

# Graduate STEM Education for the 21<sup>st</sup> Century

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Xu Group Meeting

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# Report Background

- National Academies of Sciences, Engineering, and Medicine charged to examine current status of STEM education in US
  - Last studied in 1995; how have things changed since?
- Published end of 2018

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Graduate STEM Education for the 21st Century (2018)

**DETAILS**

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# Main Findings of Study

- System should become more student-centered
- Current incentives too heavy on publishing and future scientists
  - Need for more “transferable skills” in graduates

# Student-Centered Education

- Understand and prepare students for careers post-graduate career
  - >60% PhDs *do not* go into academia
  - Better preparation of students' expectations coming into grad school
- Improve advisors' mentoring of students
  - Includes mental health support, realistic expectations of students time and efforts

# Changing Faculty Incentives

- Give more support for and rewards for effective mentoring
  - How can receiving tenure depend on mentoring outcomes?
- Funding agencies use their influence to encourage continual learning and improvement of faculty

# Transferable Skills

- “Core competencies” of Masters & PhD students
  - 1. Scientific and technical literacy; conducting original research
  - 2. Leadership, communication, and professional skills  
e.g. writing, non-scientist communication, budgeting

# How to Achieve These Things?

## FACULTY MEMBERS

Faculty play a, if not *the*, central role in fostering the next generation of STEM professionals through their roles as educators, mentors, and advisors. They are what one might consider the “front line” of graduate education. The relationships that graduate students develop with faculty members help shape their interests, build their professional networks, and spark their growth as scientists, technologists, engineers, and mathematicians. Most faculty invest considerable time and resources supporting the development of students, and the recommendations that follow provide details on the ways in which all faculty can ensure that the time spent with students benefits all parties to the fullest extent possible. This list includes some substantial changes in the way some faculty regard and interact with graduate students. The committee recognizes that expecting such changes in faculty behavior will not be possible unless there are broader cultural changes in the entire graduate education system, and that these changes will not be expressed at the faculty level unless the academic incentive system is adjusted as discussed in this report. To play their part in the modernization of the graduate STEM education system, faculty should

- Review and modify curricula, dissertation requirements, and capstone projects to ensure timeliness and alignment with the ways relevant work is conducted on a periodic basis, and to provide students with opportunities to work in teams that promote multidisciplinary learning.
- Develop, adopt, and regularly evaluate a suite of strategies to accelerate increasing diversity and improving equity and inclusion, including comprehensive recruitment, holistic review in admissions, and interventions to prevent late-stage attrition.
- Foster understanding of how to support and engage with students requiring or seeking mental health services and take action when appropriate.
- Use evidence-based and inclusive teaching and mentoring practices for graduate students.
- Cultivate their individual professional development skills to advance their

abilities to improve the educational culture and environment on behalf of students.

- For those who serve as primary research mentors, review their mentees’ individual development plans on an annual basis to help students map educational goals, career exploration, and professional development to help students acquire the core competencies, as outlined in this report for master’s or doctoral students.
- Discuss with students their areas of interest, educational and professional goals, and potential career paths.
- Discuss with their students, undergraduates interested in graduate education or current graduate students, whether and how a master’s or Ph.D. degree will advance the students’ long-term educational and career goals.

# How to Achieve These Things?

## GRADUATE STUDENTS

While many other stakeholders have more power to change the graduate STEM education system, prospective and current students still play a critical role in driving change. They can and should seek out an education experience that best fits their goals and need to take initiative in shaping their own educations. The committee urges students to use the recommendations in this report as a resource and a guide to help determine their educational experience and advocate for improvements. To seek the ideal graduate education, current and prospective graduate students should

- Discuss with their advisors how a master's or a Ph.D. degree will advance their long-term educational and career goals, including how to explore opportunities within a graduate program to gain the knowledge and competencies needed to pursue their career interests.
- Use a range of data, from national datasets on graduate education and workforce trends to department-level data on current students and alumni,

to inform graduate program selection, educational goal development, and career exploration.

- Seek multiple mentors to meet their varied academic and career needs, such as information about potential career paths and employers.
- Learn how to apply their expertise in a variety of professional contexts and seek guidance from faculty, research mentors, and advisors on strategies to gain work-related experience while enrolled in graduate school.
- Engage in group activities and experiences outside of traditional academic settings to increase feelings of inclusion and to normalize feelings associated with negative phenomena, such as imposter syndrome, that can reduce productivity and success in the training experience and extend time to degree.
- Create an individual development plan that includes the core competencies, as outlined in this report for master's or doctoral degrees, as a key feature of their own learning and career goals and that utilizes the resources provided by their university and relevant professional societies. Students should update these plans annually in consultation with faculty advisors to map educational goals, career exploration, and professional development.
- Communicate with graduate faculty and deans to encourage the implementation of practices that support holistic research training and diverse career outcomes and provide feedback on their experiences.
- Seek opportunities to work in cross-disciplinary and cross-sector teams that promote multidisciplinary learning during their graduate education and via extracurricular activities.



# Interesting Things Being Tried



NATIONAL SCIENCE FOUNDATION  
2415 EISENHOWER AVENUE  
ALEXANDRIA, VIRGINIA 22314

NSF 18-102

## Dear Colleague Letter: Non-Academic Research Internships for Graduate Students (INTERN) Supplemental Funding Opportunity

August 27, 2018

Dear Colleagues:

Fostering the growth of a globally competitive and diverse research workforce and advancing the scientific and innovation skills of the Nation is a [strategic objective of the National Science Foundation \(NSF\)](#). The Nation's global competitiveness depends critically on the readiness of the Nation's Science, Technology, Engineering and Mathematics (STEM) workforce and NSF seeks to continue to invest in programs that directly advance this workforce. As part of this effort, a supplemental funding opportunity is available in fiscal years FY 2019 and FY 2020 to provide support for non-academic research internships for graduate students to support career opportunities in any sector of the U.S. economy. NSF currently invests in a number of graduate student preparedness activities and has historically encouraged principal investigators (PIs) to include such activities in research proposals to NSF. This Dear Colleague Letter (DCL) describes new funding opportunities at NSF to ensure graduate students are well prepared for the 21st-century STEM workforce.

A screenshot of the NIH website page titled "NRSA Institutional Predoctoral Training Grants Program Description and Guidelines". The page features a navigation menu on the left with options like "Research Areas", "Research Training", "Capacity Building", "Grants and Funding", "Science Education", "News and Events", and "About NIGMS". The main content area includes a "T-32" label, a brief overview of the program, and a list of related information such as "NIH Predoctoral Stipends, Training Related Expenses, Institutional Allowance, and Tuition/Fees Policy on NRSA Awards". The page also includes a search bar and social media icons at the top.

UW-Madison: non-traditional dissertations

UT-Austin: paid vacation time for grad students