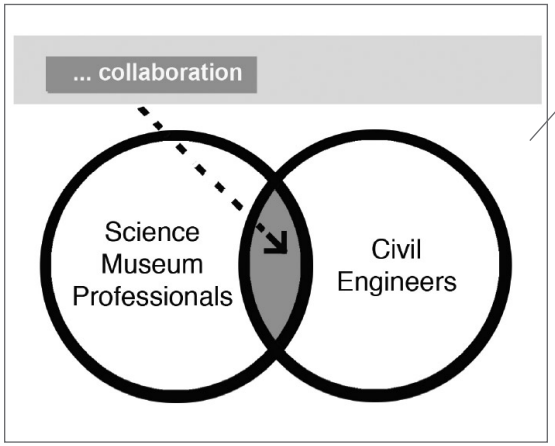
Dr. Peter Wong, Museum of Science

Robert Reitherman (right) with Robert Hone

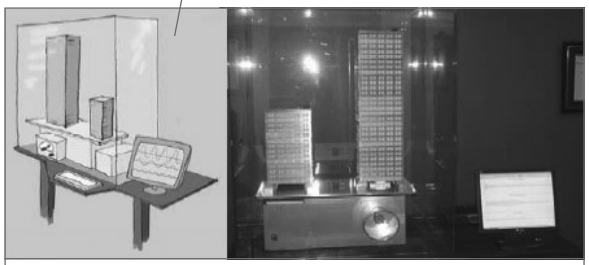


collaborate, and we quickly realized there is a rather small intersection. Think about your neighbor across the street. You might be good friends, but your life and their life have a small area of intersection on a Venn diagram like this. Your relatives are different, and so on, but you still might have a close relationship. We were just looking for those areas that are possible to collaborate in. We are not expecting civil engineers to become science museum professionals or vice versa.

Our organization is a consortium of universities, two dozen around the country, that do earthquake engineering and other kinds of civil engineering research and education. Our Board of Directors asked me, as Executive Director, this question: How can the public learn more about civil engineering?

1. How can the public learn more about civil engineering?

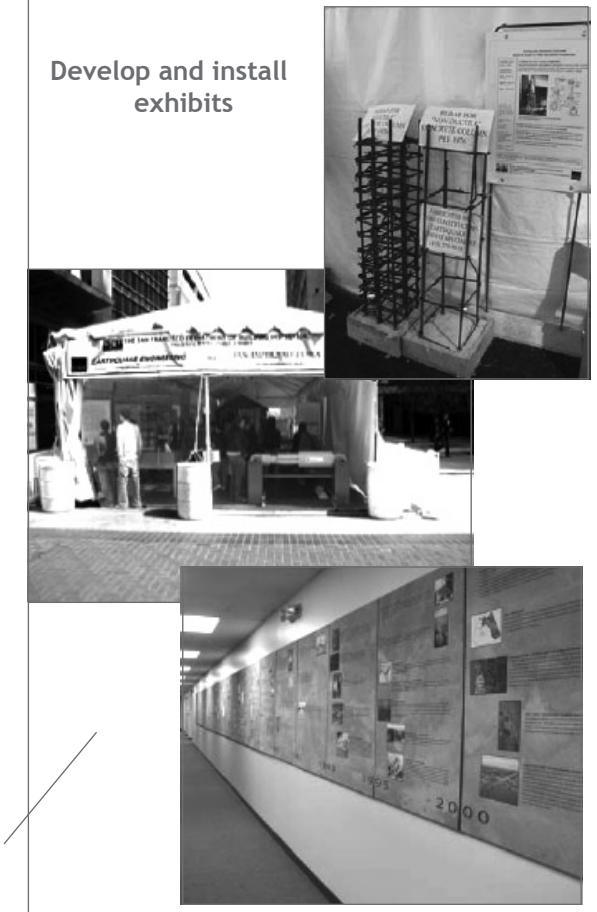
So we went out and tried it. We installed some exhibits including a shake table: you turn a dial and it affects the frequency, and one building responds more than another. That's a dynamic response principle that applies to how you tune your radio in your car to a certain frequency and so on.



2. Develop and install exhibits

If you look to the right of the shake table, there is a model of the rebar within a concrete column. The one on the right looks like the aftermath of the earthquake in Haiti (though this was done about five years ago) and the one on the left is what you need to do if you want the building to stand up when the earth shakes.

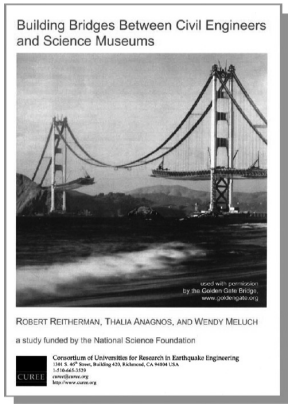
Develop and install exhibits



We went on from those sorts of experiences with a few exhibits and asked the question:

How can collaboration be enhanced between these two communities or fields?

3. How can collaboration be enhanced between science museums/ centers and engineers?



That led to the study I just mentioned, *Building Bridges Between Civil Engineers and Science Museums*. At that point we wondered what we should do next, and that led to the collaboration that Denis Mulligan will talk to you about.

4. What to do next?

Denis Mulligan
Chief Engineer, Golden Gate Bridge, Highway, and Transportation District, San Francisco, California; PI of The Golden Gate Bridge as an Informal Science Education Resource

I am not an informal science education person, I am not affiliated with a museum or a science center, and I want to thank you for welcoming me into your world. I encourage you to welcome others because it creates opportunities and possibilities.

The Golden Gate Bridge is a very visible infrastructure. It's not a pipeline buried in the ground or a series of telephone poles that are part of the background wallpaper of society, and it attracts lots of people. People are curious about our infrastructure and oftentimes, in our case in particular, we don't offer much

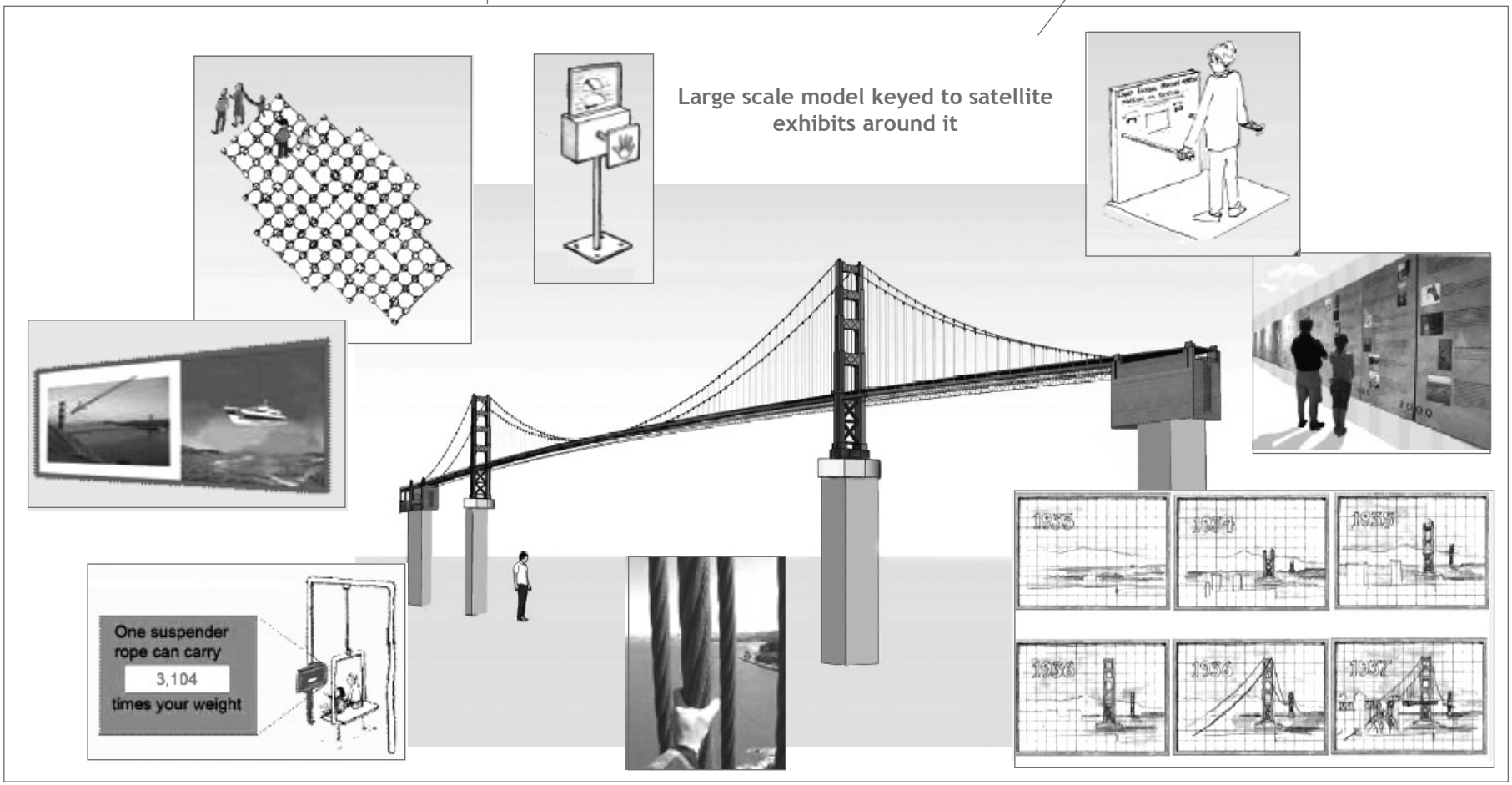
Denis Mulligan

- 10 million visitors per year
- They come as sightseers. They will leave with a learning experience about the engineering and science of the Bridge.
- Permanent outdoor exhibition area
  Centerpiece “table of contents” model, 20 satellite exhibits
- Deadline: 2012 (75th Anniversary)

to them. We have ten million visitors every year. These are not people who drive across the bridge, they are visitors who come, they walk on the sidewalks, they ride their bikes there. On a busy day over six thousand people ride their bikes across the bridge and many of them are tourists visiting the site.

So we have the eyeballs, we have the brains, but we don’t offer interpretation. We have a statue of the original chief engineer and a chunk of cable, and that’s it. We are very appreciative of the National Science Foundation and Al DeSena in taking a leap of faith in agreeing to fund outdoor interpretive exhibits and look at using this as a catalyst for using public works for public education.

The centerpiece is a large-scale model 90 feet long. It will serve as a table of contents. We will have lots of interesting outdoor exhibits and it is all free, so it is open to people from



all economic backgrounds. Science doesn't require a language, but we will reach out to all languages using cell phone technology because we have people from all over the world.

We are also planning a conference on the 75th anniversary of the bridge to bring your community together with my community to leverage other opportunities.

Broader Impacts

- Conference related to 75th Anniversary June 20-22, 2012, San Francisco
- American Public Works Association 29,000 members, deploy a course
- Develop new outlets and funding for informal education
- Present civil engineering content and thought process, not just science

I encourage all of you to keep in the back of your minds that in June of 2012 there will be a conference in San Francisco that looks at using public works for public education.

We have a very talented team that we brought together. Robert Reitherman, along with Professor Maria Garlock from Princeton, are the Co-PIs. We have folks from the Exploratorium, various artists, and various educational institutions that will bring this project to fruition, and hopefully we will use this as a catalyst to do this elsewhere.

Project Team

Project Funding: National Science Foundation award DRL 0840185, and Golden Gate Bridge, Highway and Transportation District

Project Management: Golden Gate Bridge, Highway and Transportation District, Consortium of Universities for Research in Earthquake Engineering

Partner and Overseer for Site Planning and Site Usage: National Park Service, Golden Gate National Recreation Area

Evaluation: Inverness Associates and David Heil & Associates

Exhibit Developers: CUREE, Exploratorium, EyeThink Inc., Princeton University Sciencenter, West Wind Lab

Master Planning: EHDD Architecture

Engineering Knowledge Communication: Professors Thalia Anagnos and Sarah Billington

Advisors: Jill Andrews, University of Michigan; Cathy Frankel, National Building Museum; Alan Friedman, The Museum Group; Chris Gallagher, Bay Model Visitor Center; Roy Griffiths, North Carolina Museum of Life and Science; Howard Levitt, Golden Gate National Recreation Area; Lawrence Lux, American Public Works Association; Dr. Joyce Ma, Exploratorium; Prof. Henry Petroski, Duke University; Dr. Stephen Ressler, West Point Military Academy; Carol Willis, The Skyscraper Museum

Public Engagement with Science-based Issues

Ellen McCallie
Deputy Director, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania

Ellen McCallie

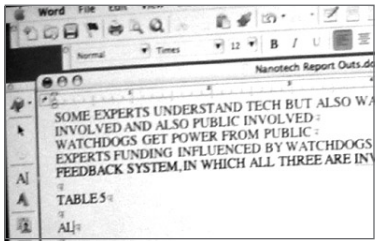
What would ISE be if publics were asked to move beyond learning what we told them to learn, to move beyond only asking questions of scientists, and to move beyond only interacting with exhibitions in the way we asked them to? What would ISE be if publics started sharing their views and their knowledge with ISE professionals, with scientists, policy makers, and social scientists, and started deliberating with each other about the science, the ethics, the values, and a shared vision for society as a whole?

What would ISE be if experts were asked to move beyond being advisors and "the ones who know," and instead were welcomed into the community as part of a process? As people who have part of the knowledge but not all of the knowledge? As people who are challenged to transparently apply what they know to complex issues, and share how they come to their understandings?

If publics, scientists, social scientists, and policy makers came together to discuss and deliberate and make transparent what we think and why we think it, and if collectively we listened to others and maybe even changed what we think or what we do based on these conversations, would we foster more investment, commitment, and understanding

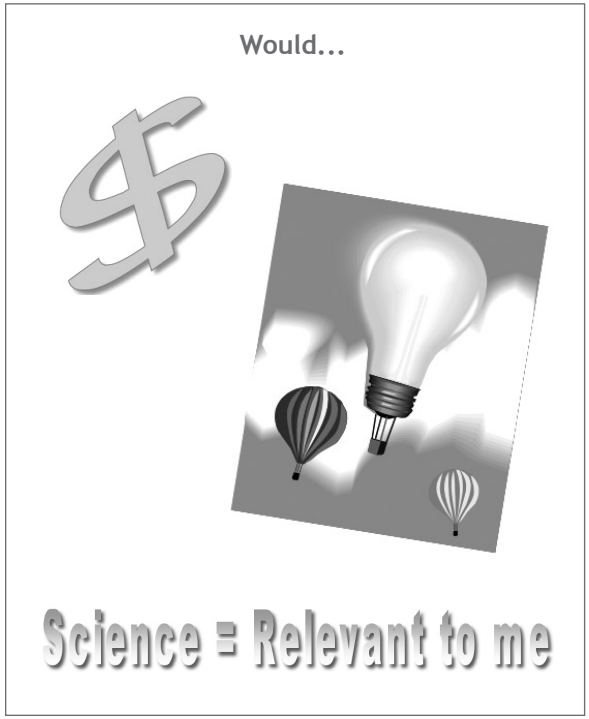
What would ISE be if publics...

Web 2.0



Photos courtesy of Museum of Science, Boston

What would ISE be if experts...



in science? Would our practices become more reflective and thoughtful about what we do and why we do it? And would people look at science as something that is relevant to themselves?

I would argue that Public Engagement with Science does just that. It is an overarching strategy, and it deals with content that is complex. It is about current and controversial issues. And, it is beyond science, though it inherently includes science. It is a process by which scientists and publics bring valuable knowledge and perspectives, including ethics and values, to the table. We then figure out why we think what we think, and make those conclusions transparent. This is where the science comes in, and this is where our values come in. These are not siloed issues.

The goal of PES is that everyone learns. Scientists go back to their institutions, and the questions that they ask are influenced by what publics think. And publics go out and they are more energized and activated about applying science in their everyday lives. We are looking to move from a transmission model of Public Understanding of Science to a model of public dialogue and participation in science.

Do we have to do this? Yes, we do, so let's talk about strategy. We must engage publics in science because a fundamental part of our mission—to our collective missions across platforms—is using the language of science and civic literacy: talking about what we know, why we know it, and what we are going to do with it. But it is also crucial because of political and funding necessities. If people don't see us as relevant, we will cease to exist, and science as an integral part of the community will not exist.

There is also an outside impetus. We have been asked by our government as well: How does science fit in? How can we use science to promote our workforce and economic development? These are all things that can be done through Public Engagement with Science.

Public Engagement with Science does not mean having science determined by publics. It also does not mean simply asking people to think about multiple sides of an issue. Instead, it is about providing people, scientists, and

Public Engagement with Science

- *Content*: Current and/or controversial science-related issues
- *Process*: Scientists & publics bring valuable knowledge and perspectives – including ethics and values
- *Goal*: Everyone learns—more about science, more about society, more about creating robust science, civic dialogue, and policy

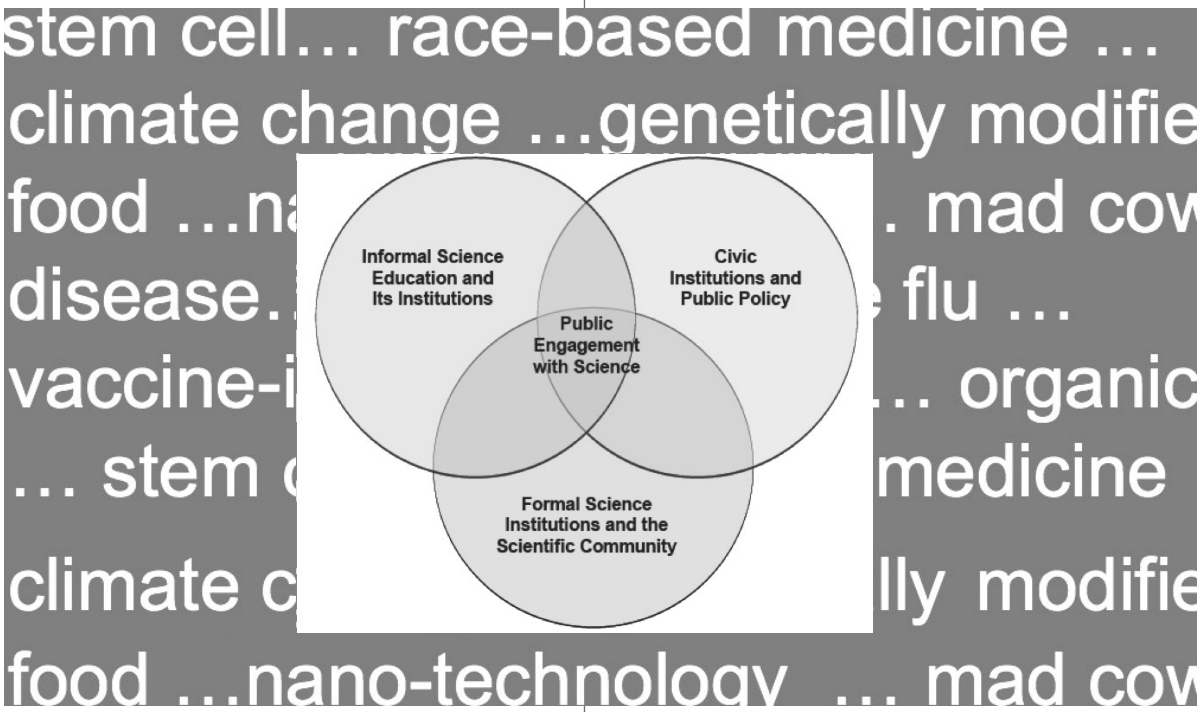
From transmission to dialogue and participation

Mission-related
Language of SCIENCE
CIVIC LITERACY

Funding/political necessity
RELEVANCE

Outside impetus
ECONOMIC DEVELOPMENT

policymakers with ways to meet—online, in person, in real time, and asynchronously—to learn from one another, to develop deeper understandings and new ways of thinking, to affect the process and even policy, to become uncomfortable and to move beyond our silos to think about our society's complex issues.



Contributions of PES to ISE

- Re-frames ISE platforms from sources of *information disseminators* to *knowledge producers*—where scientists, publics, and policy makers learn and create together.
- Opportunities to engage adult and young adult audiences

What is the contribution of Public Engagement with Science to informal science education? It reframes ISE platforms, transforming them from traditional sources of information and dissemination into dynamic collaboratives of knowledge producers and conveners.

PES Inquiry Group

- Larry Bell, Museum of Science, Boston
- Tiffany Lohwater, AAAS
- Ellen McCallie, Carnegie Museum of Natural History
- John Falk, Oregon State University
- Jane L. Lehr, California Polytechnic State University
- Bruce Lewenstein, Cornell University
- Cynthia Needham, ICAN Productions, Ltd.
- Ben Wiehe, WGBH Educational Foundation

The report of the Public Engagement with Science Inquiry Group is posted on the CAISE Web site.

Many Experts, Many Audiences: Public Engagement with Science and Informal Science Education

A CAISE Inquiry Group Report

March 2009

http://insci.org/resources

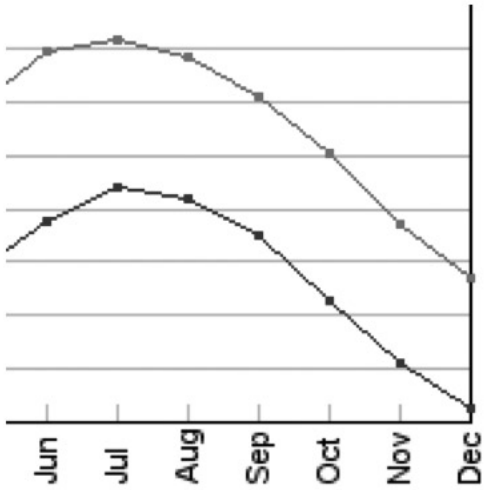
Public Participation in Scientific Research

Rick Bonney
Director of Program Development and Evaluation, Cornell Lab of Ornithology, Ithaca, New York

CAISE Public Participation in Scientific Research Inquiry Group

This picture below clearly shows, as most of the public apparently now believes, that the earth is cooling. You know—it's been a bad winter, it's snowing in Washington.

Falling temperatures clearly show global cooling ...



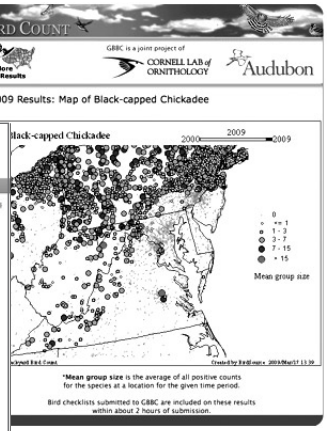
One of the questions that comes to my mind is, how can we help people learn to investigate and evaluate evidence?

How can we help people learn to investigate and evaluate evidence?

At the Cornell Lab of Ornithology we have been refining the concept of citizen science: volunteers or amateurs or publics contributing to the process of science by learning about important scientific questions which can only be answered by having a large number of observations collected over time and space;

Rick Bonney

Citizen Science?



learning how to collect data by following carefully designed protocols; submitting the data to smart databases; and then, once all the data are online, going in and being able to visualize, analyze, and understand the information; and hopefully learning something about the process of science while understanding how the natural world works.

If I had a couple of hours I could tell you all about the impact findings that we do know about. This is not just at the Lab of Ornithology, this is across many projects in the field that now call themselves citizen science. We know that participants learn to identify more species than they knew before. We know that they're learning how to observe interesting behaviors such as birds fighting at their feeders. They're actually starting to keep records of their own and pay attention to them over time. They do understand that they are contributing to science. And maybe, just maybe, they are using some of the data analysis tools to ask and answer some of their own questions about bird diversity and abundance or changing fish populations or invasive plant species, but we need to do so much more with this last part of the equation.

A couple of years ago I was asked to head up one of the CAISE Inquiry Groups. It started out as a Citizen Science Inquiry Group, but we changed the name to Public Participation in Scientific Research because we didn't think there was enough jargon and terminology out there. We wanted to add to it, so we have PPSR. Actually, what we were trying to do was look beyond the concept of citizen science as it was being practiced by most projects.

There are many processes of science. There is no one scientific method, but if you think about a scientific investigation it has many steps.

	Scientist/ Technician	Public Participants
Define a question/issue	☑	☐
Gather information	☑	☐
Develop explanations	☑	☐
Design data collection methods	☑	☐
Collect samples	☑	☐
Analyze samples	☑	☐
Analyze data	☑	☐
Interpret data/conclude	☑	☐
Disseminate conclusions	☑	☐
Discuss results/inquire further	☑	☐

In a standard or traditional model it is scientists and technicians who do all of those steps. When you bring publics into the process of science, then you have to stop and think: What do we want participants in these projects to do? Which parts of the process do we want them to be involved in?

We came up with the idea that there are at least three different models of projects: contributory, collaborative, and co-created (making up three more terms for everybody to learn). In the contributory model, which is what most of the projects are so far that call themselves citizen science, participants are mostly collecting and analyzing samples.

Citizen Science Impact Findings

- Participants learn to identify more species
- Observe interesting behaviors
- Begin to keep records
- Understand that they are contributing to science
- Use data analysis tools to answer questions about bird diversity and abundance???

insci.org/resources

	Project Models		
	Contributory	Collaborative	Co-Created
Define a question/issue	☐	☐	☑
Gather information	☐	☐	☑
Develop explanations	☐	☑	☑
Design data collection methods	☐	☑	☑
Collect samples	☑	☑	☑
Analyze samples	☑	☑	☑
Analyze data	☐	☑	☑
Interpret data/conclude	☐	☐	☑
Disseminate conclusions	☐	☐	☑
Discuss results/inquire further	☐	☐	☑

In the collaborative model we are involving them in more parts of the project, and in the co-created model we are actually involving participants in the entire process, from coming up with questions to answering them and taking them out into their community.

In our Inquiry Group we looked at about ten different projects, and I have two that I am going to briefly share with you. One was the Salal Harvest Sustainability Study, in which it was shown by a researcher named Heidi Ballard that she could bring a whole bevy of harvesters untrained in science into the process of understanding how to harvest this product sustainably. She was able to show that they learned a tremendous amount about content and process by being involved in the whole project.

The same thing happened in North Carolina when the community got involved in studying the health effects of industrial hog operations. In this case they were even able to have a community impact on land use and siting of hog operations.

What does this mean for the field?

Opportunities for the ISE Field

- Make projects fun and worthwhile
- Ensure relevance
- Provide opportunities for data visualization, analysis, and interpretation

Salal Harvest Sustainability Study

- Goals
  - inform management
  - provide technical skills
  - involve/empower harvesters
- Inputs
  - research methods training
  - data analysis workshop
- Outcomes
  - content and process learning
  - skill development
  - increased community involvement

UC Berkeley

Northwest Research and Harvester Association

Health Effects of Industrial Hog Operations

- Goals (community-driven)
  - monitor public health effects
  - community health education
  - community decision-making
- Inputs
  - data collection training
  - data analysis workshop
- Outcomes
  - content and process learning
  - increased community involvement
  - impact on land use policy

Tillery, North Carolina

Projects need to be fun and worthwhile to get people involved in them. A lot of the people in the salal project and in the hog farm project would never have gone to a science museum or participated in something that wasn't relevant to them in their community.

We need to provide opportunities for data visualization, analysis, and interpretation and start to get people working with these massive databases. This is going to be challenging, and this is an area in which I think we can all start to work in the informal science education field.

PPSR Inquiry Group Participants

- Rick Bonney, Cornell Lab of Ornithology
- Heidi Ballard, University of California, Davis
- Rebecca Jordan, Rutgers University
- Ellen McCallie, Carnegie Museum of Natural History
- Tina Phillips, Cornell Lab of Ornithology
- Jennifer Shirk, Cornell Lab of Ornithology
- Candie Wilderman, Dickinson College

Older Adults and Informal Science Education

Kali Lightfoot
Director, National Resource Center, Osher Lifelong Learning Institutes, Portland, Maine

From left: Robert Reitherman, Kali Lightfoot, Robert Hone

There are 120 Osher Lifelong Learning Institutes around the country in all fifty states. They are university-based, non-credit programs, which reach about 90,000 members across the country. Although they are all different organizations and are structured differently, the common vision is learning for the joy of learning in community. We have a planning grant to create a

Planning Grant: A Science Education Center for the Third Age

The Team:

- National Resource Center for Osher Lifelong Learning Institutes (OLLI)
- OLLI at California State University East Bay
- Exploratorium
- OLLI at University of Missouri Columbia
- OLLI at University of South Florida
- Educational Development Center – Evaluator

usm UNIVERSITY OF SOUTHERN MAINE

OSHER LIFELONG LEARNING INSTITUTE

Science Education Center for the Third Age within our National Resource Center, the "third age" being a European concept that means anything over fifty. In our planning and in working on a full proposal for NSF, we really want to encourage all of us and all of you to think about STEM education for older adults. That is really our bottom line. There are questions and issues that we are considering as we are thinking about all of this.

There have never been this many educated, healthy people over age fifty alive at one time in the whole history of the human race. What does and will this mean? The field of aging has coined the term "the new awkward age," and I can tell you, being sixty-five, that it is getting more awkward all the time.

We like to think of older adults as an audience by themselves, not only as volunteers, docents or grandparents. What do they want to learn? We know in our OLLIs they want to learn history, current events, literature, music and some science. But we would like them to think a little more about how science concepts relate to everything.

They are different audiences. If you are thinking of seniors as being people who are all about so tall with gray hair and glasses, yes we are all about so tall with gray hair and glasses, but we are all different. People who come from assisted living in busses are different from the people who are driving themselves, who have just been out with their hiking club, for instance.

There have never been this many educated, healthy people over age 50 alive at one time.

What does and will this mean?

(OLLI U New Mexico)

(OLLI San Francisco State U)

Older adults are an "audience" themselves, not only as volunteers, docents or grandparents.

What do they want to learn?

(OLLI at Towson Univ.)

(OLLI at U of Richmond)

Adults over age 65 in 2010 did not typically grow up with after-school programs, experiential learning, service learning, environmental education, or other informal education programs and were told “don’t touch!”).

How best do we engage (and free) them?

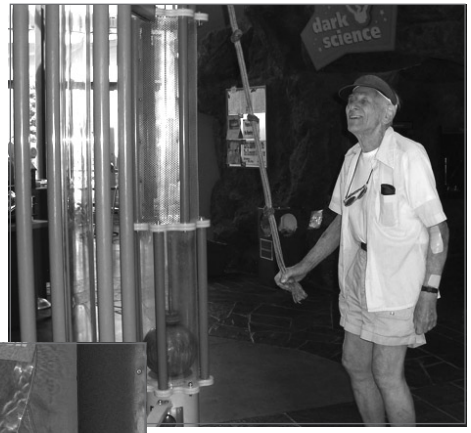
(OLLI at Eckerd College)

Adults over age sixty-five in 2010 did not typically grow up with after-school programs, experiential learning, service learning, environmental education, or other informal education programs, and we were told, “Don’t touch!” So how do we best engage and free older adults? We grew up in museums, the diorama years.

Older adults learn differently and for different reasons than youth, but old dogs do learn new tricks. What are the pathways?

Older adults learn differently and for different reasons than youth, but old dogs do learn new tricks.

What are the pathways?



We are interested in helping you broaden the ISE community. OLLI members range from fifty to one hundred years old, from high school grads to Ph.D.s. The tricky part of that is, how do we reach across generations and cultures, even within the older generations? One end of this group of older adults grew up

Broadening ISE Community

OLLI members range 50 to 100 years old, from high school grads to PhDs

How do we reach across generations and cultures even within the older generations?

(OLLI at Cal State Los Angeles)

(Amy Snyder, (c) Exploratorium)

listening to Frank Sinatra, the other end grew up listening to Pink Floyd. It's a different world.

Working across silos, OLLIs can and do form bridges between university, research, community and science center partners. How do we develop engaged collaboration? Many of the OLLIs are already collaborating with many of you. How do we make that more intentional and more engaged?

Healthy aging means connection and participation in the fabric of communities. We in ISE can raise the level of science literacy and develop informed citizen scientists among the older population.

Healthy aging means connection and participation in the fabric of communities.

We in ISE can raise the level of science literacy and develop informed citizen scientists among the older population.

What supports are needed to make that happen?

Nebraska

Working across silos, OLLIs can and do form bridges between university, research, community, and science center partners.

How do we develop engaged collaboration?

Nebraska

What supports are needed in order to make that happen?

Coming soon there will be a CAISE forum on all of these issues and many more about older adults and informal science education. That will be followed by a national survey of science centers and organizations about

And coming soon, a CAISE forum in April

Followed by a national survey of science centers/organizations about older adult programming...

Stay tuned...

older adult programming. That is happening as part of our planning grant activities. So stay tuned.

www.osher.net
kalil@usm.maine.edu

(OLLI + ScienceWorks, OR)

(OLLI at U Montana)

Science Education Center for the Third Age

(OLLI at U Alaska)

(OLLI at George Mason U)

CAISE Formal/Informal Collaborations Inquiry Group

Report available at:
http://insci.org/resources

Making Science Matter: Collaborations Between ISE and K-12

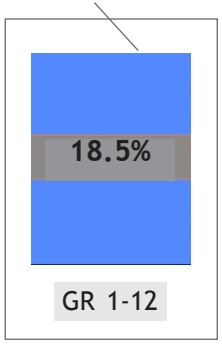
Bronwyn Bevan
Director, Center for Informal Learning and Schools, Exploratorium, San Francisco, California

I led an Inquiry Group over the last year on the connections between formal and informal collaborations. So working with schools is the hot topic, and I'm going to try to make it interesting. The conversations and the collaborators that were part of this group were really amazing, and I want to thank CAISE for

Bronwyn Bevan

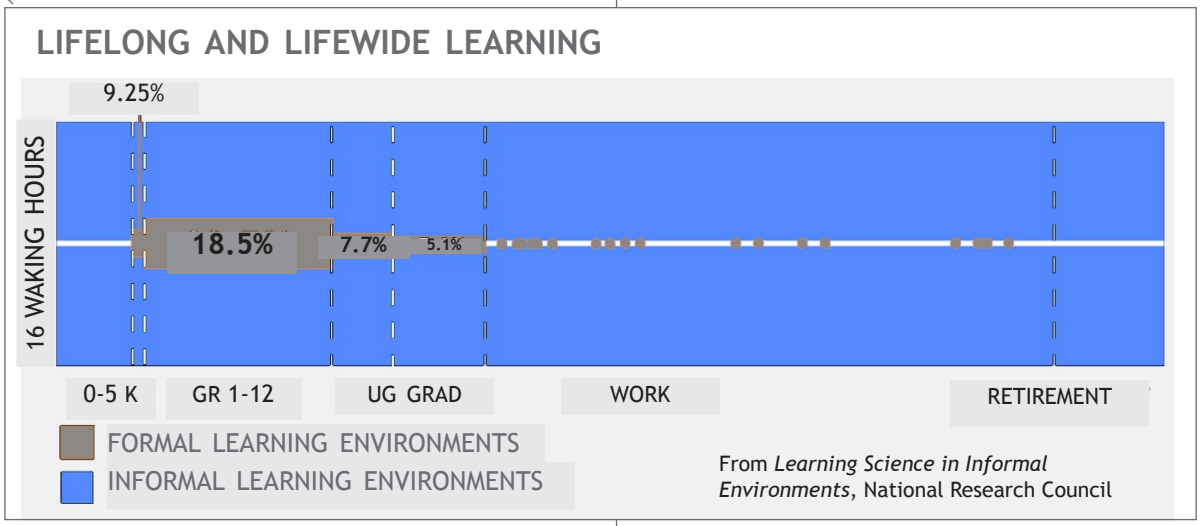
the opportunity. What this did was get a number of us to sit in a room together and really talk through a lot of work that we are doing, a lot of work that isn't happening, and work toward a point of resolution, which is the report from this Inquiry Group now available on the CAISE Web site.

I wanted to start with this image developed by the LIFE Center that Kevin Crowley shared earlier during this summit. As Kevin mentioned, we talk about the "deep blue" being all of this stuff that happens outside of formal learning, and what is in gray is schooling. In thinking about how to organize my talk today, Dennis Schatz recommended starting with this LIFE Center image and then zooming in to the Grade 1-12 part where schooling is happening. I thought that was a really great idea and I've done that here.



But when I looked at this close-up I thought, this is not very convincing. There is still a lot of blue. It just doesn't feel representative of reality. This 18.5% of 16 waking hours is just under three hours a day. Now I know that this is a true number because they have done the math and they are accounting for weekends and summer and vacations, but this is not reality.

If you have a child of school age or if you ever were a child of school age, you absolutely know that it dominates your day and your weeks and even your life for a very long time. If you're a parent, you know about that period at the end of summer when the countdown begins, and your kids are counting for one reason and you're counting for another, and you realize fully how incredibly important schools are in terms of how they take up the time in our day. They are hugely influential socializing agents and they deeply shape interest, identity and the ability to know and do science.



From *Learning Science in Informal Environments*, National Research Council

I wanted to push back a little on the very important and exciting work that we are doing—recognizing the sheer volume of the 85% of a person's life that makes up the deep blue in this image from the LIFE Center—to remind us that these very small dots on the page cannot be discounted by virtue of their size. They have enormous weight and influence in the field. My message today is that any public engagement with science strategy that we undertake as a

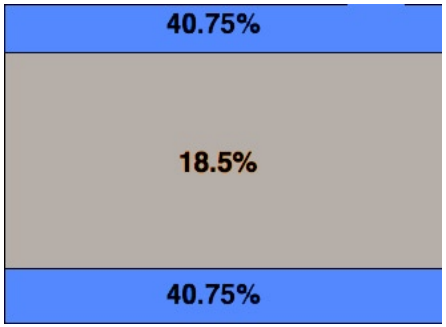
Some of the data about the scale and scope of collaborations that are still ongoing:

>70% of science-rich cultural institutions offer programs for schools (Phillips et al 2007)

>90% of afterschool program leaders want to increase science for kids (Chi et al, 2008)

- Almost half of school audiences are from high-poverty communities

First Wednesday after Labor Day



Rationale

- Science literacy is complex and multi-faceted
- Learning develops across time and setting
- Low participation rates non-dominant communities

field, or as institutions, has to take into account, and work with, the activities that occur in these grey dots. This time is too influential to ignore. Many of us in this room might say that we are doing what we are doing in life not because of something that happened in school, but because of events and experiences in the deep blue part of our life graph. But I would like to turn that on its head and ask you if perhaps you are NOT doing something that you are not doing because of what happened in school? Did school actually turn us off? Did it shut down some doors? Were there windows or possibilities that were never opened, that we weren't even aware of? I think that is a reality for a lot of people.

Why does this matter? Inspired by yesterday's talk, I created a kind of homunculus map of the time we spend in school. This is what that 18% actually feels like, especially right after kids go back to school. This graph might not match the numbers, but that is the felt reality. The reason I want people to think about this is, if we are going to take ecological perspectives seriously, we really have to think about all of the players in the field.

Our report makes this point about the rationale for collaborations between formal and informal organizations, which is three-pronged. One is that growing research indicates that science literacy is complex and multifaceted. No one institution can do it alone. There is ongoing research regarding the idea that learning develops across time and setting and that there are very low participation rates of people from non-dominant communities, women and high-poverty communities.

Take a look at our report. What it does is provide a rationale which builds off of the points I just made. It provides theoretical perspectives and program examples of collaborations between formal and informal that have data to support the outcomes. Then we have done an analysis of the affordances, so we actually looked not just at wanting more of these, but with intentionality about how we can build on the affordances of informal and formal to build collaborations that make a difference.

MSM Inquiry Group Report

- Rationale
- Theory
- Program Examples
- Analysis of Affordances
- Recommendations

You're going to have to read the report to learn more about the recommendations and the cross-cutting themes.

Cross-Cutting Themes

- Conceptually rich, compelling science learning activities
- Cross-field learning communities
- More equitable access to science
- Lack of valid, meaningful measurement tools and evidence
- Collaborations are transformative for individuals and institutions

Recommendations

- Expand the research base
- Create funding categories for formal-informal collaborations
- Provide cross-cutting/setting professional development
- Invest in more systems-oriented program designs and studies
- Develop greater understanding within ISE for work with K12

I wanted to end with the names of the members of the Inquiry group, who were really great to work with.

Formal/Informal Collaborations Inquiry Group Members

- Bronwyn Bevan, Exploratorium
- Justin Dillon, King's College London
- George Hein, Lesley University
- Maritza Macdonald, American Museum Natural History
- Vera Michalchik, SRI International
- Diane Miller, Saint Louis Science Center
- Dolores Root, New Visions Inc.
- Lorna Rudder-Kilkenny, Queens Public Libraries
- Maria Xanthoudaki, Da Vinci SciCntr, Milano Italy
- Susan Yoon, University of Pennsylvania

Inclusion, Disabilities, and Informal Science Learning

Christine Reich
Museum of Science, Boston, Massachusetts

I am here representing the work of the CAISE Access Inquiry Group, and we have just produced a report that will be available online called *Inclusion, Disabilities and Informal Science Learning*. We are also going to continue this discussion through an online forum later this spring, so we encourage you all to participate.

We spent a lot of time defining the challenge and designing a vision for what a future would be like if people with disabilities were included in informal science education and creating a path forward that was based on some of the best case examples from the field.

Defining the Challenge

- How do we ensure that all individuals are provided the opportunity to learn about, discuss, and engage in the practice of science, technology, engineering and mathematics?

In terms of defining the challenge, we wanted to employ what is called the "social model of disability." The social model of disability differentiates itself from traditional notions of disability in that it doesn't presume that there are defects in individuals that need to be fixed.

CAISE Access Inquiry Group

- Christine Reich
- Wendy Pollock
- Jeremy Price
- Ellen Rubin
- Mary Ann Steiner

Inclusion, Disabilities and Informal Science Learning

Report available at:
http://insci.org/resources

Christine Reich and Bronwyn Bevan

Instead, the social model of disability tells us that the problem lies in the fact that we as a society have decided that some individuals are "normal" and other individuals are "other."

What we need to do is devise policies and practices that really start to embrace the diversity that exists within the human population and make sure that we do not set up a false notion of what it means to be "normal." If you think about this, then the onus is on all of us to make sure that everyone is included in the valuable experiences we afford. So we asked the question: How do we ensure that all individuals—and we really do mean all—are provided with the opportunity to learn about, discuss and engage in the practice of science, technology, engineering and mathematics?

Once we defined the problem, we then needed to define what it would mean to be successful. In defining inclusion, we wanted to go very broad. So many of us think about physical aspects of inclusion: making sure there is captioning on videos, making sure our Web site can be read by a screen reader, making sure exhibit table tops are at the right height for a wheelchair. That's an important first step, but it's not enough.

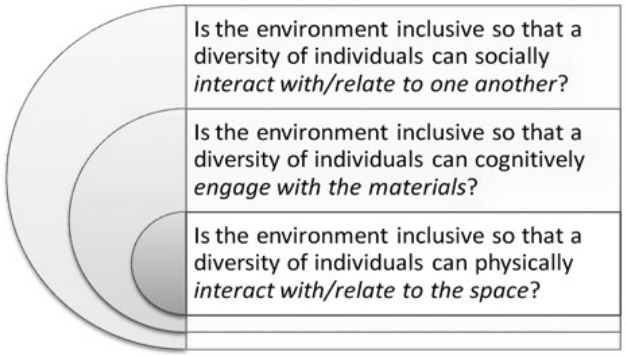
If we are really going to include people with disabilities in learning, then we need to make sure they are able to cognitively engage with the learning materials and the learning environments that we create, offering multisensory, multimodal ways of engaging and sufficient supports and scaffolds.

We also need to think about inclusion in terms of its social dimensions. We all know how important learning conversations are for facilitating learning in informal settings. Therefore, it is important that people with disabilities are engaged in conversations with people who also have disabilities and people who don't have disabilities to facilitate that learning. Then there is a broader social dimension. As informal science institutions, we represent a very powerful place within our communities, or at least we hope to. It is an important social message to send out that everybody is to be included in informal science learning.

What we are really proposing is that we need to move away from a model of exclusion. Ray McDermott talks about the fact that "If a particular kind of learning is not made socially available to us, there will be no learning to do." We wanted to move away from situations where

Defining Inclusion

- Physically interact with/perceive the space
- Cognitively engage with the materials
- Socially interact with one another



Move from Exclusion...

"If a particular kind of learning is not made socially available to us, there will be no learning to do."

(McDermott, 1996)

there is no learning to do for certain individuals in certain aspects of informal science education and move towards a model where Roth and Barton talk about "...conversations that allow individuals] to be successful and able participants, rather than disabled, marginalized and forgotten individuals." We want everyone to be successful and able to learn about science.

...to Inclusion

"...conversations that allow individual[s]... to be successful and able participants, rather than disabled, marginalized and forgotten individuals."

(Roth and Barton, 2004)

What does the path look like to move forward, to move toward that model of inclusion?

It requires a change in our standards of design, and we were really excited by some of the models we found out there in the field, particularly those models, such as exhibits, that no longer say that text is the only way people are going to receive information, and that embrace this notion that people receive information through audio, images and text.

We want to start to expand professional capabilities. We are excited about organizations out there that are engaging ISE professionals in learning about serving people with disabilities by working with people with disabilities. We think that is a really fruitful area.

We also think it is important that we start to generate new understandings for the field. There is some research out there, such as looking at effective models for use in zoos and aquaria.

The Path Forward

Expand professional capabilities

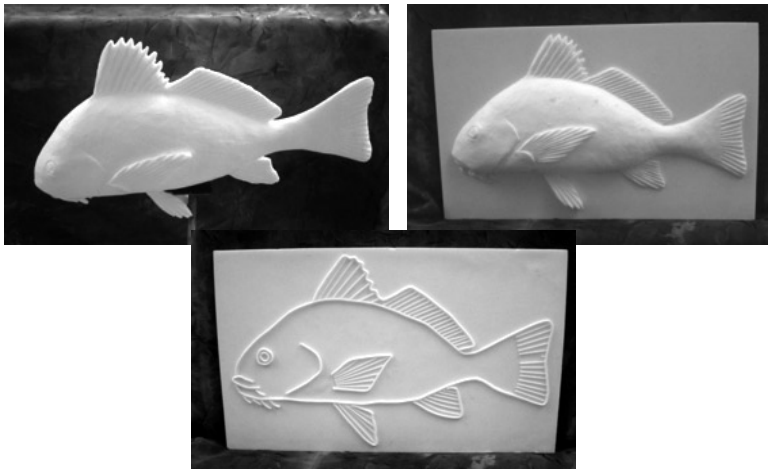
The Path Forward

Change in standard design

Photos courtesy of exhibitfiles.org

The Path Forward

Generate new understandings



The Path Forward

Innovate through cross-pollination

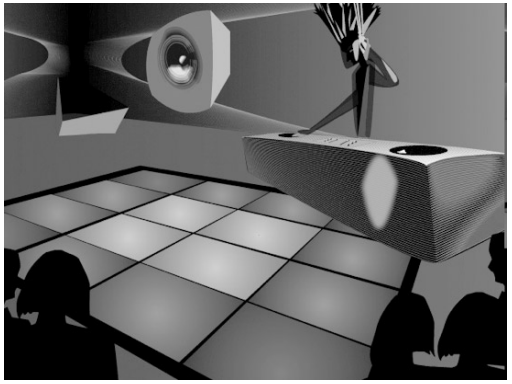


Photo courtesy of http://gambit.mit.edu/loadgame/audiodyssey.php

We think that's great, but we need a lot more. We found a great absence in the literature, both evaluation studies and research studies, that look at truly effective practices for inclusion.

Finally, we realized there is a strong need to innovate through cross-pollination. Our group looked at a broad range of ISE areas—community programs, museums, media, technology—and one of the things we realized is that there is a lot that we can each learn from one another. For example, in the gaming community there is a movement right now to create universally designed games in which people who are blind and sighted can participate together. There is a lot that museums and community programs can learn from that.

So the path forward for us is really a mix, and it focuses all of us on thinking about changing our practices and who we include or, perhaps unintentionally, exclude from learning about science.

Christine Reich and Robert Hone

Serious Games (we live in interesting times)

Robert Hone
Creative Director, Red Hill Studios, San Rafael, California

We use the term "games that matter" because they are games that are being built for a particular purpose. That could be health care. We are developing physical games using low-cost motion controllers for Parkinson's disease. Lots of other people are doing this as well.

People are also developing cognitive games. We are developing games for Multiple Sclerosis to address the cognitive challenges of that disease.

It's being done for training. For integrated pest management, farmers are using this to learn about "tragedy of the commons" issues. It is also used in networked technology. CISCO is using this to train half-a-million people to go through their courses. It is their game and we are working with them to refine and improve it.

It is being used in education and is beginning to find its way into museums. We just finished up something for the California Science Center,

showing visitors about the LA basin smog. It is beginning to come into the formal education world, both as practice problems and formative assessment. For example, we have worked on a set of games for college developmental math. More specifically, for this audience, games have come into the informal world first and so we have had more experience with it, and I will talk a little about one of the games that we are working on.

Our thinking about this is informed through our practice in informal, and we look at the old definition of education and gaming as diametrically opposed. We think of it as

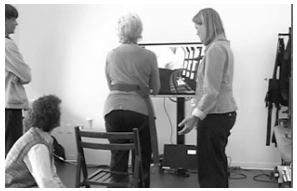
Education and Gaming

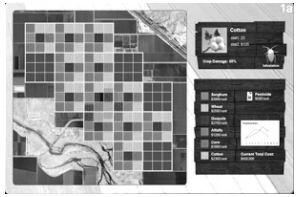
Old Definition: Diametrically opposed

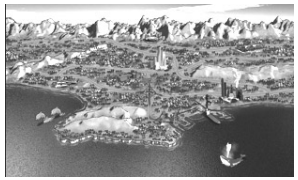
New Definition: Perpendicular dimensions of an educational gaming 'space'

perpendicular dimensions of an educational product space.

So you have textbooks on one side, consumer video games on the other, and there is a lot that happens in the middle. I think a lot of informal science education happens in the middle. That is really where we are aiming in





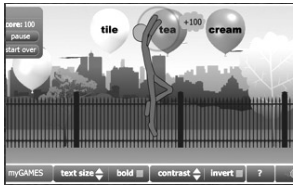


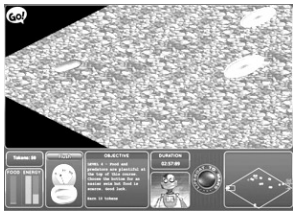
Games that Matter

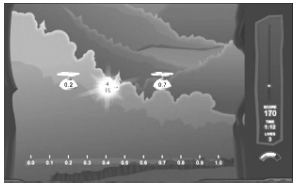
Health Care
Physical – Parkinson's Disease
Cognitive – Multiple Sclerosis

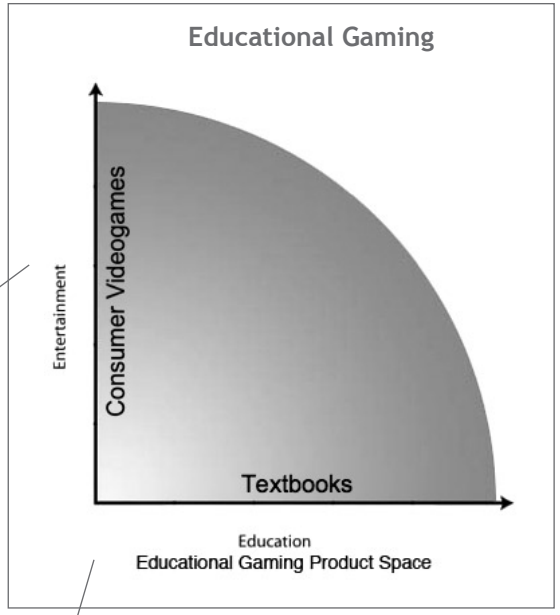
Training
Integrated Pest Management
Networking Technology

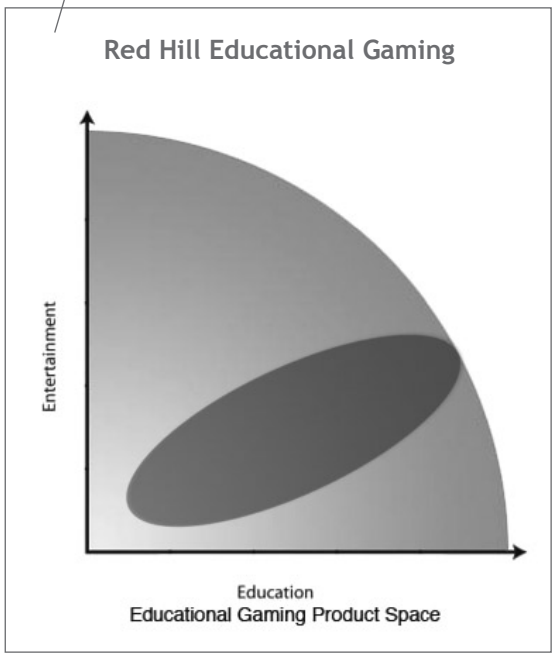
Education
Museum: L.A. Basin Air Quality
Formal: College Development Math
Informal Online: K-12: Biology



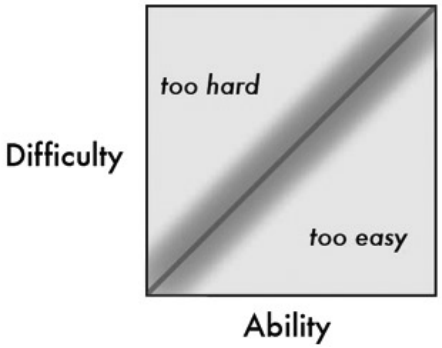






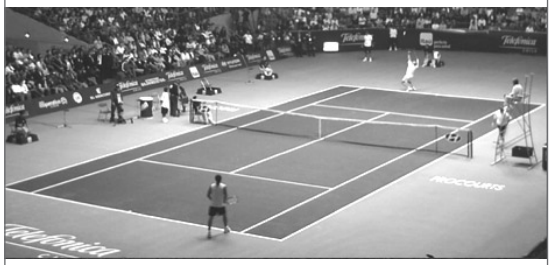


Area of Maximal Engagement



Sweet spot between
hard/frustrating and easy/boring

Area of Maximal Engagement



Balanced challenge
(7-6,6-7,7-6)
Csikszentmihalyi's concept of 'flow'

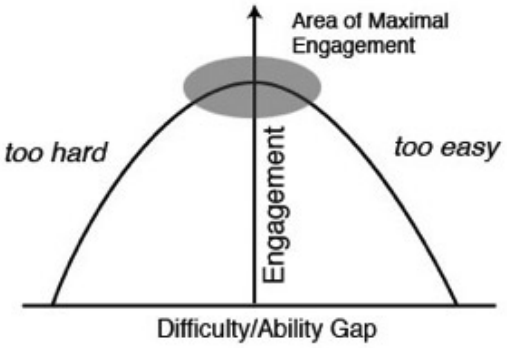
our own gaming. It is a little bit more on the education side, and I will talk more about that as we proceed.

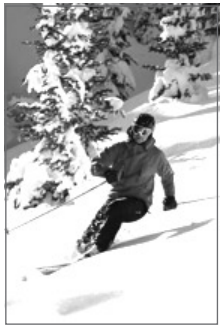
In games, what you are trying to do is maximize the engagement. You want to find a place where the challenge is not so hard as to be frustrating and not so easy as to be boring. The founder of Electronic Arts once compared computer games to a perfectly balanced tennis match where you win 7-6, 6-7, 7-6. You want that challenge to be there, you want the threat of failure to be there. When you do that, when you bring it to peoples' level of ability, you can get into "flow."

Games provide multiple opportunities, multiple entry ways for people, and you can also grow that over time. Engagement falls off in some games if they are too hard or too easy. And if that looks familiar, yes, it is similar to Vygotsky's Zone of Proximal Development. So we had a lot of educational theory that is coming into play, but it is not enough to be there once, you have to continue to be there. Think of a bunny slope. The challenge is easy because people are learning, but you also have to build stuff that the experts are going to be happy with. The consumer game people figured this out a long time ago. They constantly ramp it up, they keep people in the area of flow. That's why games are addictive.

One of the ways that you can approach it is to build individual levels—you take this continuum that you are working on and you build individual pieces. What we are trying to do is marry those pieces with a learning progression so that the levels are not just increases in difficulty because we are adding entertainment value, but because we are also stepping up the educational challenge.

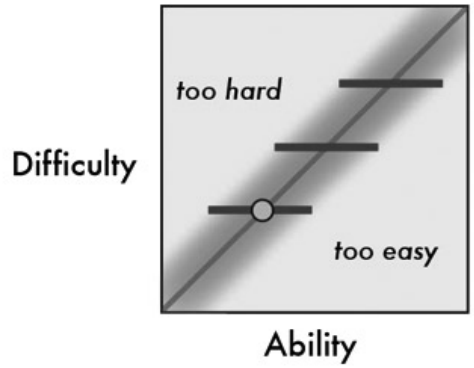
Area of Maximal Engagement





Vygotsky's Zone of Proximal Development

AME Staircase Model

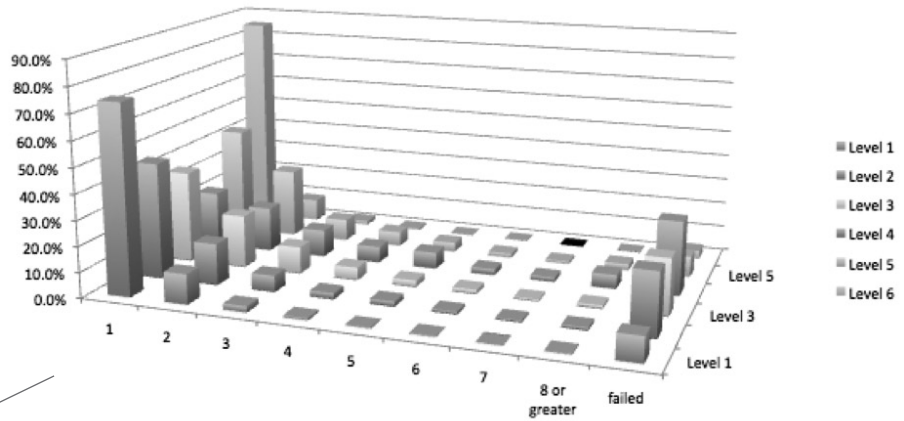


Graded sequence of levels
mapped to learning progression

What we have done in particular, and here we get to *Lifeboat to Mars*, is build a series of games around two basic simulations, one about microbial function and one about ecosystem interactions and dynamics. These are simulation-based games, which are a subset of games (there are lots of different kinds of games). What happens when you have a simulation-based game is that you can build many, many different levels, so you can build a lot of different stepping stones for a particular learning progression or a particular environment.

So how are we doing? This game has been up since early January and about 60,000 game levels have been played. We have to sort of walk the talk, so have we brought kids into the area of maximal engagement? With the data that we have captured, we

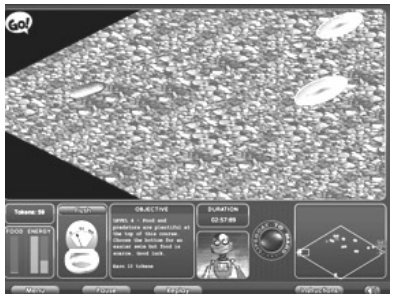
Difficulty Assessment

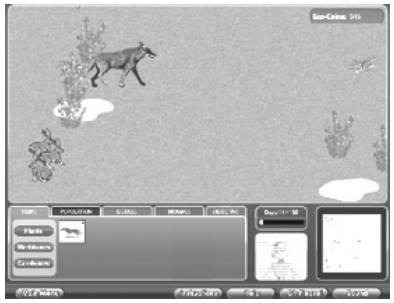


Detailed, rapid assessment of player ability vs. game challenge
(Area of Maximal Engagement)

Lifeboat to Mars

Middle School Biology Games





- Learning progressions on microbes and ecosystems
- Simulation-based game engines and > 90 game levels
- 60,000 game levels played since launch (1/13/10)

actually have the ability to look at that. What we are looking at now is, how many times do they have to play the game to be successful? We have this metric for capturing a lot of data and you can see that a lot of people completed that first level on the first try, and that is fine. That is actually a standard game design technique, which is that you don't want to frustrate people. They're learning the interface and you want to give them a sense of confidence that they can do this.

We have six levels here, going back in time, and you can see that levels two, three and four are much harder. The number of people completing those levels on the first pass are lower. You can see the number of people doing it on second, third and fourth tries. But we are also seeing that the number of people who are failing isn't what we would like to see. That is too high. We would like it so that if they are trying many times, eventually they will be successful.

If you look towards the back, at level 5, that is what we would like to see. It is tough enough that some particular portion of our audience, in this case about 2,000 kids, have to try it more than one time to succeed. That tells us it is the right level of difficulty. Level 6 (the bar all the way in the back) is way too easy. Everybody is getting it. If we have games at that low a level of difficulty, the kids are going to leave because they're going to get bored. This is a snapshot that we can take after we do design changes so that we can learn from what we have done so far, change it, and then watch and see if our changes have, in fact, improved what we are trying to do.

In summary, games can provide supplementary learning opportunities. They are another arrow in the quiver. They don't replace anything that is going on. They can increase engagement by matching ability and providing multiple entry ways. Simulation-based games can provide a huge number of games.

We didn't even get into the fact that we have modding tools that allow kids to build their own versions. There are 800 games that kids have uploaded to PBS.org. We just gave them the tools and they built them.

Finally, online games can allow you to do design-based research because we have the ability to collect the data and learn from it.

Summary

- Serious games provide supplementary learning opportunities
- Can increase engagement by providing 'ability-matched' challenges that adapt over time
- Simulation-based games facilitate creation of many game levels and
- Simulation-based games enable players to create their own game challenges (modding).

Science Learning Through Media Creation

Sue Ellen McCann
Executive Producer, KQED Public Media,
San Francisco, California

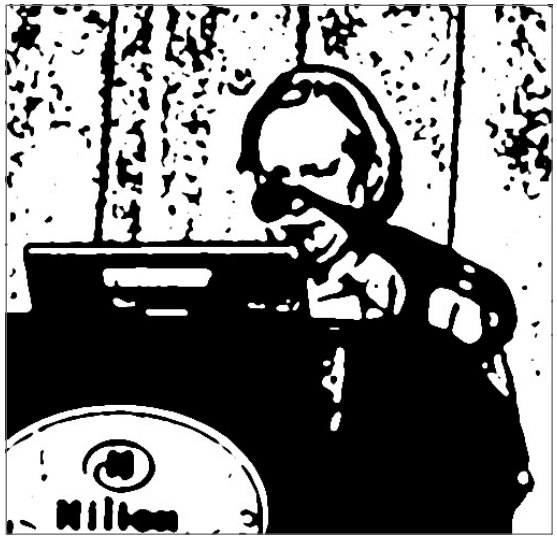
I'm here to talk to you about science learning through media, and public broadcasting's potential to participate and collaborate with you. The project I work on is called Quest and is produced at KQED Public Media in San Francisco. It is a multiplatform, multimedia project about the science and environment of Northern California and serves as a case study for you to think about potential ways of including public broadcasting in the work that you do in science learning.

We create content through a participatory practice of working with and including the community in the content we create. We also think about our audience and about trying to

reach the widest audience possible. In our particular case, we emphasize local science and environment content and what is relevant in our backyard. We create media—TV, radio, web and education—share our media, promote it in a variety of ways and we also evaluate our content and process. And the QUEST staff provides a lot of new media training to our community collaborators.

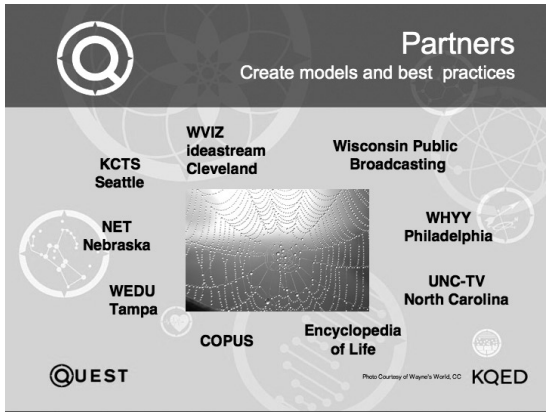
QUEST works with sixteen community partners—science research centers, parks, zoos, science

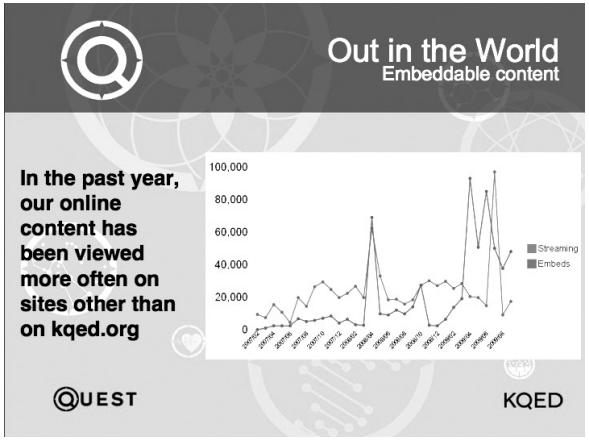
Sue Ellen McCann



museums and aquariums—in our participatory practice, and several of our partners are represented here today: Lawrence Hall of Science, the Chabot Space and Science Center and the Exploratorium. We collaborate with local scientists through story idea sessions as well as with staff at each of the partner organizations. We work with partner staff on educational activities and community events, and in several cases co-create media.

QUEST, in its fourth year, is also in the process of taking this project to other public broadcasting stations around the PBS and NPR system as a way to share this model, our practices, and to figure out how to introduce and scale it in other communities.





Public Attitudes Toward Climate Science

Edward Maibach, MPH, PhD
Center for Climate Change Communication,
George Mason University, Fairfax, Virginia

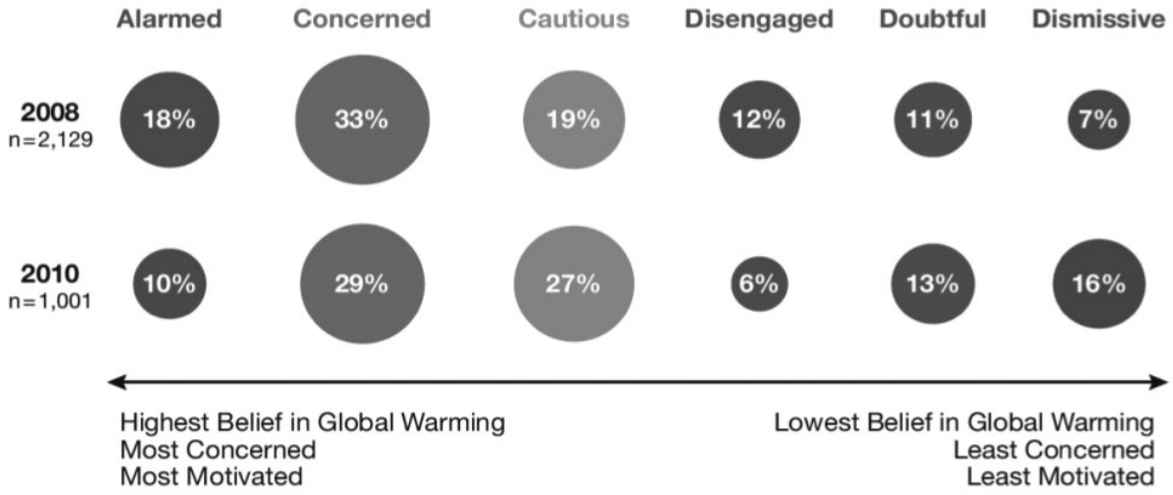
I would like to tell you a short story that I call "Global Warming's Six Americas," and I am going to tell you that story in three chapters. The first chapter takes us back to the fall of 2008, the run-up to the presidential election. My colleagues, Tony Leiserowitz and Connie Roser-Renouf, and I conducted a very big survey of the American adult population. By "very big" I mean 2,100 people, and by "very big" I also mean lots and lots of questions. The point of the survey was to find out what was on Americans' minds with regard to global warming. What were they doing, what were they thinking, and what were their preferences regarding America's response to the challenge?

What we found was that Americans cluster into six groups. We call them "Global Warming's Six Americas." Because I'm telling you a short story, I can't describe these groups as fully as I would like. I will simply point you to the fact that the Six Americas fall along a continuum.

Edward Maibach

Figure 1: Proportion of the U.S. adult population in the Six Americas, 2008 and 2010

Proportion represented by area



Leiserowitz, A., Maibach, E., & Roser-Renouf, C. (2010) Global Warming's Six Americas, January 2010. Yale University and George Mason University. New Haven, CT: Yale Project On Climate Change. http://www.climatechangecommunication.org/resources_reports.cfm

For the full report, *Global Warming's Six Americas*, go to:

http://www.climatechangecommunication.org/resources_reports.cfm

Question: Reasons for the Decline in Alarm

- Regarding the reason that this change occurred in the Six Americas, do you think it is due to the fact that most Americans don't understand how science is done? • Participant

- That may indeed be part of it, but I don't think that is the whole story. I think part of the story is that cognitive psychologists tell us we have a finite pool of worry. It's just innate to the human condition. We can only worry about so many things at any one time. When we are worried about the fact that our mortgages are underwater and we are worried about the fact that our spouses have lost their jobs, that predominates.

  When you look at what people still want to do to address climate change and the direction they would like to see our elected leaders in Washington take, there is still a fairly large wellspring of support for personal and national action. But essentially. the amount of psychological effort that we, on average, are willing to expend on climate change has diminished appreciably because we've got some other really pressing issues on our plate right now. • Edward Maibach

There are the positively engaged, those we call the "Alarmed." They believe deeply that global warming is a real problem and that it is human-caused. They are trying to change their lifestyles and behavior to lessen their own personal contribution to the problem, and they support a very aggressive policy response. They were 18% of the population in the fall of 2008.

On the opposite end of the continuum we have a group that we call the "Dismissive." They were only 7% of the population in the fall of 2008. Like the Alarmed, they are very engaged in the issue, but engaged in the exact opposite manner to the Alarmed. The Dismissives don't believe that global warming is real. If they have any belief that it might be real, they certainly don't believe it is human-caused. And they are adamantly opposed to any sort of national response to deal with the non-problem.

Which brings me to chapter two of my story. After the presidential election, some bad things happened in America. One out of four of us now have mortgages that are underwater. At least one out of ten of us have lost our jobs. The rate of underemployment in America is approaching 20%.

Last summer managed to get global warming legislation passed through the U.S. House of Representatives, but that had the consequence of kicking the global warming denial machine into full gear, which invoked a whole lot of claims that global warming is baloney and other monkey business. Late this last fall we had "Climategate," the stolen e-mails from the University of East Anglia's server, which purportedly showed that climate scientists are themselves up to monkey business. Shortly thereafter, the Intergovernmental Panel on Climate Change (IPCC) got itself into a bit of hot water. Dr. Pachauri, the director of the IPCC, has also found himself in the thick of it. If all of that wasn't enough, we had two feet of snow here in Washington last month.

We now reach chapter three of my story. Last month we went back and surveyed another random cross-section of the American people. We asked them the same questions. We asked them additional questions as well, but the purpose of our survey was to ascertain whether the size of the Six Americas had changed.

What I would like to point your attention to is the fact that the Alarmed segment, the public who believe most deeply that global warming is a problem and feel most strongly that we need to move toward national solutions, have shrunk in size from 18% to 10% of the public. That is a fairly alarming change. As a matter of fact, you can even look at that as up-ending much of the collective wisdom in communication and psychological research, which says that once people make up their mind they tend not to change it. We had a 40% reduction in the proportion of people in this segment, who clearly changed their minds to a sufficient degree to move down at least one segment.

On the opposite end of the continuum, we have the Dismissive segment, who a year-and-a-half ago were only 7% of the population. They are

now 16% of the population. They have grown in size by 250% over a year-and-a-half.

I will let you draw your own conclusions. This is a story to focus you on the nature of the challenge of engaging the American people on the issue of climate change. I would contend that some of the bad things that happened in this story won't necessarily have a lasting impact on people's beliefs and on their desire for a national response on global warming, but some of them absolutely will. So the question for us collectively is, how do we move people back toward the left end of this continuum?

Question: Changing Public Attitudes by Working with TV Weathercasters

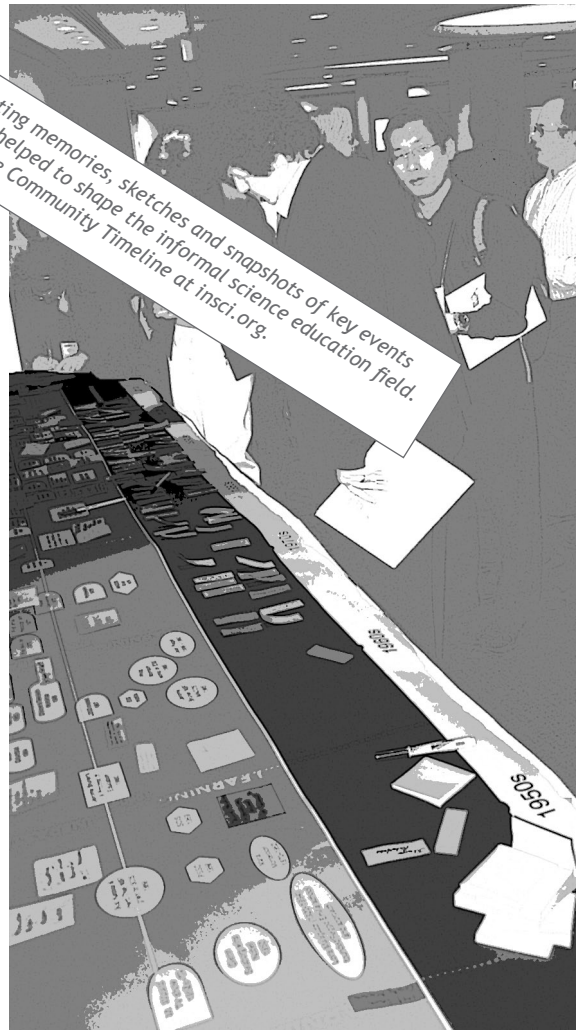
- Are you doing work with TV weathercasters as part of this? • **Participant**
- Thank you for asking that question because that is my NSF-funded project. The National Science Foundation has funded us to work with the nation's weathercasters, 1,400 television meteorologists, because our surveys show that the public is looking to television weathercasters for information about global warming. Americans see weathercasters as scientists and credible sources on the issue.

  Anecdotally, and based on previous surveys, there is a fair amount of evidence that many of the nation's television meteorologists are not strong believers in climate change. Because the previous surveys were done without much funding, we didn't until now have a firm fix on how many of those 1,400 meteorologists, those 1,400 potential climate change educators, are believers in the science of climate change or are climate change science sceptics. I do know the number now, but can't tell you because we promised that the first people we would tell would be our survey respondents, and we are currently working with our advisory board to finalize that report.

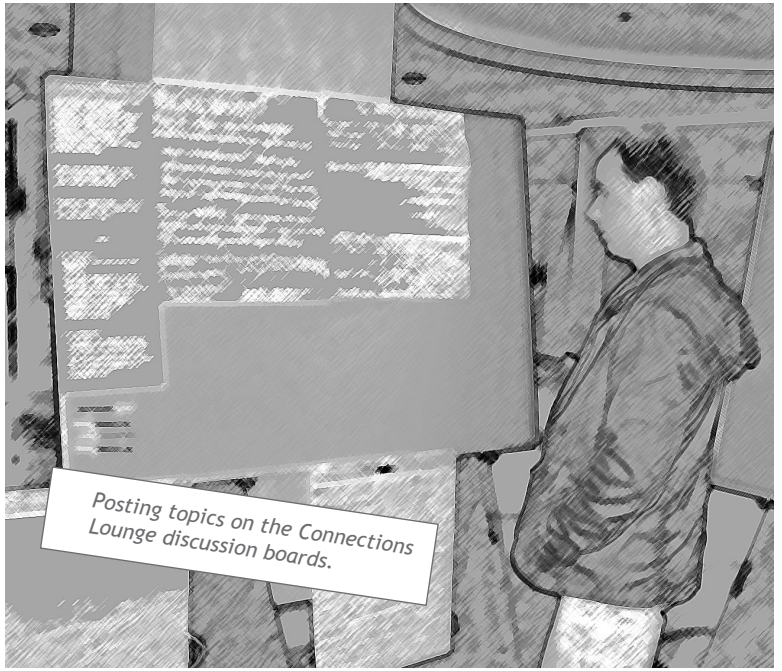
  I will foreshadow just a little and say that the situation is not nearly as dismal as some people in the meteorology community had led me to believe. The majority of television meteorologists do in fact believe in the science of climate change, and there is a palpable hunger for support to help them do a better job of educating their viewers about the connection between extreme local weather events and the changing global climate.

  • **Edward Maibach**

intermission



Posting memories, sketches and snapshots of key events that helped to shape the informal science education field. See the Community Timeline at insci.org.



Posting topics on the Connections Lounge discussion boards.

Browsing and discussing posters and project materials.