Broader Impacts Toolkit

NSF now requires a section in all proposals that addresses one or more of five broader impacts. This document includes ideas, examples and resources to help faculty conceptualize their proposals and meet NSF's new requirements. The NSF Proposal & Award Policies & Procedures Guide (PAPPG) contains more information in Sections III.A.1. and III.2.d.(i).

Broader Impact Themes:
I.   Advancing Discovery While Promoting Teaching, Training and Learning
II.   Broaden Participation of Underrepresented Groups
III. Enhancing Research and Education Infrastructure
IV.   Broadly Disseminating Results
V.   Benefits to Society

I. Advancing Discovery While Promoting Teaching, Training and Learning

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.

Resources @ Stanford
- Tap into Stanford's Summer Research Program for Teachers to host a teacher; you design the project and select the teacher from a pool of candidates (and where possible, provide stipend funding); the OSO does the rest.
- Participate in one of Stanford's many formal high school internship programs. Internships can be arranged in all areas of STEM. Or host a high school intern on an ad hoc basis, using this packet (first bullet) with checklist and forms to guide you.

This information is based on materials developed by the University of Nebraska and the Sheridan Center for Teaching and Learning at Brown University.

The Office of Science Outreach is here to help. Contact Kyle Cole at kylecole@stanford.edu.

- Tap into one of Stanford's many Research Experiences for Undergraduates (REU) programs. Or host an undergraduate on an informal basis, using this packet (2nd bullet) with checklist and forms to guide you.
- NSF often provides supplemental **funding** for all of these internships to PIs with active projects. The OSO can help you request this supplemental funding.
- Participate as a speaker in a summer workshop for teachers, undergraduates or high school interns. There are many on campus; OSO can get you linked in.
- Encourage your students to teach a course in SPLASH! or participate in any of dozens of other student-run outreach programs.

Examples @ Stanford
- David Camarillo hosted three high school interns to work on a special project assembling and testing sophisticated mouth guards used by Stanford athletes to monitor head injuries.
- Christopher Chidsey and Jennifer Schwartz Poehlman hosted high school chemistry teachers for a number of summers to develop and test low cost, standards-aligned chemistry labs suitable for high school students. They then partnered with the Graduate School of Education to offer summer workshops to chemistry teachers and published the labs online. Their graduate students also partnered with specific high schools to co-teach the labs to students.
- George Hilley developed shoMe to let anyone create and share virtual journeys through the real world, touring landmarks, making scavenger hunts, or taking a virtual field trip.

II. 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 NSF recognizes women, African-Americans, Hispanics, Native Americans, Pacific Islanders, military veterans and persons with disabilities as underrepresented groups.

This theme should infuse your broader impacts strategy. You can address this priority with many of the activities provided as examples here, by targeting the teachers, schools or students with whom you partner. The OSO can help you find a partner to meet this criterion.

III. Enhancing Research and Education Infrastructure

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/education platforms.

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- 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.

Examples @ Stanford

- Nick McKeown's team developed the NetFPGA platform, making makes it easy for students and researchers to build and deploy high-performance networking systems using Field Programmable Gate Array (FPGA) hardware. NetFPGA hardware is being deployed in backbone networks, other research laboratories, and classrooms in EPSCoR states.
- Jure Leskovec in Computer Science released datasets and computational tools for the analysis of large networks through Stanford Network Analysis Platform (SNAP).
- Eric Pop's lab built a remote web-enabled probe station for testing nano-electronics, eventually allowing access for anyone in the world to do cutting-edge device measurements.

IV. Broadly Disseminating Results

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, or in similar 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.
- Integrate research with education activities in order to communicate in a broader context.

Note: "Broader" doesn't necessarily mean non-scientists; sharing information outside your immediate field counts.

Resources @ Stanford and Beyond

- Offer a demo or exhibit at the annual Bay Area Science Festival Discovery Day or the Bay Area Maker Faire and reach thousands of people (many of them families with young children).
- Speak to the general public about your research as part of a Stanford lecture series (LASER, Café Scientifique, or SLAC Lecture series).

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- The AAAS Center for Public Engagement with Science & Technology offers a communication toolkit containing fundamentals, tips for working with media, giving presentations, communicating online, etc.

<u>Examples @ Stanford</u>

- Stanford PIs have created materials for use in a K-12 classroom such as learning modules, videos, virtual labs, or computer simulation. Examples include Steve Palumbi's *Microdocs: The Short Attention Span Science Theater on Ecological Sustainability*, Vijay Pande's *Folding@Home*, and Andrew Spakowitz's LABSci science curriculum for students in hospitals and other non-traditional settings.
- Stanford at the Tech trains Stanford biology graduate students and postdocs in effective communication and they then serve as docents at the Tech Museum of Innovation's *Understanding Genetics* exhibit.
- The Prakash Lab developed Abuzz, a mosquito monitoring platform to produce the most detailed global map of mosquito distribution.
- Deborah Gordon developed the Ant Colony Search Citizen Science Project to help K-12 students and the public investigate how ants work together.

V. Benefits to Society

Every NSF grant has the potential to not only advance knowledge, but benefit society. This can be achieved by: 1) Building STEM talent for the next generation workforce, 2) Innovating for the future, 3) Improving our society via scientific discovery, 4) Reaching beyond borders, or 5) Engaging a wider audience.

<u>Ideas from NSF</u>
- Demonstrate the linkage between discovery and societal benefit by providing examples and explanations about the potential application of research and education results.
- Partner with academic scientists, staff at federal agencies and 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.

<u>Examples @ Stanford</u>
- Christopher Field co-chaired Working Group II of the Intergovernmental Panel on Climate Change, leading the effort on the IPCC Special Report on "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation."
- Sean Reardon investigates the causes, patterns, trends and consequences of social and educational inequality. He heads up the Stanford Education Data Archive (SEDA), an initiative harnessing data on the patterns of achievement and achievement gaps in every school district in the United States.