NSF Support for Graduate Education in Science & Engineering

For the National Science Foundation, promoting excellence in graduate education in partnership with academia ensures the continued advancement of knowledge in the science and engineering (S&E) disciplines, promotes innovation in the research enterprise, and helps secure the future S&E workforce. In the FY 2016 Budget Request, NSF reported $1 billion in support of over 43,000 graduate students (with 80% applied to research assistantships, 15% to fellowships, and 5% to traineeships).

In July 2014, the NSF convened the Graduate Strategic Planning Committee to review NSF investments in graduate education and training. The committee concurred with external reports (see Reference Reports below) that: (a) scientific disciplines vary in their practices and content with regard to graduate education, and (b) that graduate education must respond to profound changes in the knowledge and skills required by a highly dynamic S&E workforce. The following summary of the committee’s ideas reflects several discussions about graduate education.

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1. **Advancing Science and Engineering (S&E) Research**

A key goal of support for graduate students and graduate education is to advance research in all areas of S&E so that graduate students develop the capacity for long-term contributions to the S&E enterprise. Several reports listed at the end of this document cite the need for highly-skilled individuals to meet growing national and global priorities. Addressing each of these challenges demands advanced disciplinary and interdisciplinary knowledge and models of graduate education that support the individual development of emerging scientists and their ability to contribute to the national and international S&E enterprise.

1. **Broadening Participation to Promote Excellence in S&E**

The recent National Science Board report[[1]](#footnote-1) *Revisiting the STEM Workforce* noted that the future of the S&E workforce requires “that every individual in the United States is afforded the opportunity to reap the benefits of advancements in science and technology; second, that our ability to respond to national needs and remain globally competitive will require the capabilities and ingenuity of individuals of diverse backgrounds.”

Further, the NRC study *The Science of Team Science*, and other sources[[2]](#footnote-2) emphasize that the inclusion of people from diverse backgrounds and perspectives in scientific teams increases research productivity and innovation by introducing creative perspectives and diverse modes of thinking.[[3]](#footnote-3) **B**roadening participation remains an indispensable asset and critical challenge for promoting the Nation’s scientific and engineering research enterprise. Qualified graduate students should be broadly recruited from a variety of geographic, demographic, social, and educational backgrounds.

1. **Advancing Research on Graduate Education and Workforce Development**

Graduate education and training should prepare students for the changing nature of the conduct of science, the increased need for interdisciplinary as well as disciplinary work, the tradition of scholarship that is core to graduate training, and the preparation needed for diverse career paths in R&D including science policy, academia, the private sector, and federal, state and local government.

Investments in graduate education should be informed by research and evaluation that best supports the next generation of “discoverers” as well as discoveries. Graduate education should respond to increasingly limited career opportunities in academia by preparing the next generation of discoverers to tackle complex challenges that require both disciplinary and interdisciplinary training for a diverse, knowledge-based and innovation-driven economy.

1. **Improving Knowledge About NSF Investments in S&E Graduate Education**

Improved data collection and analysis are necessary to model and optimize its multiple mechanisms for supporting graduate education. Better data collection, management, and analysis will help NSF understand its impact on a range of scientific and career outcomes, and share best practices with external stakeholders, and inform coordination of federal investment in graduate education.

1. **Implementation Ideas**
* Encourage career development opportunities for graduate students that complement what is available at their university. Possible activities include supplements for RAs for research experiences in a government setting (analogous to the GRIP component of GRFP), an international setting (analogous to the GROW component of GRFP), or an industrial setting.
* Study, evaluate and scale those practices that attract the broadest range of students to S&E majors, retain them to graduation, and prepare them for diverse career trajectories.
* Each S&E discipline should explore innovative approaches to address areas of national need within its unique disciplinary context for graduate education and training. Graduate students should be supported to conduct original studies, master the responsible and ethical conduct of scientific research, manage scientific information, and communicate research findings. Summer Institutes or supplements are potential mechanisms to address these goals.
* Explore the changing nature of the conduct of science, the increased need for interdisciplinary as well as disciplinary research experiences, and the preparation necessary for diverse career paths by such activities as surveying current practices by Colleges and Universities, and sponsoring regional workshops with external stakeholder communities, (including professional societies, advisory committees, industry, and federal partners, private foundations and international funding organizations).
* NSF principal investigators will soon be able to list a unique identifier (ORCID ID) on all research proposals. The Graduate Research Fellowships Program will also enable applicants to include his or her ORCID ID.[[4]](#footnote-4) NSF has the opportunity to learn from these ORCHID ID data in order to inform a more comprehensive data analytic strategy across the entire investment in graduate education, particularly for research assistantships.
* Explore data extraction tools that can draw information from proposal metadata, ORCID-IDs, NSF budget databases, and other sources of data in order to more accurately monitor NSF support of graduate education and provide information on demand to multiple audiences. The NSF-wide GRFP data-analytics efforts can inform cross-directorate efforts for metadata collection on all incoming proposals, post-award data mining, program evaluation and reporting.
1. **Relevant References**
2. *The National Science Foundation. (2014)* [*Strategic Plan for 2014-2018*](http://www.nsf.gov/pubs/2014/nsf14043/nsf14043.pdf)
3. *Council of Graduate Schools and Educational Testing Service. (2010).* [*The Path Forward: The Future of Graduate Education in the United States*](http://www.fgereport.org/rsc/pdf/CFGE_report.pdf)*. Report from the Commission on the Future of Graduate Education in the United States.*
4. *Committee on Science, Engineering, and Public Policy, National Academy of Sciences, National Academy of Engineering, Institute of Medicine. (1995)* [*Reshaping the Graduate Education of Scientists and Engineers.*](http://www.nap.edu/catalog/4935/reshaping-the-graduate-education-of-scientists-and-engineers)
5. *The National Science Board. (2015)* [*Revisiting the STEM Workforce: A Companion to Science and Engineering Indicators 2014.*](http://www.nsf.gov/nsb/publications/2015/nsb201510.pdf)
6. *The Committee on STEM Education, National Science and Technology Council. (2013)* [*Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-Year Strategic Plan.*](https://www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf)
7. *Committee on Research Universities; Board on Higher Education and Workforce; Policy and Global Affairs; National Research Council. (2012)* [*Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security*](http://www.nap.edu/catalog/13396/research-universities-and-the-future-of-america-ten-breakthrough-actions)*.*
8. *The Carnegie Foundation for the Advancement of Teaching. (2006) Envisioning the Future of Doctoral Education: Preparing Stewards of the Discipline.*
9. *The National Research Council. (2015)* [*Enhancing the Effectiveness of Team Science*](http://www.nap.edu/catalog/19007/enhancing-the-effectiveness-of-team-science)
10. *The American Chemical Society. (2013)* [*Advancing Graduate Education in the Chemical Sciences.*](https://www.acs.org/content/dam/acsorg/about/governance/acs-commission-on-graduate-education-summary-report.pdf)
1. http://www.nsf.gov/nsb/publications/2015/nsb201510.pdf [↑](#footnote-ref-1)
2. http://davinci-institute.net/gs4eup/wp-content/uploads/2014/07/p3-Falk-Krzesinski.compressed1.pdf [↑](#footnote-ref-2)
3. http://sites.nationalacademies.org/dbasse/bbcss/currentprojects/dbasse\_080231 [↑](#footnote-ref-3)
4. The information provided by the applicant’s ORCID ID will be used to inform GRFP of future career outcomes. The information will not be used by the panel in the determination of GRFP awards. [↑](#footnote-ref-4)