Graduate Education in Physics Conference: Sustaining Thriving Programs by Embracing Challenges and Opportunities in the 21st Century

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(Thanks to NSF for support)
Second Conference on Graduate Education in Physics

• Organized by APS and AAPT at ACP from Jan 31 to Feb 2, 2013

• 107 participants
  – Graduate program Directors and/or Chairs from 74 physics departments
  – Industry and National Lab representatives
  – Professional society representatives
  – Graduate student leaders

• Attendees shared best practices and brainstormed innovative strategies & creative approaches to sustain thriving programs in the 21st century
  – Keeping in mind challenges and opportunities
Need to Respond to Demographic Changes

• Underrepresented minorities will become the majority by 2050

• Currently approximately 10% undergraduate and 6% Ph.D. degrees for US citizens in physics to this group

• Changes occur slowly in Universities
  – Urgent need to conceive and implement programs to increase participation of underrepresented students
  
  • APS Bridge program with NSF support
  
  • Fisk-Vanderbilt/Columbia bridge program models are effective
  
  • Development of cohorts, such as critical mass of students from similar background could facilitate support for each other
  
  • Mentoring and nurturing environment are equally important
  
  • PER based curricula and pedagogies could be effective in bridging gap between prior preparation & desired level of competency
**Minority and Ethnic Profile of Physics Bachelor’s, Classes of 2009 through 2011. (3-Year Average)**

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percent of all Physics Bachelor’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>4,891</td>
<td>81</td>
</tr>
<tr>
<td>Asian American</td>
<td>347</td>
<td>6</td>
</tr>
<tr>
<td>Hispanic American</td>
<td>246</td>
<td>4</td>
</tr>
<tr>
<td>African American</td>
<td>172</td>
<td>3</td>
</tr>
<tr>
<td>Other US citizens</td>
<td>83</td>
<td>1</td>
</tr>
<tr>
<td>Non-US citizens</td>
<td>335</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,899</td>
<td>100%</td>
</tr>
</tbody>
</table>

http://www.aip.org/statistics

**Minority and Ethnic Profile of Exiting Physics Master’s, Classes of 2009 through 2011. (3-Year Average)**

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percent of all Physics Master’s</th>
<th>Percent of US Physics Master’s*</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>440</td>
<td>56</td>
<td>85</td>
</tr>
<tr>
<td>Asian American</td>
<td>26</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Hispanic / Latino</td>
<td>26</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>African American</td>
<td>23</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Other US Citizens</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Non-US Citizens</td>
<td>268</td>
<td>34</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>789</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: Exiting master’s include students from master’s-granting departments as well as students leaving departments that offer a PhD.

*Based on 521 US citizens.

http://www.aip.org/statistics

**Minority and Ethnic Profile of Physics PhDs, Classes of 2009 through 2011. (3-Year Average)**

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percent of all Physics PhDs</th>
<th>Percent of US Physics PhDs*</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>694</td>
<td>43</td>
<td>89</td>
</tr>
<tr>
<td>Asian American</td>
<td>37</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Hispanic / Latino</td>
<td>20</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>African American</td>
<td>13</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other US Citizens</td>
<td>13</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Non-US Citizens</td>
<td>823</td>
<td>52</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,600</td>
<td>100%</td>
<td>101%**</td>
</tr>
</tbody>
</table>

*Based on 777 US citizens.

**Percent’s for US citizens do not add to 100 due to rounding.

http://www.aip.org/statistics
Increased Competition for Foreign Grad Students

- Approximately, 50% of physics Ph.D. students are from other countries
- Other countries are strengthening their own research infrastructure
  - Competition for best foreign students is likely to increase
  - May need incentives, e.g., fellowships, to attract best foreign students

![First-year Physics Graduate Students at PhD-granting Departments](chart.png)
Holistic Approach to Defining Success in a Physics Graduate Program

• Participants agreed that “one size fits all” approach to graduate education in physics is not appropriate
  – Each program should capitalize on its strengths and remedy weaknesses
  – However, adopting best practices will enrich all graduate programs

• Departments should define overall goals and develop good metrics for success
  • in order to develop a coherent program and build on specific strengths
  • Flexibility is critical to ensure success of diverse group of students
Holistic Approach to Admission in a Physics Graduate Program

• Admissions criteria should be aligned with graduate program goals

• Departments should study which admissions criteria are correlated with success in their programs

• A balanced approach to evaluating applicants may serve the department better than having cut-offs for GPA, GRE etc.

• Two Universities have conducted studies investigating correlation between incoming students’ physics GRE scores and some measure of their future research excellence
  
  – No significant correlation was found

  – Since physics GRE adversely affect women and underrepresented students in admission, other departments should replicate the study and ensure that admission criteria are aligned with success in grad school and beyond
Overall Environment is Critical for Retention and Training of a Diverse Group of Students

• Although “core” physics knowledge is necessary
  – Many felt the core knowledge is upper-level undergrad physics content

• Many departments have begun to modify their curriculum and exam structure
  – Focus on helping students succeed rather than weeding them out
  – Focus more on research skills and accommodate interdisciplinary training

• Qualifying and comprehensive exams were of concern to some students since they increased their time to degree

• Monitoring of progress is critical (at least once a year formally)
  – Provide guidance and support
  – Reduce time to degree

• Family friendly policies, how to deal with mental health issues etc. should be taken seriously and advertised appropriately
Mentoring

• Departments should institute formal mentoring plan to ensure that all students are mentored appropriately regardless of their advisor

  – While mentoring is critical for students from underrepresented groups
    • It helps all students succeed

  – Confidential peer mentoring programs similar to the program at MIT could be invaluable

  – Each student could have a mentoring committee consisting of three faculty members including thesis advisor
    • Student can go to any member as needed for confidential advice

  – Mentoring activities should be seriously considered as part of the annual review for promotion and salary increases

  – All faculty members should be required to go through mentoring training
    • APS resources including mentoring handbook can be useful for this purpose

  – Departments and APS units should institute awards for good mentoring
Opportunities for Developing Professional Skills

• When defining criteria for success of a graduate program, holistic development of graduate students should be central

• Departments should have a department-wide plan to ensure that all graduate students have sufficient opportunity to develop professional skills, e.g., oral and written communication skills, interpersonal skills, teamwork, management and leadership skills and mentoring skills

  – Success in both academic and non-academic careers strongly depends on these skills

  – Universities should require the Deans and department Chairs to provide frequent verbal and written support for professional training and emphasize that it is not a waste of time

  – Departments should partner with other parts of the University (e.g., liberal arts, business school, engineering school etc.) to develop programming

  – Departments should use videotaping and associated critiques to hone presentation skills

  – Students should be encouraged to present at the conferences

  – TA training courses can be helpful
Daily use of Interpersonal and Management Skills of recent physics Ph.Ds. (AIP Statistics)

Interpersonal and Management Skills Regularly Used by New Physics PhDs, Classes of 2009 & 2010 Combined

<table>
<thead>
<tr>
<th>Skill</th>
<th>Postdocs: All Sectors (N=533)</th>
<th>Potentially Permanent: Private Sector (N=117)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working on a Team</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Writing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managing Projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Speaking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managing People</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managing Budgets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working with Clients</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Percentages represent the proportion of physics PhDs who chose “daily”, “weekly” or “monthly” on a four-point scale that also included “never or rarely”. Data only include U.S.-educated physics PhDs who remained in the U.S. after earning their degrees.

http://www.aip.org/statistics
Preparation for Non-Academic Careers

• There should be department-wide plan for providing adequate training for non-academic careers since a majority will find jobs outside of academia

• T-shaped physicist who has an in-depth knowledge in some areas of physics but broad knowledge overall is preferred

• Ability to adapt to new situations and agility are critical

• Professional skills are critical during hiring & for excelling in job

• Seminars by local industrial/national lab scientists or inviting alumni and other physicists who are in non-academic careers to talk to students and faculty can help/feedback from alumni

• Providing students opportunities to do presentations and mock interviews for industrial positions can help

• Internships industries and national labs can help
Physics Ph.Ds. Employed by Sector (AIP Statistics)

<table>
<thead>
<tr>
<th>Year of PhD</th>
<th>indus</th>
<th>acad</th>
<th>gov</th>
</tr>
</thead>
<tbody>
<tr>
<td>1946 – 1965</td>
<td>36%</td>
<td>49%</td>
<td>15%</td>
</tr>
<tr>
<td>1966 – 1970</td>
<td>38%</td>
<td>42%</td>
<td>20%</td>
</tr>
<tr>
<td>1971 – 1975</td>
<td>45%</td>
<td>31%</td>
<td>23%</td>
</tr>
<tr>
<td>1976 – 1980</td>
<td>46%</td>
<td>28%</td>
<td>26%</td>
</tr>
<tr>
<td>1981 – 1985</td>
<td>47%</td>
<td>34%</td>
<td>18%</td>
</tr>
<tr>
<td>1986 – 1990</td>
<td>41%</td>
<td>36%</td>
<td>21%</td>
</tr>
<tr>
<td>1991 – 1995</td>
<td>56%</td>
<td>28%</td>
<td>15%</td>
</tr>
<tr>
<td>1996 – 2000</td>
<td>57%</td>
<td>31%</td>
<td>10%</td>
</tr>
<tr>
<td>Total</td>
<td>46%</td>
<td>34%</td>
<td>19%</td>
</tr>
</tbody>
</table>
Advisor Helpful in Career Planning? (AIP Statistics)

Postdoc (N=545)
- Quite Helpful: 51%
- Somewhat Helpful: 35%
- Not Very or Not at all Helpful: 14%

Other Temporary (N=71)
- Quite Helpful: 51%
- Somewhat Helpful: 26%
- Not Very or Not at all Helpful: 23%

Potentially Permanent (N=299)
- Quite Helpful: 35%
- Somewhat Helpful: 38%
- Not Very or Not at all Helpful: 27%

Legend:
- Quite Helpful
- Somewhat Helpful
- Not Very or Not at all Helpful
In 1991, the survey questionnaire was changed to measure "other temporary" employment as a separate category. Data only include U.S.-educated PhDs who remained in the U.S. after earning their degrees.
Summary

• Departments should build on their strengths and remedy their weaknesses by adopting promising practices.

• Very important to develop flexible curriculum and good metrics for success of a diverse group of students.

• Supportive environment, mentoring, opportunities to develop professional skills are critical for success of a diverse group of graduate students in physics graduate program and beyond.

• The goals of the graduate program, admission criteria, curriculum, guidance and support structure should be well aligned with criteria for success defined for the program.

• What is best for a department should serve both the faculty members and graduate students equally well over long term.