Lessons Learned from Research about the Fundamentals of Mentoring STEM Graduate Students

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Education & Human Resources
THREE MAGIC LETTERS
GETTING TO PH.D.

MICHAEL T. NETTLES
CATHERINE M. MILLETT
Survey of Doctoral Student Finances, Experiences and Achievements

Three Stage Sampling Plan

- Stage 1 - selected 21 diverse doctoral granting universities

- Stage 2 - selected 11 fields of study

- Stage 3 - selected a stratified sample of 13,160 doctoral students who completed at least one year of study and who were taking at least 6 credit hours in the fall term 1996
  - 9,036 students completed surveys (70% response rate)

Source: Nettles & Millett, Survey of Doctoral Student Finances, Experiences and Achievements
 Nearly 70% of Doctoral Students Have a Mentor

- African American students having a faculty mentor is significantly different from White students overall and in Science & Math.
- Hispanic students do not differ from White students in the overall or within fields.

Source: Survey of Doctoral Student Finances, Experiences and Achievements.
What admission characteristics predict having a mentor?

- In engineering, race/ethnicity, parental socio-economic status and performance on the Verbal section of the GRE influence the odds of having a mentor.
- In science/mathematics, race/ethnicity, parental socio-economic status, performance on the Verbal section of the GRE and the type of graduate school influence the odds of having a mentor.

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Negative signs = less likely to have been had a faculty mentor.
Positive signs = more likely to have had a faculty mentor.

Source: Survey of Doctoral Student Finances, Experiences and Achievements.
Having a Mentor Can Influence Other Doctoral Experiences

Have a Faculty Mentor

- Student-faculty social interactions
- Academic interaction with faculty
- Interactions with faculty advisor
- Presenting a paper at a conference
- Publishing an article
- Overall research productivity
- Rate of progress in program
- Degree completion
- Time to Degree

No Influences
- Satisfaction with doctoral program
- Stopping out of doctoral program

* Note: Influences may not be in all fields

Source: Survey of Doctoral Student Finances, Experiences and Achievements.
Doctoral Students Reports of Achieving An Individual Measure at Least Once

- Created a composite measure that captures whether a student achieved at least one of the individual measures once.

Source: Survey of Doctoral Student Finances, Experiences and Achievements.
Doctoral Students are Publishing Refereed Journal Articles (sole or joint authored)

- African American & Hispanic students rates of publishing an article are significantly different from Whites in the total.
- Within fields, African American students differ from White students in education, science & math, and the social sciences.
- Within fields, Hispanic students do not differ from White students.

Source: Survey of Doctoral Student Finances, Experiences and Achievements.
# Being a Research Assistant and Mentoring Positively Influence Article Publication

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Negative signs = less likely to have written a refereed journal article.
Positive signs = more likely to written a refereed journal article.

Source: Survey of Doctoral Student Finances, Experiences and Achievements.
Research Productivity Can Influence Other Doctoral Experiences

Research Productivity

Influences *
- Rate of progress in program
- Degree completion

No Influences
- Time to Degree

* Note: Influences may not be in all fields

Source: Survey of Doctoral Student Finances, Experiences and Achievements.
A Snapshot in Time: Doctoral Degree Completion by 2001 for Students Beyond the First Year

- African American & Hispanic students degree completion rates are significantly different from White students in the total.
- Hispanic students differ from White students in engineering.
- Afri. Amer. students differ from White students in engineering, science & math, & soc sci.

Source: Survey of Doctoral Student Finances, Experiences and Achievements.
## Completing a Doctoral Degree by 2001

- Research productivity is a positive contributor in every field.
- Being married/partner positively influences completion in engineering and science/math.
- Hispanic and African American students differ from White students in engineering.

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<td>Married/ Partner</td>
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<td>Research assistant</td>
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<td>Has a mentor</td>
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<td>Research productivity</td>
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</table>

Negative signs = less likely to have completed their doctoral degrees.
Positive signs = more likely to have completed their doctoral degrees.

Source: Nettles & Millett, Survey of Doctoral Student Finances, Experiences and Achievements.
Questions for AAAS/NSF/AGEP and the Nation

• What experiences should all engineering graduate students have?
• What broad skill sets should graduates have and be able to use?
• How well do we understand what entering graduate students expect from their graduate programs?
• How can we exploit the differences they bring to improve their graduate experience?
Completion Data: “Big Picture” Findings have Policy Implications

- Nationally, Ph.D. completion probably higher than commonly thought (approx. 57% vs. 50%), but field differences create policy challenges.
- Some underrepresented groups are taking longer to complete than before, but not necessarily completing at lower rates.
- Overall differences in minority/majority completion rates are observable, but field differences in minority/majority completion rates are pronounced.
## Differences in Minority and Majority PhD Completion

<table>
<thead>
<tr>
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<th>Under-represented Minorities</th>
<th>Asian American</th>
<th>Majority (White)</th>
<th>Difference between URM &amp; Majority (White)</th>
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<tbody>
<tr>
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<td>7-yr</td>
<td>10-yr</td>
<td>7-yr</td>
<td>10-yr</td>
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<tr>
<td>Engineering</td>
<td>46.4%</td>
<td>58.7%</td>
<td>45.7%</td>
<td>53.6%</td>
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<tr>
<td>Life Sciences</td>
<td>43.4%</td>
<td>63.2%</td>
<td>45.2%</td>
<td>55.9%</td>
</tr>
<tr>
<td>Physical Sciences &amp; Mathematics</td>
<td>40.1%</td>
<td>47.6%</td>
<td>41.8%</td>
<td>52.3%</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>31.2%</td>
<td>48.6%</td>
<td>35.4%</td>
<td>48.5%</td>
</tr>
<tr>
<td>Humanities</td>
<td>32.4%</td>
<td>52.7%</td>
<td>33.1%</td>
<td>55.4%</td>
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</table>

Source: Council of Graduate Schools, Ph.D Completion Project Data
## Completion Rates and Timing by Race/Ethnicity and Broad Field

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Native American</th>
<th>Black/African American</th>
<th>Hispanic</th>
<th>Asian American</th>
<th>Majority (White)</th>
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<tbody>
<tr>
<td></td>
<td>7-yr</td>
<td>10-yr</td>
<td>7-yr</td>
<td>10-yr</td>
<td>7-yr</td>
</tr>
<tr>
<td>Engineering</td>
<td>69.2%</td>
<td>66.7%</td>
<td>38.1%</td>
<td>50.0%</td>
<td>52.2%</td>
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<tr>
<td>Life Sciences</td>
<td>63.6%</td>
<td>100.0%</td>
<td>41.4%</td>
<td>59.5%</td>
<td>42.7%</td>
</tr>
<tr>
<td>Physical Sciences/Math</td>
<td>54.6%</td>
<td>66.7%</td>
<td>36.4%</td>
<td>41.0%</td>
<td>45.6%</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>29.6%</td>
<td>20.0%</td>
<td>33.6%</td>
<td>50.7%</td>
<td>28.2%</td>
</tr>
<tr>
<td>Humanities</td>
<td>29.2%</td>
<td>71.4%</td>
<td>34.7%</td>
<td>53.7%</td>
<td>28.1%</td>
</tr>
</tbody>
</table>

Source: Council of Graduate Schools, Ph.D Completion Project Data
Department-Level Data Collection and Use

Chris M. Golde
Stanford University
Findings

- Integration into intellectual community
- Mentoring and advising
- Information flows and feedback
Integration into intellectual community

- Advance information
- Orientation
- Peer mentors
- Initial advising
- Shared courses
- Shared office space
Mentoring and advising

- Frequency of communication
- Multiple mentors
- Annual reviews
- Safety nets
Information flows and feedback

- How is graduate school different from undergraduate?
- Clear expectations for & access to experiences
- Career paths of alumni
Questions to ask from data

- Does the department have a vibrant intellectual community?
- How are new students (postdocs, faculty) integrated into the departmental community?
- Does the department have a shared definition of “a successful student”? Are these expectations clearly conveyed to students?
- What career paths do program graduates follow? Are students gaining the experiences to be successful in their chosen career paths?
What Students Should Know
- Abstracts/posters
- Oral presentations
- Literature reviews
- Formulate research questions.
- Statistical/computational skills
- Prepare(review) paper.

What Students Should Understand
- The patent process
- Intellectual property
- Ethics.
- Best practices in teaching.
- Setting up/managing a lab
- Grant-writing
- Science policy
In summary, the fundamentals of mentoring should be about retention to the PhD and STEM workforce preparation:

- Academic preparation & support programs, particularly during the early course-taking years
- Making sure students are on track towards the PhD, including nurturing during prep for qualifying and comprehensive exams.
- Early detection of switchers and leavers by departments
- Social and intellectual integration into the department
- Faculty mentoring that focuses on research productivity, career counseling, and workforce prep
- Attention to financial aid and debt burden
- Attention to family/work balance