

NATIONAL SCIENCE FOUNDATION

The NSF self-defines its merit review component as a rigorous and competitive based process for maintaining high standards of excellence and accountability. NFS utilizes two National Science Board approved merit criteria: **Intellectual Merit** and **Broader Impacts**.

BOTH must be addressed in the one-page Project Summary or the proposal will not be reviewed, and both must be elaborated upon in greater detail within the body of the proposal.

BROADER IMPACTS CRITERION

There are 5 components of *Broader Impacts Criterion*

- I. What are the Broader Impacts of the Proposed Activity?
- II. How well does the proposed activity broaden the participation of underrepresented groups (e.g. gender, ethnicity, disability, geographic, etc.)?
- III. To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks and partnerships?
- IV. Will the results be disseminated broadly to enhance scientific and technological understanding?
- V. What may be the benefits of the proposed activity to society?

Advance Discovery and Understanding While Promoting Teaching, Training and Learning

- Training and mentoring students
- Presenting seminars, organizing workshops and symposia
- Updating the curriculum by writing texts and developing new classroom instructional materials and laboratory experiments
- Sharing laboratory methods, instrumentation, software for data analysis, and samples of compounds
- Devising and sharing safer laboratory procedures and more economical research practices

Broaden Participation of Underrepresented Groups

- Including students from underrepresented groups as participants in the proposed research and education activities
- Establishing research and education collaborations with faculty who are members of underrepresented groups or are from minority-serving institutions, community colleges, undergraduate institutions and colleges for women

Enhance Infrastructure for Research and Education

- Mentoring early-career scientists and engineers
- Consulting with industrial and government colleagues
- Establishing collaborations with scientists from around the world
- Maintaining, operating and modernizing shared instrumentation and facilities
- Developing the computing infrastructure that will allow cyber-enabled chemistry

Broad Dissemination to Enhance Scientific and Technological Understanding

- Writing scholarly review articles and articles describing research to non-specialist audiences
- Creating websites enhanced by engaging animations and movies
- Working with science centers on new exhibits
- Assisting journalists with their stories on technical topics
- Developing new art forms for communicating science to wider audiences

Benefits to Society

- Designing new routes to commodity and fine chemicals
- Preparing new compounds of industrial, medical, and environmental significance
- Identifying more effective ways to use energy resources
- Developing new devices and methodologies for national security
- Forming start-up companies for disseminating new technologies

INTELLECTUAL MERIT CRITERION

What is the *intellectual merit* of the proposed activity?

This question addresses the overall quality of the proposed activity to advance science through research and education.

- How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields?
- How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work)
- To what extent does the proposed activity suggest and explore creative and original concepts?
- How well conceived and organized is the proposed activity?
- Is there sufficient access to resources

Undergraduate research vs. Research-centered proposals

Some projects are explicitly oriented towards education and/or broadening participation of under-represented groups, such as at Brooklyn College with the BPC-DP, BOSC and BC-CAL programs. These **undergraduate research** grants are education-oriented with a primary emphasis on broader impacts.

However, even if a proposed project centers on laboratory research, the broader impacts are still essential for a successful proposal.

Be creative – how can your research and/or its results have a broader impact?

Some examples of broader impacts of successful research-oriented grants:

- Provides research training for undergraduate and graduate students
- Provide facilities, creates software, etc. which will be used by other researchers and both graduate and undergraduate classes and students
- PI's research to be incorporated into their classes to benefit students
- Collaboration with other schools or departments
- Practical applications outside of academia, positive impacts on public sphere – environmental, safety, productivity, etc.
- Creation of material or tool with applications in other disciplines or industries (i.e. art conservation, efficient energy production, etc.)
- Creation of a model applicable to future research (perhaps interdisciplinary research)
- Research will be shared with general public -- through a website, publications, demonstrations, lectures, etc.
- International scientific cooperation
- Outreach to high schools:

- Involve high school students from schools geared toward minority urban students
- Involve students in laboratory research
- Workshops for high school teachers
- Field trips
- Remember Brooklyn College’s role in programs to support minority participation (BPC and BOSC) – is there a way your project can build on this?

BROADER IMPACTS EXAMPLES FROM SUCCESSFUL BC PROGRAMS

Powell/ Miele: Science and the City

The **intellectual merit** of the proposal is associated with finding answers to the following questions: What is required to formalize a partnership between higher education and informal science institutions for teacher preparation? What is the added-value to geoscience teachers prepared systematically in a program developed and taught in partnership with community-based informal science and cultural institutions?

Much of this proposal for an innovative undergraduate program already addresses the criteria for **broader impact**, especially broad benefits to society, and the promotion of teaching, training and learning. They are intrinsic to the “Science and the City” program’s design and implementation: training more earth science teachers who will stay in the job longer and will be better equipped to teach geoscience in New York City. However, additional broader impacts of this program include:

- The establishment of meaningful professional relationships between the partners that will likely promote further cooperation amongst these educational organizations in various combinations leading to wholly new educational collaborations;
- Direct transfer of agreements between Brooklyn College and our partners to the other 19 colleges, and potential adoption and implementation by any other college in New York City to benefit the 1,000,000 college students who live here;
- The main beneficiary will be students of Brooklyn who constitute 26% of Brooklyn’s 2.5 million people and of which only 27% of them are identified as non-Hispanic White.

[FOR RECENT DEMOGRAPHIC INFORMATION REGARDING BC, GO TO:

<http://www.brooklyn.cuny.edu/bc/offices/avpbandp/view/institutionaldata/enrollment.htm>

Click on particular semesters for which enrollment data is sought, then enter password: **ipra**]

BROADER IMPACTS

- **Building Networks and Partnerships:** The Science and the City program will build a partnership of Brooklyn College. However, establishment of meaningful professional relationships between the partners will likely promote further cooperation amongst these educational organizations in various combinations leading to wholly new educational collaborations. Given the multi-disciplinary nature of the partnership established herein, the benefits of our network has the potential to benefit science education in general.
- **Benefits to Underrepresented Groups:** Brooklyn College’s student population is drawn predominantly from our borough’s melting pot of cultures, nationalities, and social classes. Greater than half the (51.6%) of the total population of graduate students (including teachers) that are currently enrolled at Brooklyn College self-identify as non-white (including Hispanics), and 68% are female. Thus our proposed MAT program will likely enroll a majority of nationally underrepresented groups. Furthermore, the vast majority of teachers currently enrolled at Brooklyn College teach within the borough

where 73% of the total 650,000 school-age children are identified as non-white (including Hispanics), and so our efforts to improve the number and quality of Earth Science teachers in the borough will have the greatest benefit on nationally underrepresented ethnic groups.

Lesser: NSF/ BOSC

The *intellectual merit* of Brooklyn Outreach for Science Careers is in testing a model for increasing STEM majors in physical sciences including physics, earth sciences and environmental studies by redirection of qualified students who have not expressed interest in a STEM major. This project is based upon the hypothesis that if entering college students are made aware of the variety of rewarding careers available to STEM graduates, they can be induced to enter STEM majors in the physical sciences. A second hypothesis is that activity-based instruction supported by Peer-led Team Learning will help retain these redirected students. A fourth hypothesis is that a learning environment that is supportive both socially and academically will contribute to retention of these redirected students in STEM majors. A final hypothesis is that such a program can become self-sustaining in a comprehensive publicly-supported urban institution.

The project's *broader impact* will be to develop and test a prototype for redirection of qualified college students into majors in physical sciences that can be replicated in other large urban colleges. Locally, our city's young people will be made aware of, and provided with an avenue to enter a broader range of financially and socially rewarding careers. The project will also increase the number of well-trained local high school science teachers, which should positively impact the pipeline of qualified STEM majors from the largely minority area high schools in the future.

Sklar: BPC-DP: Building a Bridge in Brooklyn

When broadening participation in computing, one solution does not fit all situations [Galpin 2002] – what works at Carnegie Mellon University (CMU) will not necessarily achieve optimal results at an urban commuter school. One of 19 colleges that comprise the City University of New York (CUNY), Brooklyn College (BC) is a public liberal-arts 4-year college that primarily attracts working-class students, many of whom are the first in their families to attend college and most of whom hold part-time jobs while they go to school. Three-quarters of BC's 15,000 students attended Brooklyn high schools. The student body is 60% female; and nearly half the students are ethnic minorities underrepresented in computing fields (30.7% African American, 11% Hispanic). Yet despite this diversity on campus, like most institutions in the US, a disproportionate number of the computer science (CS) majors at BC are white males (78%). Of the female CS majors, 18% are African American and 5% Hispanic. In this **demonstration project**, we will examine the factors that contribute to this imbalance and will implement interventions designed to increase the number of female and minority CS majors.

The **intellectual merit** of this proposal lies in the strength and dedication of the project team combined with our unique environment for learning. The high concentration of diverse ethnicities in the Brooklyn College community and surrounding neighborhoods present an unusual opportunity to examine at once the effects of interventions in different groups – Black and Hispanic students of heritage ranging from Africa to the Caribbean to Mexico – at both high school and undergraduate levels. The team is working in cooperation with four local minority high schools, committed to the success of this program and interested in developing a CS curriculum for their students. The team itself includes computer scientists from a variety of fields with proven track records in research, teaching, mentoring and outreach. Two of the PIs and all the senior personnel (including the Dean of Research and Graduate Studies) are female. Many of

their activities have included interdisciplinary projects and community service work, both involving female and minority participants.

The **broader impacts** of the proposal will be realized in new and adapted solutions that work for diverse urban populations with a deep-seated community base. While what works for Women @ SCS at CMU will certainly inform our project, one size does not fit all – and we need to design solutions that succeed for inner-city students from strong ethnic backgrounds, students who live at home and feel the pressures of their parents and their heritage on a daily basis. Results will be widely disseminated in the form of portable context-based curricular-service oriented mentoring programs. Broadening participation in computing in Brooklyn means building bridges that reach just across the street – yet at the same time, because of its diversity, the population represents a microcosm and an opportunity to learn about how to attract and retain students from varied backgrounds into the world of computing.

Polle: NSF Career: A Biology Approach to Improve Biomass Production in Microalgae Mass Cultures

INTELLECTUAL MERIT AND BROADER IMPACTS

The PI's new project will help transition teaching at Brooklyn College to establish research as a culture within biology courses. Further, a number of high-school, undergraduate, and K-12 teachers will be performing genuine research in the laboratory thus learning cutting edge research techniques. Moreover, Brooklyn College serves a broad and large minority student body and therefore is an ideal setting for recruitment of underrepresented minorities for genuine hands-on research in the PI's laboratory.