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INSTITUTE for Science + Math EDUCATION

Promoting Learning Pathways to Broaden Participation in the Geosciences

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This research is funded by the National Science Foundation through the Science of Learning Center program under grant SBE-0354453. However, all opinions are strictly our own.

COSEE CENTERS FOR OCEAN SCIENCES EDUCATION EXCELLENCE

OCEAN LEARNING COMMUNITIES

PIs: Rick Keil, Kathy Sider, Philip Bell, Carrie Tzou & Fritz Star

The Center promotes scientifically and educationally rigorous citizen science experiences dedicated to broadening participation in the geosciences.

College of the Environment

School of Oceanography

College of Education

SEATTLE AQUARIUM

OCEAN INQUIRY PROJECT

UNIVERSITY of WASHINGTON BOTHELL

Diversity Efforts Are Needed

Deep inequalities in STEM participation still exist.

For example, between 1973 and 2003, more than 21,000 people received Ph.D.'s in geosciences (i.e., ocean, earth & atmospheric sciences).

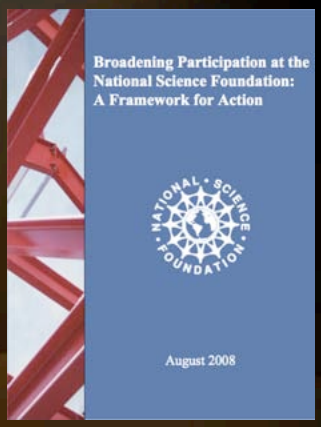
Ph.D. graduates included only 313 (1.5%) Hispanic Americans, 135 (0.6%) African Americans, and 49 (0.2%) Native Americans. This is less than 2.4% compared to their 36% representation in the population.

WHOI *Oceanus*, "A Diversity of Geoscientists," 21 Aug 2009

NSF Mandate & Approach

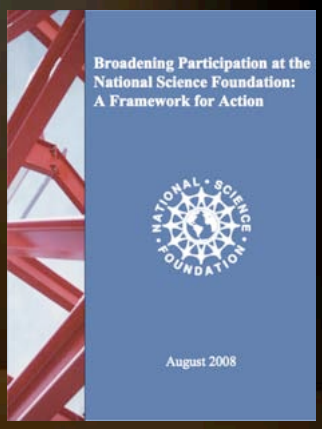
Given these long-standing inequalities, broadening participation is a high-level NSF priority.

Broadening opportunities and enabling participation of all citizens — in terms of gender, race/ethnicity, persons with disabilities, social class, etc. — is essential to the health and vitality of science and engineering.



NSF Mandate & Approach

NSF defines broadening participation in terms of individuals from underrepresented groups as well as institutions and geographic areas that do not receive proportional NSF funding.



Broadening participation is part of the overall merit review process used at NSF—as a dimension of broader impacts. Some NSF programs, however, have a particular focus or emphasis on broadening participation.

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Making Science Inclusive

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

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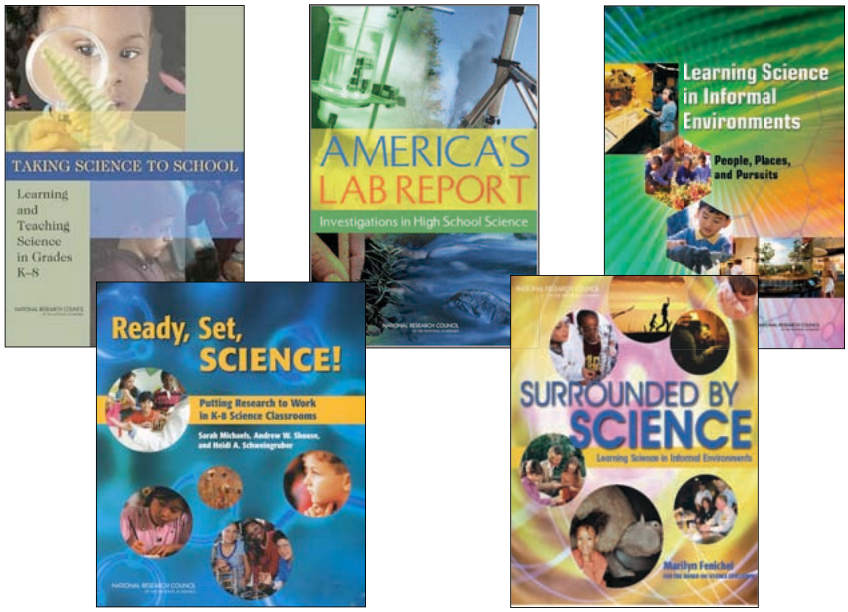

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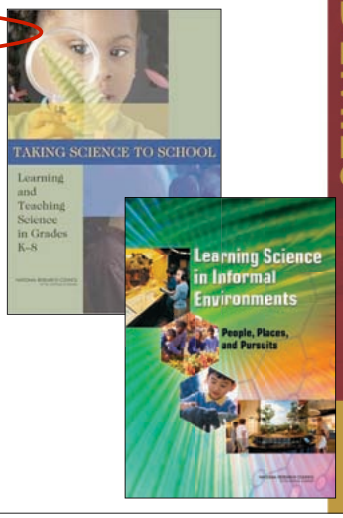
What is Science Learning? Consensus: Six Strands of Scientific Proficiency

1) Developing Interest in Science
2) Understanding and Using Scientific Knowledge
3) Engaging in Scientific Explanation and Argument
4) Reflecting on the Scientific Enterprise
5) Engaging in Scientific Practices
6) Identifying with the Scientific Enterprise



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Promoting Learning

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

Educational efforts should focus on building upon ***prior interest*** *and* ***prior identity*** *as much as building upon* ***prior knowledge****.*

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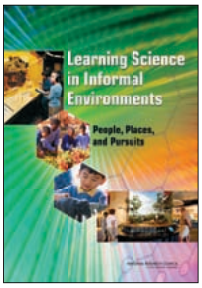
Conclusion: Cultural Variation in Science Learning

Science is a cultural endeavor.
Learning science is a cultural process.

Cultural groups develop knowledge of the natural world through their participation in learning experiences and forms of exploration shaped by their community history and language as well as the demands of particular settings.

Diverse knowledge and ways of knowing about nature should be recognized in designing science learning experiences.



Plant Knowledge among Zapotec Children (Hunn, 2002)

How are you seen as a scientist?

Google image search top 10 hits

Society breeds narrow, misconstrued, sometimes bigoted notions of science and scientists which can reproduce inequity—and which we can counteract!

Multiple Venues for Science Learning

Designed Informal Settings
(e.g., Allen & Gutwill, 2004; Callanan & Jipson, 2001; Rennie & McLafferty, 2002)

Everyday Settings & Family Activities
(e.g., Callanan & Oakes, 1992; Crowley & Galco, 2001; Goodwin, 2007; Bell et al., 2006)

Classroom Instruction
(e.g., Barton, et al., 2003; Davis, 2003; Linn, 2006; Newton, Driver & Osborne, 1999; Reiser et al., 200x)

Programs for Young & Old
(e.g., Halpern, 2002; Noam, et al., 2003; Gibson & Chase, 2002)

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Culturally Responsive Education

Recommendation: [Educators] . . . should actively integrate into science learning experiences, questions, everyday language, ideas, concerns, world views, and histories of diverse learners.

[illegible]

[illegible]

(Carrie Tzou, Amanda Bruner, Tansy Clay, Brittany Kimball, Blakely Tsurusaki,Philip Bell, Rick Keil)

SOUND CITIZEN www.soundcitizen.org

University of Washington Institute for Science & Mathematics Education

CoSEE Centers for Ocean Sciences Education Excellence — Ocean Learning Communities

OACIS Ocean & Coastal Interdisciplinary Science

NSF

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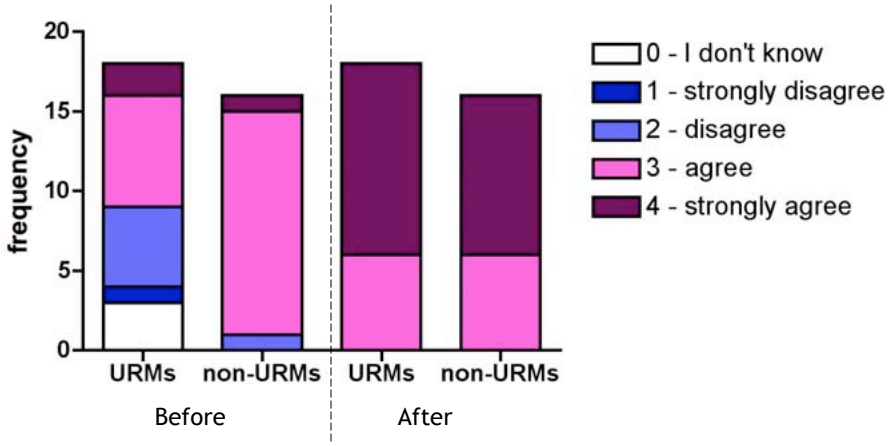

Bruner & Clay, unpublished work

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Broadening Participation in STEM

In terms of broadening participation in STEM, studies do suggest that informal learning environments ma youth from histor communities.

Cultural diversity can play a powerful, constructive role in science learning in these (and all) settings. There is a growing scholarly community developing *a science of broadening participation* which leverages the sciences of learning.

Cultural Variation of Science Learning (e.g., Hunn, 2002)

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Project COOL

Broadening Participation through Community Based Science Apprenticeships

Program / Research Focus

- Youth engagement in authentic scientific practices across settings
- Opportunities for development of science-linked identities
- Relationships and structures that support joint scientific work between youth and scientists

SOUND CITIZEN www.soundcitizen.org

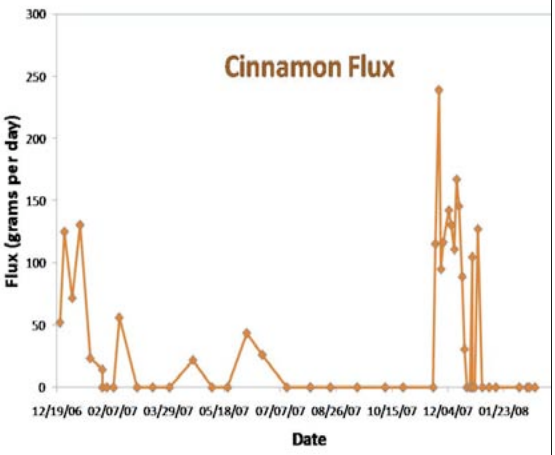
College of Education

SACNAS CHAPTER

CoSEE Ocean Learning Communities — Centers for Ocean Sciences Education Excellence

Apprenticeship Program: Building Upon the SoundCitizen Volunteer Water Sampling Network

SoundCitizen volunteers collect water samples and ship them to the lab for processing, making direct contributions to the lab's scientific work.



SoundCitizen also produces reports on inert substances which fluctuate seasonally such as cinnamon during the holiday season. These reports are are intended to inform the public about the relationship between their behavior and water quality.

http://soundcitizen.org/

Apprentices Engage in Inquiry

- Work with mentors in the lab: Apprentices conduct duties in a 'research group' fashion with varied duties and overlapping goals
- Students identify questions relevant to personal and community interests, design studies, analyze data, and communicate results in authentic contexts
- Network with professionals of color in science-based fields in the region (SACNAS)

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Developing Reciprocal Partnerships

Conclusion: Partnerships between science-rich institutions and local communities show great promise for fostering inclusive science learning. Developing productive partnerships requires considerable time and energy.

Reframe one-way 'outreach' to focus on 'reciprocal partnerships' that attend to context and lived experience within communities

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Community-Centered Educational Design

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

Reciprocal Partnerships…

- are mutually beneficial to all parties; interests of each group are attended to
- operate through shared governance & decision-making
- involve equitable sharing of financial and material resources & project benefits
- look out for and work against power differentials that may be operating (e.g., between university and community / school participants)
- leverage diverse expertise of the team to create productive learning opportunities

Diversity STEM-related Organizations:

Making the Connections

SACNAS
Advancing Hispanics/Chicanos & Native Americans in Science

AISES
American Indian Science & Engineering Society

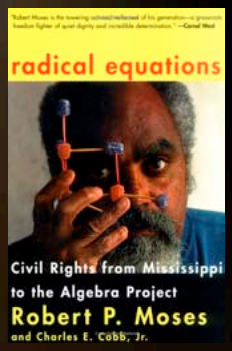
SHPE
Society for Hispanic Professional Engineers

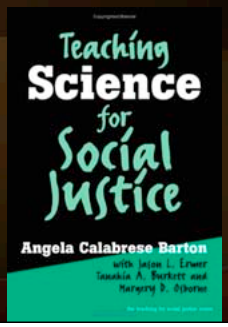
NSBE
National Society of Black Engineers

NOBCChe
National Organization of Black Chemists & Chemical Engineers

Understanding STEM Education as a Civil Rights Issue

- In general, the social consequences of not achieving in academic terms are profound
- STEM Education should be oriented to providing equitable access to knowledge associated with high socioeconomic occupations anticipated in the future
- Science and math literacy provide a strong foundation for productively navigating the circumstances of everyday life, including civic participation





Questions or comments?