



**NATIONAL SCIENCE FOUNDATION
4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230**

NSF 17-078

Dear Colleague Letter: Improving and Supporting the Transition to Graduate School in the Mathematical Sciences

April 19, 2017

Dear Colleague:

The National Science Foundation's Directorate for Education and Human Resources (EHR) and Directorate for Mathematical and Physical Sciences (MPS) are collaborating to encourage proposals that would improve and support student transition to and subsequent success in doctoral programs in the mathematical sciences. Participating divisions within the two directorates are the Divisions of Mathematical Sciences (DMS), Graduate Education (DGE), Undergraduate Education (DUE), and Human Resource Development (HRD).

Background

Current data ^[1] indicate that both the percentage of women and the percentage of students from underrepresented racial and ethnic groups entering doctoral programs and receiving doctoral degrees in the mathematical sciences have remained relatively constant since 2004, and these levels are well below the representation of these groups in the general population. At the same time, as evidenced in part by the references ^[2-12] listed below, the scientific community has developed a knowledge base of successful techniques for training and encouraging students to achieve success in advanced mathematical study, in particular students from underrepresented groups. It is time to use this knowledge base to create inclusive, wide-reaching, and sustainable ways to enhance U.S. student preparation for and success in doctoral programs, with an eye towards both academic and non-academic career pathways.

Desired parameters for proposals

NSF invites proposals for projects designed to encourage and prepare U.S. students to pursue and succeed in graduate doctoral study in the mathematical sciences generally, with a particular emphasis on broadening participation among students from underrepresented populations, including racial/ethnic groups underrepresented in mathematics and statistics, individuals with disabilities, and women. While proposed projects need not focus solely on members of underrepresented groups, they should utilize evidence-based techniques known to be effective for students from these groups.

Proposals submitted in response to this Dear Colleague Letter (DCL) should describe projects that are scalable to serve large numbers of students without large increases in cost and sustainable, that is, have continued impact without on-going large influxes of grant funding.

Projects that develop partnerships among faculty, departments, and graduate schools, as well as those that

leverage technology are expected. To achieve the dual aims of (1) scalability and (2) sustainability, it is envisioned that most proposed strategies will also: (3) reach students predominantly at their home institutions, with limited student travel required, and (4) have the potential to create systemic change regarding how students are prepared for success in graduate school, particularly doctoral programs. All projects should contain a rigorous evaluation plan that includes assessment of impact on students and the institution.

To align with the NSF research mission, proposals should involve mathematical sciences research as part of student training, and/or educational research that produces new knowledge to help the community understand for whom and under what circumstances proposed activities are effective in preparing a diverse population of students to be successful in graduate school.

Proposals should address one or more of the following three components (examples under each component are meant to be illustrative and not mandatory or comprehensive):

Curriculum, Content, and Careers. Develop innovative ideas/activities designed to provide students with core skills that are key for success in graduate school and expose students to the wide range of career possibilities in the mathematical sciences. For example:

- Online courses with introductory graduate-level material to reach undergraduate students who cannot access this material at their home institutions;
- Enhanced opportunities for undergraduate research; or
- Activities that emphasize ways in which careers in the mathematical sciences can provide opportunities for professional collaboration and contribution towards solving complex societal problems.

Environment and Confidence. Undertake institutional transformation activities intended to create a supportive and inclusive environment that encourages the participation of underrepresented groups. For example:

- Faculty training on implicit bias, stereotype threat, and the importance of a growth mindset;
- Processes to recruit majors early in their academic careers, encourage successful participation in advanced coursework, and facilitate applications to graduate programs while recognizing potential talent and interest from students with nontraditional backgrounds or preparation; or
- Opportunities for students to solve challenging and tractable problems and receive appropriate, timely, consistent, and constructive feedback.

Community and Social Capital. Encourage, build, and support sustainable networks and communities of scholars and educators. For example:

- Workshops or networks for faculty dedicated to the improvement of mentoring;
- Development of structured communication channels between mathematical sciences faculty and graduate admissions teams;
- Development of mechanisms for students to engage in mathematical sciences-related discussions with peers outside of the classroom, and potentially outside of their home institutions; or
- Development of local, regional, or national support networks for undergraduate students that are sustainable as students enter graduate school and the workforce.

Note: Projects addressing the Community and Social Capital component are encouraged to collaborate with current or future NSF INCLUDES projects targeting underrepresented students that are building local, regional, or national networks designed to support graduate studies at the doctoral level in mathematical sciences. For more information on this NSF-wide initiative, see

https://www.nsf.gov/news/special_reports/nsfincludes/index.jsp and this news release about the first cohort of awardees: https://www.nsf.gov/news/news_summ.jsp?cntn_id=189706.

Funding Level and Award Duration

The funding level and award duration will depend on the program(s) under which an award is made.

Directions for submission: Proposals that have a core component of research in the mathematical sciences should be submitted to the Infrastructure Program within DMS, with a deadline date of December 6, 2017. Proposals that address educational research and development questions should be submitted to one of three programs in EHR: the Historically Black Colleges and Universities - Undergraduate Program (HBCU-UP) and the Tribal Colleges and Universities Program (TCUP) in HRD, or the Improving Undergraduate STEM Education (IUSE) program in DUE. Questions regarding submission dates should be directed to the program directors below in the relevant divisions. Proposals with both mathematical sciences and education research components can be submitted to either DMS or EHR programs. The first sentence in the Project Summary should state that the request is with reference to DCL NSF 17-087.

Interested Principal Investigators are encouraged to contact cognizant program directors prior to submission, using the e-mail UG-GradMathSci@nsf.gov. Investigators are also strongly encouraged to include a one-page statement explaining the core idea of their projects. Program directors for this DCL are:

Division of Mathematical Sciences: Jennifer Pearl

Division of Graduate Education: Tara Smith

Division of Human Resource Development: Claudia Rankins

Division of Undergraduate Education: Ron Buckmire

Sincerely,

Michael Vogelius
Division Director, Division of Mathematical Sciences

Dean Evasius
Division Director, Division of Graduate Education

Lura “Jody” Chase
Division Director (Acting), Division of Human Resource Development

Lee Zia
Division Director (Acting), Division of Undergraduate Education

References:

[1] American Mathematical Society (2004-2014), Data on the Profession, *Annual Survey*.
<http://www.ams.org/profession/data/annual-survey/annual-survey>.

[2] Beasley, M.A. & Fischer, M.J. (2012). Why they leave: the impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors. *Social Psychology of Education*, 15: 427-488. Describes a study using longitudinal data that examined “the impact of stereotype threat-the anxiety caused by the expectation of being judged based on a negative group stereotype” on the retention

of underrepresented students in STEM.

- [3] Borum, V., Hilton, A.A., & Walker, E. (2016). The Role of Black Colleges in the Development of Mathematicians. *Journal of Research Initiatives*, 2(1): Article 6. <http://digitalcommons.uncfsu.edu/jri/vol2/iss1/6>. "...explores the characteristics and practices of Black colleges that support mathematics development, incubate mathematical talent, and disseminate effective practices ..."
- [4] Burgstahler, S., Ladner, R.E., & Bellman, S. (2012). Strategies for increasing the participation in computing of students with disabilities. *ACM Inroads*, 3(4): 42-48. "Addresses the unique challenges faced by individuals with disabilities, and shares practices of a nationwide alliance, AccessComputing, that show promise for attracting qualified individuals with disabilities to computing fields."
- [5] Corbett, C. & Hill, C. (2015). *Solving the Equation: The Variables for Women's Success in Engineering and Computing*. American Association for University Women. Washington, DC. <http://www.aauw.org/research/solving-the-equation/> Cites research findings on and makes recommendations to mitigate the factors "underlying the underrepresentation of women in [engineering and computing], including stereotypes and biases, college curriculum, and workplace environment."
- [6] Espinosa, L.L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review*, 81(2): 209-240. "Examines the effect of precollege characteristics, college experiences, and institutional setting on the persistence of undergraduate women of color in STEM majors and also investigates how this pathway might differ for women of color in comparison to their White peers."
- [7] Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so Few?* American Association for University Women. Washington, DC. <https://www.aauw.org/files/2013/02/Why-So-Few-Women-in-Science-Technology-Engineering-and-Mathematics.pdf>. Cites research findings and makes recommendations on "cultivating female achievement and interest in science and engineering; creating college environments that support women in science and engineering; and counteracting bias."
- [8] Institute for Higher Education Policy. (2009). *Diversifying the STEM pipeline: The Model Replication Institutions Program*. http://www.ihep.org/sites/default/files/uploads/docs/pubs/report_diversifying_the_stem_pipeline_report.pdf. Description of the Model Replication Institutions (MRI) Program, which sought to implement promising practices at nine minority-serving institutions. The report has sections that "analyze self-reported information from the MSIs regarding their evaluation of successful initiatives to improve STEM education, best practices for adopting and adapting lessons learned, and anticipated next steps in the implementation process. The report aims to disseminate the steps for replicating the MIE [Model Institutions of Excellence] model to postsecondary institutions that are seeking to improve excellence and diversity in the STEM pipeline."
- [9] Kuh, George. "High-Impact Educational Practices: A Brief Overview." Excerpted from *High-Impact Educational Practices: What They Are, Who Has Access to Them, and Why They Matter* (2008). Association of American Colleges & Universities. Washington, DC. <https://www.aacu.org/leap/hips> Provides a brief overview of "teaching and learning practices have been widely tested and have been shown to be beneficial for college students from many backgrounds."
- [10] National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2011). *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the*

Crossroads. The National Academies Press. Washington, DC. doi:10.17226/12984.
<https://www.nap.edu/catalog/12984/expanding-underrepresented-minority-participation-americas-science-and-technology-talent-at>

[11] Sowell, R., Allum, J., & Okahana, H. (2015). *Doctoral Initiative on Minority Attrition and Completion*. Council of Graduate Schools. Washington, DC.
http://cgsnet.org/ckfinder/userfiles/files/Doctoral_Initiative_on_Minority_Attrition_and_Completion_2015.pdf. Presents data collected from 21 institutions and addresses questions such as: “What activities or initiatives have been implemented at participating institutions to facilitate completion of STEM doctoral programs among URM students? What factors appear to contribute to higher completion and lower attrition of URM STEM doctoral students?”

[12] Whittaker, J.A., & Montgomery, B.L. (2012). Cultivating diversity and competency in STEM: Challenges and remedies for removing virtual barriers to constructing diverse higher education communities of success. *Journal of Undergraduate Neuroscience Education*, 11(1): A44-A51. Aims to “address issues related to the engagement of [underrepresented] students in majority settings and describe some efforts that have shown success for promoting diversity in STEM and highlight continuing issues and factors associated with cultivating diversity in academic STEM disciplines at majority institutions. Recommended efforts include addressing academic assistance, professional and cultural socialization issues and institutional environmental factors that are associated with success or lack thereof for [students from underrepresented racial/ethnic groups] in STEM.”