Exploring Doctoral Admissions Practices in Physics

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• Thank you for coming!
**Motivations**

High school physics course-taking

<table>
<thead>
<tr>
<th>Year</th>
<th>Conceptual</th>
<th>Regular 1st year</th>
<th>Honors</th>
<th>AP/2nd year</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>4</td>
<td>81%</td>
<td>11</td>
<td>4</td>
<td>624,000</td>
</tr>
<tr>
<td>1990</td>
<td>10</td>
<td>73%</td>
<td>12</td>
<td>5</td>
<td>623,000</td>
</tr>
<tr>
<td>1993</td>
<td>8</td>
<td>67%</td>
<td>13</td>
<td>6</td>
<td>697,000</td>
</tr>
<tr>
<td>1997</td>
<td>11</td>
<td>58%</td>
<td>15</td>
<td>8</td>
<td>807,000</td>
</tr>
<tr>
<td>2001</td>
<td>11</td>
<td>55%</td>
<td>13</td>
<td>11</td>
<td>931,000</td>
</tr>
<tr>
<td>2005</td>
<td>14</td>
<td>45%</td>
<td>16</td>
<td>12</td>
<td>1,100,000</td>
</tr>
</tbody>
</table>

- Consistent long-term growth for more than two decades.
- Diversification of the type of courses and textbooks offered.

Source: AIP Statistical Research Center
Motivations
Total bachelor’s degrees in physics since 1955

- After the initial post-war boom, little long term growth.
- Since historic low point in 1999, notable rebound.

Source: AIP Statistical Research Center
Motivations
Total bachelor’s degrees in STEM since 1955

Bachelor's Degrees by Field, 1970-2010

Source: Digest of Education Statistics, 2012
Motivations
Doctoral degrees in the U.S.

Source: AIP Statistical Research Center
Motivations
Graduate attrition in the physical sciences

• The median length of a doctoral degree has increased by one year in the past 25 years.
  • This increase has been largely attributed to the changing nature of doctoral research - increasing specialization, complexity of experimentation, etc.
• Little research to explain attrition or the long-term impacts of graduate experiences.

Source: Digest of Education Statistics, NSF Survey of Earned Doctorates
Motivations
Gender trends in physics

Source: AIP Statistical Research Center
Motivations
Gender trends in physics

http://www.aip.org/statistics

Source: AIP Statistical Research Center
Motivations
Trends in bachelor’s degrees for African American and Hispanic American students

Number of Physics Bachelor’s Degrees Earned by African Americans and Hispanic Americans, Classes of 1994 through 2010.

Class of
0  50  100  150  200  250  300
0  94  96  98  00  02  04  06  08  10

African American
Hispanic American

http://www.aip.org/statistics

Source: AIP Statistical Research Center
Motivations
Recent graduate enrollments by race/ethnicity

Race and Ethnicity of Physics PhDs, Classes of 2010 through 2012.

<table>
<thead>
<tr>
<th></th>
<th>3-Year Average Number</th>
<th>Percent of all Physics PhDs</th>
<th>Percent of U.S. Physics PhDs*</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>744</td>
<td>45</td>
<td>88</td>
</tr>
<tr>
<td>Asian American</td>
<td>41</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Hispanic American</td>
<td>28</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>African American</td>
<td>17</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other U.S. Citizens</td>
<td>13</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Non-U.S. Citizens</td>
<td>826</td>
<td>49</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>1,669</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Based on a 3-year average of 843 U.S. citizens.

http://www.aip.org/statistics

Source: AIP Statistical Research Center
Motivations

What happens between Bachelor’s and Ph.D.?

- There are \( \sim 400 \) students who identify from traditionally underrepresented racial/ethnic backgrounds who complete Bachelor’s degrees in physics every year.
  - A disproportionate number of these students do not go on to enroll in doctoral programs.
- Graduate admissions are difficult (and intimidating), so a thorough investigation is warranted.
  - We should be conscientious to ensure that admissions decisions are based on valid and appropriate criteria.
  - The messages we translate to prospective students determines, in part, who attempts to get into graduate school.

Source: AIP Statistical Research Center
Context
APS Bridge Program

- Responding to the APS’ Joint Diversity Statement, the APS Bridge Program is designed to “increase the number of physics PhDs awarded to underrepresented minority (URM) students, including African American, Hispanic American, and Native American students”.

- The Bridge Program is working to establish sites that accept and mentor students who would not otherwise get accepted to PhD programs, and provide support & mentoring for 1-2 years.
- In year 1 (2013-2014), the first two sites (USF, Ohio State) brought in 9 students to their bridge programs, and three unofficial but affiliated institutions brought in another ~ 10.
This provides opportunities to explore the issues connected to the recruitment, selection, and retention of graduate students in physics.

As an example of one such opportunity, we undertook a study of current admissions practices.
Data Collection
Survey development

• A preliminary survey was developed based on earlier work (e.g. Project Crossover) as well as through discussions with the Bridge Program Management Team and contacts in the physics community.
• The initial draft was given to participants (faculty and students) at the 2nd Graduate Education in Physics Conference (January 2013).
• Feedback was solicited from these and other focus groups.
• The finalized instrument was put online for data collection.
Data Collection
Sampling and Deployment

- A solicitation was sent in August 2013 to a list of program coordinators/department chairs maintained by the APS.
- Recipients of the solicitation email were asked to respond to the survey and distribute to other members of their department who had recent admissions experience.
- Reminders were sent periodically throughout the fall semester, with the response data finalized in early November.
Data Collection

Final response rates

- The APS list of program coordinators and department chairs contained 199 different institutions.
- The survey received responses from 171 individuals, who identified themselves as being at 153 different institutions.
- The institutional responses rate is estimated to be at least 77%.
- A few departments did offer responses from more than one individual; at most we received three individual responses from a single institution.
Q2. On average in the past 3-5 years, how many completed applications to your doctoral program does your department receive annually?
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Q4. Regardless of the number of offer letters tendered, what is the intended size of your annual incoming cohort of new full-time doctoral students?
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-> As a ratio of application pool / cohort size:
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-> By size of intended cohort:
Characterizing PhD Institutions

Selection Pressure

**Q4.** Regardless of the number of offer letters tendered, what is the intended size of your annual incoming cohort of new full-time doctoral students?

-> As a ratio of application pool / cohort size (Cohorts ≥ 20 ONLY):
| Q4. Regardless of the number of offer letters tendered, what is the intended size of your annual incoming cohort of new full-time doctoral students? |
| -> As a ratio of application pool / cohort size (Cohorts ≤ 10 ONLY): |
**Characterizing PhD Institutions**

**Selection Pressure**

**Q4.** Regardless of the number of offer letters tendered, what is the intended size of your annual incoming cohort of new full-time doctoral students?

- **Takeaways:**
  - Many institutions receive relatively few applications (<100), some receive a lot (>500).
  - Smaller programs appear to get less application pressure.
Q12. Please indicate the importance of each of the following factors to your admissions decisions:
Admissions Decisions
What matters most?

Q12. Please indicate the importance of each of the following factors to your admissions decisions:

-> 21 different factors, all rated from “1 - Least important” to “7 - Most important” or indicated as “Don’t Use”:

a. GPA/grades - general
b. GPA/grades - physics/math
c. Undergraduate courses taken
d. Undergraduate institution type/reputation
e. GRE quantitative scores
f. GRE verbal scores
g. GRE written scores
h. GRE physics subject scores
i. TOEFL scores
j. Quality of letters of recommendation
k. Reputation of recommenders
l. Recommenders’ rankings of students
m. Quality of interviews (conducted by your department)
n. Proximity/familiarity to department
o. Personal statements
p. Prior research experiences
q. Prior publications
r. Prior conference publications
s. Student research interests and/or stated faculty advisor preferences
t. Departmental research opportunities (specific availability in research groups)
u. Other
Admissions Decisions

What matters most?

Q12. Please indicate the importance of each of the following factors to your admissions decisions:

-> Average importance from 1 to 7 for each factor:
Q12. Please indicate the importance of each of the following factors to your admissions decisions:

-> Number of “Don’t Use” responses for each factor:
Admissions Decisions
What matters most?

Q12. Please indicate the importance of each of the following factors to your admissions decisions:

- **Top four:**
  - GPA/grades in physics/math
  - Quality of letters of recommendation
  - Undergraduate courses taken, tied with
  - GRE physics subject scores (*but relatively high “No Use” response rate*)

- **Bottom three:**
  - GRE written scores
  - Prior conference publications
  - GRE verbal scores
**GRE Scores**

**Use and misuse**

- The ETS guide book states

  *The GRE Board believes that GRE scores should never be the sole basis for an admissions decision and that it is inadvisable to reject an applicant solely on the basis of GRE scores. A cutoff score below which every applicant is categorically rejected without consideration of any other information should not be used.* (p. 14)

- Casey Miller has noted how the use of a cutoff score may have a significant impact on graduate diversity.

- The predictive validity of GRE scores should also be understood appropriately: GRE scores are significantly correlated to first-year graduate GPA and success in qualifying exams, but much more weakly related to outcomes like citations and research products.
Q13. Are GRE scores (quantitative, verbal, written, or physics subject) used as a minimum cutoff in admissions decisions? (Yes/No)

Q13a. Please briefly describe how GRE scores are used:
Q13. Are GRE scores (quantitative, verbal, written, or physics subject) used as a minimum cutoff in admissions decisions?

-> 56 indicated Yes, 115 indicated No.

Q13a. Please briefly describe how GRE scores are used:

-> 49 out of the 56 Yes responses provided more details, 29 out of 115 No responses did as well.
Q13a. Please briefly describe how GRE scores are used:

-> An analysis of the No responses indicates the long shadow cast by GREs:

-> Several indicate a process in which the GRE **effectively acts as a cutoff**, despite answering No to Q13.

  e.g. “No fixed cutoff, but GRE quantitative should be about 90 [sic] percentile or higher.”

  e.g. “No hard cutoff, but used as a first cut in going through applications and GRE scores trump GPA scores in assessing students.”

-> Another typical sentiment is that **low GRE scores need to be compensated** for by some other outstanding quality:

  e.g. “There is no strict cutoff, but a very low score means other parts of the application must compensate and explain why the student may nonetheless be successful in our program.”
Q16. Please explain how applicants’ gender is factored into application reviews and decisions, if at all:
Q16. Please explain how applicants’ gender is factored into application reviews and decisions, if at all:

-> ~ 51 indicated it is not factored in at all (17 non-responses)
-> Of the ~ 103 responses indicating some consideration, a few themes are evident:

  • A number of respondents indicate that their institution offers diversity fellowships (some before admissions, some after)
    e.g. “Some fellowships are available only for female students.”
  • Some programs review female applicants first, or make sure to spend a little more time reading female applications.
  • Some respondents report not being very successful as they would like at attracting female students:
    e.g. “Approximately 15%-20% of our applicants are female. We make an effort to increase the representation of women in our program and, other things being equal, we always give priority to female applicants in our admissions. Even then, we end up with only 10%-15% female students in our incoming classes.”
Q17. Please explain how applicants’ race/ethnicity (e.g. students who identify as underrepresented minorities) is factored into application reviews and decisions, if at all:
Admissions Decisions
Accounting for representation problems

Q17. Please explain how applicants’ race/ethnicity (e.g. students who identify as underrepresented minorities) is factored into application reviews and decisions, if at all:

-~ 48 indicated it is not factored in at all (19 non-responses)

-~ Themes from the ~ 104 responses indicating some consideration:

- A significant number of respondents focus solely on the availability of diversity fellowships.
- A number of responses outline policies that give priority to domestic and/or underrepresented students if “other factors are equal”.
- Notably, several respondents indicate that not enough students (sometimes, zero) from underrepresented backgrounds apply to their program.

  e.g. “Unlike the male/female situation, we are not very successful in recruiting underrepresented minorities. If we find a candidate, we find a fellowship. The numbers are just not there in our pool.”

  e.g. “We get very few (to none) applicants that identify themselves at underrepresented minorities, the ones we get we look at carefully to see if we can accept them.”
Factors that increase doctoral completion time:

- **Academic and personal factors:**
  - Need to take any part of comps more than once
  - Got married or became a parent during PhD
  - M.S. awarded upon leaving another program

- **Research and advisor factors:**
  - Timing of choice of final dissertation topic
  - Mismatch between topic at start and end of research
  - Change of advisors
  - Lower satisfaction with advisor

- **Structural/departmental factors:**
  - Number of years of required coursework
  - Number of courses taught during doctorate
Improving Graduate Admissions
Modeling doctoral completion

• **Important**: factors that do *not* influence doctoral completion time:
  • Prior academic achievement (UG or high school grades)
  • Early science interests
  • Motivations for pursuing graduate school
  • Prior research experiences

• Many of these factors are regularly hypothesized to play an important role.

Improving Graduate Admissions
Reasons for entering graduate school

• Based on responses to a few direct questions about their motivations towards science and graduate school, categorized scientists as exhibiting “performance” and “learning” goal orientations.

• Looked at the impact of these orientations on career productivity:

Summary
Comprehending graduate admissions

• Takeaways:
  • For prospective student applicants:
    • Consider at least a few programs which get less application pressure (which may be smaller programs).
    • Note that prior research experiences are roughly as important as GRE-Q; undergraduate GPA, courses taken and letters of recommendation are really important.
  • For faculty:
    • GRE physics subject test – many consider it highly important, but a notable minority are not using it at all.
    • GRE cutoffs are used explicitly or implicitly by a sizable number of institutions, and GRE scores cast a long shadow elsewhere. Consider the ETS’ recommendations.
Summary

How might graduate admissions be improved?

• Question: are we transmitting what we really care about to potential applicants?
  • Advertising and recruitment might help to alleviate representation concerns at some institutions – there are many potential applicants!
  • Generally, graduate admissions need to be “aligned” with the factors that lead to successful graduate outcomes.
    -> These decisions need to be disseminated clearly.

• Specifically, as a community, we may want to consider the following more explicitly in our decision-making:
  • Student motivations
  • Grit (see Duckworth et al, 2007)
    -> One place we may already be doing this is in the evaluation of letters of recommendation.

Summary
Going beyond graduate admissions

• Remember that graduate admissions are the **beginning** not the end of graduate education.

• Lovitts (2001) and others have noted that graduate attrition and success is most strongly tied to two departmental factors:
  • The effort and resources committed to integrating graduate students into the department, and
  • The effort made toward students’ development and understanding of the formal and informal structures of the graduate programs and research cultures.

• She noted that a “student deficiency model” is often assumed to explain student completion and attrition; that is, the presumption is that deficiencies in students’ backgrounds explain their failure to complete doctorates in a timely manner.