Report of the NSF Workshop on Proactive Recruitment in the Lower Division

Washington, DC, 28-29 April 2008

A workshop panel consisting of 30 faculty members, researchers, and administrators from mathematics, statistics, science and engineering departments met in Washington on April 28-29, 2008 to advise the NSF on a potential new funding initiative targeted to the recruitment of students into mathematics and science through collaborative efforts between one or more disciplines. The following individuals participated in the workshop:

Marcel Agueros	Columbia Astrophysics Laboratory	Columbia University
Anand Batra	Department of Physics	Howard University
Al Boggess	Department of Mathematics	Texas A & M University
Lawrence Braile	Dept. of Earth and Atmos. Sci.	Purdue University
James Curry	Dept. of Applied Mathematics	Univ. of Colorado, Boulder
James A. Davis	Department of Mathematics	University of Richmond
Katherine Davis	Department of Mathematics	University of Texas, Austin
Patrick Dussault	Department of Chemistry	Univ. of Nebraska, Lincoln
Erik van Erp	Department of Mathematics	University of Pennsylvania
John Fountain	Dept. of Marine, Earth & Atmos. Sci.	North Carolina State Univ.
Jeff Goldberg	Assoc Dean, College of Engineering	University of Arizona
Sue Goodman	Department of Mathematics	University of North Carolina
Robert Jacobsen	Department of Physics	Univ. of California, Berkeley
Jim Lewis	Department of Mathematics	Univ. of Nebraska, Lincoln
Luen-Chau Li	Department of Mathematics	Pennsylvania State Univ.
David Manderscheid	Dean, College of Arts & Sciences	Univ. of Nebraska, Lincoln
J. Peter May	Department of Mathematics	University of Chicago
William McCallum	Department of Mathematics	University of Arizona
Steve McKelvey	Dept. of Math, Stat, and CS	St. Olaf College
Laurie McNeil	Department of Physics & Astronomy	University of North Carolina
David Nitz	Department of Physics	St. Olaf College
Deborah Nolan	Department of Statistics	Univ. of California, Berkeley
Sastry Pantula	Department of Statistics	North Carolina State Univ.
Matthew Platz	Dean, College of Math & Phys. Sci.	Ohio State University
Joshua Plotkin	Department of Biology	University of Pennsylvania
Harihar Rajaram	Dept. of Civil, Env., & Arch. Eng.	Univ. of Colorado, Boulder
Matt Richey	Assoc Dean – Natural Science	St. Olaf College
Sarah Simmons	Prog. Dir., College of Natural Sci.	University of Texas, Austin
Mark Daniel Ward	Department of Statistics	Purdue University
Abdul-Aziz Yakubu	Department of Mathematics	Howard University

The workshop was chaired by Al Boggess (Texas A&M) and co-organized with Hank Warchall (NSF). Though there was not unanimous agreement on all points contained in this report, most of the committee members concur with its basic philosophy and enthusiastically recommend that NSF pursue new resources to fund this initiative.

Goals and Vision for the Program

In response to the American Competitiveness Initiative, the committee's vision is that this program should seek proposals that aim to improve the lower undergraduate division (freshman and sophomore) experience in mathematics and statistics to better prepare undergraduates to major in science, engineering, mathematics, and statistics. A primary theme is to increase the exposure of lower division students in mathematics, statistics, science, and/or engineering, to a wider cross section of the mathematical sciences. Research in many fields of science and engineering is increasingly reliant on mathematical and statistical tools. Therefore, this program should seek to inspire lower division students to learn a greater amount of mathematics and statistics to prepare them for modern research and training in their disciplines. It is anticipated that an increase in the number of graduates in targeted STEM majors and/or minors will be an outcome of successful proposals.

The following overall features will be required of all proposals.

- Partnership programs between the Mathematical Sciences with other non-DMS discipline(s) in science or engineering; such partnerships could result in an increase in the number of double majors or major/minor combinations between the mathematical sciences and the partner discipline(s); or the partnership could seek to significantly increase the mathematical sciences component of the degree program of the partner discipline(s).

- Increased opportunities for research experiences for lower division students in the mathematical sciences and/or the partner discipline(s) with careful attention to mentoring; here, research should be interpreted broadly to include many forms of discovery learning appropriate to the level of the student.

As part of the collaboration, the institution can propose to create or enhance a set of lower divisional mathematics, statistics and/or science/engineering courses. These courses could include freshman seminars designed to expose students to the interesting and exciting developments and career opportunities in the mathematical sciences and their applications to science and engineering.

In some cases, institutions could propose radical changes that affect the lower division curriculum for one or more departments. In other cases, such as at large universities, institutions could propose changes that affect cohort groups within one or more departments. The committee feels that the NSF should be receptive to a variety of strategies since institutions vary considerably in mission and size.

The goal of the program is to increase and enhance the mathematical and statistical content of degree plans across certain mathematics/statistics and science/engineering fields or cohort groups within these disciplines as chosen by the institution. This program is not meant to encourage on STEM discipline, such as mathematics/statistics, to gain majors at the expense of another.

Partnerships with high-schools and two-year colleges should be considered and encouraged where appropriate.

Proposing institutions are expected to design programs that also attract greater numbers of students from underrepresented groups into mathematics, statistics, science, and engineering.

The solicitation should not be prescriptive in terms of specifying which STEM disciplines should be involved or strategies used to achieve the desired goals. This solicitation should differentiate itself from other existing NSF programs. Here are a few such differences of the vision of this program from others:

- This solicitation can be more focused and involve fewer departments than STEP, which has a goal of increasing the number of majors in all STEM fields

- This solicitation should seek to modify or add more than one type of course or research experience for students. Proposals that change just one course should be submitted to CCLI

- All science and engineering fields should be allowed as possible partner disciplines. This would distinguish this program from others at NSF, such as UBM, which target specific partner non-DMS disciplines

- This solicitation requires partnerships with at least one other non-DMS discipline; proposals that seek to address changes in only mathematics and/or statistics departments should be directed to other DMS programs, such as MCTP.

Details on the required elements of a successful proposal, suggested strategies, eligible budget items, and evaluation considerations are given in the sections below.

I. Required Elements of a Proposal and Review Criteria

A successful proposal must have the following elements:

- Well defined partnership(s) between the mathematical sciences and other science or engineering discipline(s); in particular, the lead PI must be an investigator in the mathematical sciences (Mathematics or Statistics) and at least one co-PI must be from another non-DMS discipline

- Primary emphasis on students in the lower undergraduate divisions

- A plan for recruitment, selection, and retention of participants, including members of underrepresented groups

- A plan for mentored research activities that is student-focused and includes learning experiences that go beyond the traditional core curriculum

- A comprehensive evaluation plan (see details below)

- Evidence of a substantial institutional commitment to the goals of the project

- A plan to disseminate results, best practices, and any lab/course materials that arise from the project

- A management plan that describes how major tasks of the project will be handled by project personnel

- A description of which components of the program will be sustained after the life of the grant, and a realistic plan for sustaining those components

II. Strategies

Strategies for successful proposals could include:

- The design of core activities that enhance the engagement of lower division students with the mathematical sciences and its applications to science and/or engineering, as well as the creation of multi-year programs that show clear continuity with and connection to their upper division work

- The creation or enhancement of a strong mentoring and vertical integration component within collaborating departments; possible strategies include the use of upper division students, graduate students, postdocs, and/or learning communities. In such cases, the program must be designed to enhance the professional development of advanced students and/or postdocs as future scientists.

- Curricular change in mathematical sciences and joint degree programs that might include co-teaching of some courses by partner departments

- Outreach collaborative activities with high schools and/or two-year colleges. These collaborations could include:

    - High school/two-year college teachers participating in research projects
    - High school /two-year college teachers adapting projects to their own classes
    - Undergraduates involved in teaching high school students
    - Career fairs and mathematical science competitions at the high school level

- Early intervention to inform students of the career possibilities in the mathematical sciences and related fields through the use of seminars, alumni visits (to share career experiences), and internships.

III. Eligible Budget Items

- Overall Budget: up to $500K plus indirect costs per year for 3–5 years

- Faculty compensation for those directly involved in the project

- Support for graduate students and postdocs provided they are directly involved in the mentoring of undergraduate participants and/or supervising research

- Stipends for summer and/or academic year support for student participants

- Funds for administrative support should be limited

- Funds for innovative course/laboratory development, and/or software/hardware acquisition directly relevant to the core research and instructional experience

- Approximately 10% of the budget and/or effort should be devoted to evaluation of the project (see below)

Other operational considerations: Awards should be announced no later than October to allow for adequate recruitment of participants for programs beginning in the following summer/fall.

IV. Evaluation

To meet project goals, proposals should develop specific strategies with quantifiable metrics which can be tracked for evaluation purposes. Federal emphasis on project evaluation has increased. Larger proposals may wish to utilize the services of professional evaluators and incorporate their costs in proposal budgets. Costs of professional evaluators are substantial. This is the reason for the rather high percentage of the budget and/or effort (10%) devoted to evaluation.

Examples for evaluation should be provided in the solicitation. Here is an example of a set of strategies with accompanying metrics to be tracked:

- **Strategy:** Increased research experiences (broadly interpreted) in the freshman year – **evaluation metric:** track the number of follow-up research activities as tracked through presentation at undergrad conferences and publications

- **Strategy:** Retention in major and/or college – **evaluation metric:** track the GPA and success in subsequent science, engineering and/or mathematical science classes; surveys can identify whether or not research involvement played a significant role in retention

- **Strategy:** Increased preparation for research – **evaluation metric:** pre-intervention interviews with students and faculty can identify essential elements in research preparation; post intervention interviews can examine the students' and faculty's perceptions of the intervention's effectiveness in increasing research preparation

Formative survey data from participants should be collected during the life of the grant in order to make necessary midcourse corrections in implementation and to gage the efficacy of the various intervention elements.

Baseline data, such as the number of majors and minors of the participating disciplines should be collected before proposal submission. Data on the gender and ethnicity of participants should be given. Similar such data reporting is now required for infrastructure grants such as VIGRE, MCTP, and RTG. University registrars or similar institutional offices rather than the departments should be the source of all data. Data should be reported both in absolute terms and as a percentage of degrees offered by the university. This data should continue to be reported for the duration of the grant and for at least three years after the conclusion of the grant to ensure that most participants who started the program during the grant are tracked through graduation.

A midterm review that includes a team of outside evaluators should be a required part of the evaluation plan. The size and composition of this evaluation team will depend on the size and scope and number of partner disciplines involved in the project.

We advise the NSF to seek out advice from a professional evaluator on specific evaluation criteria before issuing the solicitation. Advice from professionals should also be sought on the evaluation of the program as a whole.

A yearly PI meeting to share meaningful best practices is a good idea if the number of PI institutions is significant.