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What do the NSF Broader Impact themes mean?¹

Themes:

- [Advancing discovery while promoting teaching, training and learning](#)
- [Broaden Participation of Underrepresented Groups](#)
- [Enhancing Research and Education Infrastructure](#)
- [Broadly Disseminating Results](#)
- [Benefits to Society](#)

Advancing discovery while promoting teaching, training and learning

- i. Ideas from NSF
- ii. Examples
- iii. Resources

i. Ideas from NSF

- Integrate research activities into the teaching of science, math and engineering at all educational levels (e.g., K-12, undergraduate science majors, non-science majors, and graduate students).
- Include students (e.g., K-12, undergraduate science majors, non-science majors, and /or graduate students) as participants in the proposed activities as appropriate.
- Participate in the recruitment, training, and/or professional development of K-12 science and math teachers.
- Develop research-based educational materials or contribute to databases useful in teaching (e.g., K-16 digital library).
- Partner with researchers and educators to develop effective means of incorporating research into learning and education.
- Encourage student participation at meetings and activities of professional societies.
- Establish special mentoring programs for high school students, undergraduates, graduate students, and technicians conducting research.
- Involve graduate and post-doctoral researchers in undergraduate teaching activities.
- Develop, adopt, adapt or disseminate effective models and pedagogic approaches to science, mathematics and engineering teaching.
- Involve a teacher in research (See Research Experiences for Teachers http://broaderimpacts.info/BIT/BIT_K12_RET.php)

ii. Examples

- Julian Tyson at U-Mass Amherst engaged middle school students with an exercise involving arsenic in pressure-treated lumber. This is paired with bringing the teachers into the lab over the summer for a research experience (<http://umassk12.net/rays/arsenic/Tyson.ppt>).
- Cassandra Fraser provides an example of a new course at U.Va. that was developed in her research area <http://www.reinventioncenter.miami.edu/conference2006/cassandrafraser/summary.htm> (Proposing a new course for BI can sometimes produce the 'but that's part of your job anyway' response from reviewers, so if you go this route, you need to make a good argument.)
- Scripps Institution of Oceanography researcher G.D. worked with H.H. and staff of the Ocean Institute, an informal science education center in Dana Point, CA, to develop a multifaceted educational outreach plan for his NSF proposal entitled "A parametric study of the link between energy dissipation and bubble creation in laboratory breaking waves". Approximately 10% of the funds requested were allocated to support the outreach activities. The collaboration, facilitated by

¹ This information was collated from the Broader Impacts Toolbox website developed by the University of Nebraska. Available: <http://broaderimpacts.info/>

S.F. of COSEE California, will result in a new educational exhibition, Sea Bubbles!, to introduce the public to the role of bubbles in gas exchange between the atmosphere and the ocean. Working with the Ocean Institute's curriculum development team, G.D. will participate in the design of six tested informal science education treatments that include the public exhibit, a one-hour interactive tour, a 30-minute Interactive Public Program, Family Kits, a Teacher Workshop, and a 16-piece Art and Science display. Visitors to the Ocean Institute will learn about the technology by generating bubbles in a tank and using lasers and sensors to detect the bubbles. It is expected that the exhibition and associated programs will reach at least 36,000 general public visitors, 50 K-12 teachers and 2,000 elementary students.

- Alaska's farflung schools face many problems, among them how to improve the science curriculum for grades 8-12. At the University of Alaska Fairbanks, an intensive summer course has shown that lessons of a 300-level undergraduate course, Introduction to Geoinformatics, can be applied effectively to the training of pre-service and in-service teachers. The course, which introduces undergraduates to concepts of remote sensing, geographic information systems (GIS), global positioning system (GPS), data management, and cartography, was retailored as a two-week, intensive course designed to attract outstation teachers who could not attend a semester long course. Because recreational grade GPS receivers are now commonly available at affordable prices (about \$100 per receiver), it has become easy to introduce GPS into middle and secondary schools. GPS still has a certain "wow" factor, so teachers are eager to learn about the technology. Indeed, while undergraduates take less time to study and practice GPS, our teacher training course spent a fair amount of time on its use, with the result that teachers felt confident of being able to passing this knowledge on to students. We made other adaptations, including shortening lab exercises. A typical lab period in an undergraduate class varies from 2 to 3 hours. In contrast, the longest class period for 8th through 13th grades is 75 minutes. Considering this limitation, we reconstructed the lab exercises so that they could be successfully completed by students in roughly 45 minutes. In addition, we adopted a "cook book approach" to lab assignments, providing more detailed instructions than we do for undergraduates. Our experience showed that teachers needed greater support for learning new computer-based tools, such as GIS software packages, than younger students do. Consequently, we encouraged teachers to participate and work in teams of two from each school. This team approach also meant that when teachers implemented the course once they returned to their classrooms, one teacher could provide backup to the other.

iii. Resources

- See Resources provided in separate document.

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Broaden Participation of Underrepresented Groups

What are "Underrepresented Groups"?

- Underrepresented groups in math, science and engineering (MS&E) are those groups whose demographics in MS&E do not reflect their representation in the general population. The National Science Foundation recognizes women, African-Americans, Hispanics, Native Americans and Pacific Islanders as underrepresented groups.
- A good source of reliable statistics is the Science and Engineering Indicators, which is published by the National Science Board of the National Science Foundation. The latest statistics show that the proportion of women, African-Americans and Hispanics in S&E occupations have continued to grow over time, but are still less than their proportions of the population. In particular, they found:
 - i. Women were 12% of those in S&E occupations in 1980 and 25% in 2000. However, the growth in representation between 1990 and 2000 was only 3 percentage points.
 - ii. The representation of blacks in S&E occupations increased from 2.6% in 1980 to 6.9% in 2000. The representation of Hispanics increased from 2.0% to 3.2%. However, for Hispanics, this is proportionally less than their increase in the population.

Why Broaden Participation?

The demographics of the country are changing. The proportion of Hispanic and African-American people will be getting larger. MS&E has traditionally not attracted people from these demographics into MS&E occupations.

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Enhancing Research and Education Infrastructure

- i. Ideas from NSF
- ii. Examples

i. Ideas from NSF

- Identify and establish collaborations between disciplines and institutions, among the U.S. academic institutions, industry and government and with international partners.
- Stimulate and support the development and dissemination of next-generation instrumentation, multi-user facilities, and other shared research and education platforms.
- Maintain, operate and modernize shared research and education infrastructure, including facilities and science and technology centers and engineering research centers.
- Upgrade the computation and computing infrastructure, including advanced computing resources and new types of information tools (e.g., large databases, networks and associated systems, and digital libraries).
- Develop activities that ensure that multi-user facilities are sites of research and mentoring for large numbers of science and engineering students.

ii. Examples

- i. Every NSF proposal has to address broader impacts. Any piece of equipment large enough that you need to write a grant to buy it is large enough to serve as the basis for building research infrastructure. This poster from Purdue is a good example of showing how the instrumentation builds infrastructure:
http://www.purdue.edu/strategic_plan/whitepapers/Large%20Scale%20Research.pdf

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Broadly Disseminating Results

- i. Ideas from NSF
- ii. Examples

i. Ideas from NSF

- Partner with museums, nature centers, science centers, and similar institutions to develop exhibits in science, math, and engineering.
- Involve the public or industry, where possible, in research and education activities.
- Give science and engineering presentations to the broader community (e.g., at museums and libraries, on radio shows, and in other such venues).
- Make data available in a timely manner by means of databases, digital libraries, or other venues such as CD-ROMs.
- Publish in diverse media (e.g., non-technical literature, and websites, CD-ROMs, press kits) to reach broad audiences.
- Present research and education results in formats useful to policy-makers, members of Congress, industry, and broad audiences.
- Participate in multi- and interdisciplinary conferences, workshops, and research activities.
- (DLP Note: This indicates that 'broader' doesn't necessarily mean non-scientists: sharing information outside your immediate field counts.)
- Integrate research with education activities in order to communicate in a broader context.

ii. Resources

- The *Communicating Research to Public Audiences* program at NSF (NSF 03-509) (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5362&from=fund) provides supplements of up to \$75,000 to existing grants specifically for activities that will disseminate the results and process of research to the public. No deadline, but they need at least six months for processing.

iii. Examples

- Casey Dunn in the EEB department at Brown has a nationally popular blog called Creature Cast: <http://creaturecast.org/>, a blog and video series about the unexpected world of animals.
- Jack Simons at Clemson hosts a 'theoretical chemistry website' (<http://simons.hec.utah.edu/TheoryPage/index.html>), which is an excellent way to publicize not just your own research results, but your entire field to a large number of people. This is probably a great resource for teachers as well.
- James Yardley of Columbia reports an interesting public science event held in New York City. 'Events' can sometimes be the best format for people who want to concentrate their efforts, as opposed to spreading them out throughout a year. Once you do an event, it is much easier to repeat it the next year.
- If you have a theatrical bent, you can stage a science play. Gideon Frankel at Ohio State participated in a panel to discuss the play's content with the audience. It was especially nice that the play they picked showed the public a little more of the personal side of science.

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Benefits to Society

- i. Ideas from NSF
- ii. Examples

i. Ideas from NSF

- Demonstrate the linkage between discovery and societal benefit by providing specific examples and explanations regarding the potential application of research and education results.
- Partner with academic scientists, staff at federal agencies and with the private sector on both technological and scientific projects to integrate research into broader programs and activities of national interest.
- Analyze, interpret, and synthesize research and education results in formats understandable and useful for non-scientists.
- Provide information for policy formulation by Federal, State or local agencies.

ii. Examples

- A powerpoint presentation on the Broader Impacts of the Long-Term Ecological Research (LTER) program: <http://www.nsf.gov/pubs/2005/nsf0533/nsf0533.pdf>

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