Diversity Considerations for Graduate Admissions

Casey W. Miller
cwmsch@rit.edu

Rochester Institute of Technology
Director, Materials Science and Engineering
School of Chemistry and Materials Science

APS Committee on Minorities (2015-2018)
The Back Page

Admissions Criteria and Diversity in Graduate School

By Casey W. Miller
(Feb 2013)

COLUMNN
A test that fails
A standard test for admission to graduate school misses potential winners, say Casey Miller and Keivan Stassun.

STATUS
A REPORT ON WOMEN IN ASTRONOMY

CONTENTS
Using Non-Cognitive Assessments in Graduate Admissions to Select Better Students and Increase Diversity

CAREERS

Gazette
CSWP & COM

INSIGHT
Non-Cognitive Assessments:
Enhance Validity and Diversity
Casey W. Miller, School of Chemistry & Materials Science, Rochester Institute of Technology
Invited Diversity Talks; Invite me!
Outline

• Broadening Participation Matters
• State of Physics
• Bridge Programs and their Key Features
• Admissions Criteria and Diversity
• Using Minimum Acceptable GRE Scores Negatively Impacts Diversity in STEM and does not select students with the most research potential
Broadening Participation Matters

• US Demographics are changing rapidly
  – Minorities represent 1/3 of the US population, but much less in STEM jobs (e.g., ~5.4% of PhDs)
  – Engage URM in STEM to utilize all facets of the domestic talent pool, address brain drain
Broadening Participation Matters

• Diversity is an Asset
  – Diversity enhances innovation
  – Collective intelligence from diverse social skills

Scott E. Page
THE DIFFERENCE
HOW THE POWER OF DIVERSITY CREATES BETTER GROUPS, FIRMS, SCHOOLS, AND SOCIETIES
Physics is among the least diverse of the sciences.

Credit: APS/Source: IPEDS Completion Survey
Physics is among the least diverse of the sciences.

[Graph showing the percentage of total physics degrees by race and gender, with data from the US population age 21-24 and 25-29.]

Credit: APS/Source: IPEDS Completion Survey

average of 2006-2008
Physics is among the least diverse of the sciences.

Credit: APS/Source: IPEDS Completion Survey
Physics is among the least diverse of the sciences.

Credit: APS/Source: IPEDS Completion Survey & NSF-NIH Survey of Graduate Students & Postdoctorates in Science and Engineering
### 5-year Total Degree Production of Top Producers of Physics URM PhDs

<table>
<thead>
<tr>
<th>Top URM Producers</th>
<th>2006-2010</th>
<th>Top Hispanic PhDs</th>
<th>2006-2010</th>
<th>Top African American PhDs</th>
<th>2006-2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of California-Berkeley</td>
<td>8</td>
<td>University of California-Berkeley</td>
<td>6</td>
<td>Howard University</td>
<td>8</td>
</tr>
<tr>
<td>University of Michigan at Ann Arbor</td>
<td>8</td>
<td>Rice University</td>
<td>4</td>
<td>Florida Agricultural and Mechanical University</td>
<td>6</td>
</tr>
<tr>
<td>Howard University</td>
<td>8</td>
<td>University of California-Los Angeles</td>
<td>4</td>
<td>Alabama Agricultural and Mechanical University</td>
<td>5</td>
</tr>
<tr>
<td>Florida Agricultural and Mechanical University</td>
<td>6</td>
<td>University of Michigan at Ann Arbor</td>
<td>4</td>
<td>Hampton University</td>
<td>5</td>
</tr>
<tr>
<td>University of Arizona</td>
<td>5</td>
<td>University of Texas Hlth Sci Ctr San Antonio</td>
<td>4</td>
<td>North Carolina State University at Raleigh</td>
<td>4</td>
</tr>
<tr>
<td>Alabama Agricultural and Mechanical University</td>
<td>5</td>
<td>University of Texas at Austin</td>
<td>4</td>
<td>University of Michigan at Ann Arbor</td>
<td>4</td>
</tr>
<tr>
<td>Hampton University</td>
<td>5</td>
<td>Arizona State University Main</td>
<td>3</td>
<td>Georgia Institute of Technology, Main Campus</td>
<td>2</td>
</tr>
<tr>
<td>Rice University</td>
<td>4</td>
<td>Harvard University</td>
<td>3</td>
<td>Harvard University</td>
<td>2</td>
</tr>
<tr>
<td>University of California-Los Angeles</td>
<td>4</td>
<td>Stanford University</td>
<td>3</td>
<td>University of Arizona</td>
<td>2</td>
</tr>
<tr>
<td>University of Texas Hlth Sci Ctr San Antonio</td>
<td>4</td>
<td>University of Arizona</td>
<td>3</td>
<td>University of California-Berkeley</td>
<td>2</td>
</tr>
<tr>
<td>University of Texas at Austin</td>
<td>4</td>
<td>University of Rochester</td>
<td>3</td>
<td>University of Colorado at Boulder</td>
<td>2</td>
</tr>
<tr>
<td>North Carolina State University at Raleigh</td>
<td>4</td>
<td>University of Illinois at Urbana-Champaign</td>
<td>2</td>
<td>University of Maryland at College Park</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: IPEDS Completion Survey by Race
What can be done?

Top Priority Actions

1) Increase undergraduate retention and completion via strong academic, social, and financial support.

2) Teacher prep, college prep programs, and Transition to Graduate Study.
APS Bridge Program

Physics Degrees Awarded to Underrepresented Minorities

- Bachelor's Degrees: ~400 degrees
- Doctoral Degrees: ~40 degrees
- ~30 more PhDs

Current Situation

Project Goals
But first you have to admit them.

The Back Page

Admissions Criteria and Diversity in Graduate School

By Casey W. Miller

The development of the APS Bridge Program (APS-EP) provides our community with a great opportunity to help physics shed the notoriety of being the least diverse of the sciences. We can all play a role in this effort, whether or not our individual programs are or will become affiliated with the APS-EP. In this article, I hope to raise awareness of some relatively simple but impactful means to enhance racial and gender diversity. What follows is hardly comprehensive, but hopefully suggests pragmatic next steps that can be widely and rapidly implemented.

There are about 180 physics programs listed in the AIP Graduate Programs book. The General GRE is required by 96%, a quarter of these have an explicitly stated minimum Quantitative GRE (QGRE) score for admission, with the median stated cut-off being 700 (64th–76th percentile, depending on year). As educators, we naturally expect exams to be meaningful. Most people believe this is the case for the GRE exams, and may thus prefer high scores. But analysis of the data often finds no significant correlation between
Admissions is typically a two-tier process for all fields.
Tier 1: Filters

Undergraduate GPA
GRE scores
Undergraduate Institution
Tier 2: Qualitative, Holistic

Research and leadership potential
Creativity, Innovation
Enthusiasm, passion for research
Diversity
It doesn’t really work much better than this

Ph.D. Completion and Attrition: Analysis of Baseline Demographic Data from the Ph.D. Completion Project

Many reasons for this, Admissions is only one
Issues with the norm

• Grades
  – Grade Inflation undermines minority participation

### Most URMs attend State Colleges

<table>
<thead>
<tr>
<th>URM Engineering #BA/BS</th>
<th>Rank</th>
<th>URM Physical Sciences #BA/BS</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Florida (240/yr)</td>
<td>1</td>
<td>Florida International University (85/yr)</td>
</tr>
<tr>
<td>Florida International University</td>
<td>2</td>
<td>Xavier University of Louisiana</td>
</tr>
<tr>
<td>Texas A &amp; M University-College Station</td>
<td>3</td>
<td>The University of Texas at Austin</td>
</tr>
<tr>
<td>University of Central Florida</td>
<td>4</td>
<td>University of California-Santa Barbara</td>
</tr>
<tr>
<td>Georgia Institute of Technology-Main Campus</td>
<td>5</td>
<td>Texas A &amp; M University-College Station</td>
</tr>
<tr>
<td>California State Polytechnic University-Pomona</td>
<td>6</td>
<td>The University of Texas at El Paso</td>
</tr>
<tr>
<td>The University of Texas at El Paso</td>
<td>7</td>
<td>University of California-Los Angeles</td>
</tr>
<tr>
<td>The University of Texas at Austin</td>
<td>8</td>
<td>University of Florida</td>
</tr>
<tr>
<td>North Carolina A &amp; T State University</td>
<td>9</td>
<td>Spelman College</td>
</tr>
<tr>
<td>The University of Texas-Pan American</td>
<td>10</td>
<td>University of California-Irvine</td>
</tr>
<tr>
<td>Cal Polytechnic State University-San Luis Obispo</td>
<td>11</td>
<td>University of North Carolina at Chapel Hill</td>
</tr>
<tr>
<td>The University of Texas at San Antonio</td>
<td>12</td>
<td>University of California-Santa Cruz</td>
</tr>
<tr>
<td>Arizona State University-Tempe</td>
<td>13</td>
<td>University of Arizona</td>
</tr>
<tr>
<td>University of California-San Diego</td>
<td>14</td>
<td>University of New Mexico-Main Campus</td>
</tr>
<tr>
<td>University of Houston</td>
<td>15</td>
<td>Florida State University</td>
</tr>
<tr>
<td>San Diego State University</td>
<td>16</td>
<td>Georgia State University</td>
</tr>
<tr>
<td>Morgan State University</td>
<td>17</td>
<td>Jackson State University</td>
</tr>
<tr>
<td>Prairie View A &amp; M University</td>
<td>18</td>
<td>The University of Texas at San Antonio</td>
</tr>
<tr>
<td>Alabama A &amp; M University</td>
<td>19</td>
<td>Columbia University in the City of New York</td>
</tr>
<tr>
<td>North Carolina State University at Raleigh</td>
<td>20</td>
<td>University of Memphis</td>
</tr>
<tr>
<td>Southern University and A &amp; M College</td>
<td>21</td>
<td>CUNY City College</td>
</tr>
<tr>
<td><strong>Howard University</strong></td>
<td>22</td>
<td>CUNY Graduate School and University Center</td>
</tr>
<tr>
<td><strong>Tuskegee University</strong></td>
<td>23</td>
<td>Savannah State University</td>
</tr>
<tr>
<td>University of Maryland-College Park</td>
<td>24</td>
<td>Alabama A &amp; M University</td>
</tr>
<tr>
<td>University of South Florida-Main Campus</td>
<td>25</td>
<td>Georgia Southern University</td>
</tr>
<tr>
<td>Virginia Tech (38/yr)</td>
<td>26</td>
<td>Tennessee State University (15/yr)</td>
</tr>
</tbody>
</table>
Issues with the norm

• Test Scores
  – “Guide to Use of Scores” not followed (or even known of)
  – Significant race/gender group differences
  – Correlations with Success are questionable
Pop Quiz:
With all else equal, which folder do you admit?

Folder A
GRE-Q: 740 (80%)

Folder B
GRE-Q: 800 (perfect)
It is an inexact measure; only score differences that exceed the standard error of measurement of a given score can serve as a reliable indication of real differences in applicants' academic knowledge and developed abilities.”

Translated to physics-ese:

**CONSIDER INSTRUMENT RESOLUTION**

S.E.M. ~60 points (on old GRE scale, 200-800).
740 = 800 = perfect!
US Physics PhD Programs

• About 180 graduate programs are listed in the AIP Graduate Programs book
  – ~96% require the General GRE
    • about one quarter of these have a stated minimum score for admission, with the median being 700 (~64%)
  – ~48% require the Physics GRE
    • about half of these have a stated minimum score for admission, with the median being 600 (32%).
Guidelines

- A cutoff score based only on GRE scores should never be used as a sole criterion for denial of admission.

- Any department considering the use of a cutoff score should compile a rationale justifying the appropriateness of such a score for each measure:
  (1) evidence that the proposed cutoff score for the measure usefully distinguishes between individuals who are likely to succeed in graduate school and those who are not, and
  (2) the impact of the proposed cutoff score on the institution’s goals related to diversity.

http://www.ets.org/gre/institutions/scores/guidelines/
From ETS document
"Factors that can influence performance on the GRE general test 2006-2007"

GRE Quantitative Scores (2006-2007) for Physical Sciences, US Citizens

Median (NRC; Physics): 760

25%: 700
50%: 75%
75%: 800
These performance disparities are:

- Technically not “bias”
- Nearly independent of intended graduate major
- Qualitatively unchanged when controlling for undergraduate GPA
- Qualitatively the same for
  - GRE Subject test
  - SAT Math
  - 8th grade math achievement tests
  - 4th grade math achievement tests
- A feature of standardized testing.
Physical Sciences

GRE Quantitative Score (2006-2007)

SOURCE: ETS, "Factors that can influence performance on the GRE general test 2006-2007"
Engineering

GRE Quantitative Score (2006-2007)

SOURCE: ETS, "Factors that can influence performance on the GRE general test 2006-2007"
GRE Quantitative Score (2006-2007)

Life Sciences

SOURCE: ETS, "Factors that can influence performance on the GRE general test 2006-2007"
SOURCE: ETS, "Factors that can influence performance on the GRE general test 2006-2007"
SOURCE: ETS, "Factors that can influence performance on the GRE general test 2006-2007"
SOURCE: ETS, "Factors that can influence performance on the GRE general test 2006-2007"
SOURCE: ETS, "Factors that can influence performance on the GRE general test 2006-2007"
ugGPA = A

SOURCE: ETS, "Factors that can influence performance on the GRE general test 2006-2007"

Mean SAT Math Score

SOURCE: Total Group Profile Report, College Board, 2009 College-Bound Seniors.
Despite these R/E/G/SES issues

• Cut-off scores are used all the time by admissions committee members.
  – Sorting spreadsheets is easy.
  – Faculty are busy, often reluctantly serving
  – Faculty are not trained in selection
  – “Low scores must tell you something.”
  • But correlation $R \sim 0.2-0.3$ is only with first year GPA; by second year, $R < 0.1^a$

\textsuperscript{a}NAS: In the Nation’s Compelling Interest: Ensuring Diversity in the Health-Care Workforce (2004)
Impact of Cut-off Scores?

Only physical sciences & US citz.
Impact of Cut-offs: %Δ Representation

<table>
<thead>
<tr>
<th>Cut-off</th>
<th>Asian Am.</th>
<th>White</th>
<th>URM</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td>9.3%</td>
<td>82%</td>
<td>5.2%</td>
<td>27%</td>
<td>73%</td>
</tr>
<tr>
<td>Examinees</td>
<td>7.6%</td>
<td>77%</td>
<td>11%</td>
<td>36%</td>
<td>64%</td>
</tr>
</tbody>
</table>

Representation

\[
\sum_{\text{Cut-off}} \frac{\text{one group}}{800} \sum_{\text{Cut-off}} \frac{\text{all groups}}{800}
\]
GRE Physics Subject Test

Working with APS
And ETS
21% of test takers were female

Fraction Above the Cut-off

Cut-off on GRE Physics

SOURCE: ETS (via APS)
Gender Gap Persists ∀ R/E; ∀ Nationalities

- Other Hispanic, Latino, or Latino American
- White (non-Hispanic)
- Mexican, Mexican American, or Chicano
- Black or African American
- Native Hawaiian, or Other Pacific Islander
- Puerto Rican
- Asian or Asian American

Graphs showing trends in gender gap across different nationalities.
From ETS Guide to Use of Scores

Guidelines

– A cutoff score based only on GRE scores should never be used as a sole criterion for denial of admission.

– Any department considering the use of a cutoff score should compile a rationale justifying the appropriateness of such a score for each measure:
  
  (1) evidence that the proposed cutoff score for the measure usefully distinguishes between individuals who are likely to succeed in graduate school and those who are not, and

  (2) the impact of the proposed cutoff score on the institution’s goals related to diversity.

http://www.ets.org/gre/institutions/scores/guidelines/
Correlations with success are questionable.
Similar conclusions: Michigan; Berkeley
The validity of the GRE tests, is limited to first year grades.

Subject Test may tell you a little about preparation, convolved with R/E/G

NOT about potential to become a PhD-level research scientist (the aim!)
The usual weight given to GRE scores in admissions exceeds its predictive capabilities and has negative societal impact.
Diversity needn’t come at the expense of Quality

• But it can, if you’re: careless; too busy; or just going through the motions.
• Lowering the bar perpetuates stereotypes exactly by definition
• What bar? Potential for what?

RESEARCH!
Correlating clinical performance with admissions criteria and *non-cognitive competencies*

<table>
<thead>
<tr>
<th></th>
<th>Didactic</th>
<th>Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Non-Cognitive</td>
<td>Maybe</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Self-Management competencies** correlate with clinical grade.

1. Achievement Orientation
2. Adaptability
3. Initiative
4. Emotional Self-Control
5. Trustworthiness
6. Conscientiousness
7. Optimism

“Cognitive ability and knowledge are threshold aspects of professional work, necessary but not sufficient for outstanding professional performance.”
Issues with the norm

- Non-cogs considered after using filters that negatively impact diversity
Non-Cognitive Constructs

• Measurable!

• Results from decades of Industrial-Organizational Psychology research
  – non-cogs predict academic/job performance
  – non-cogs show little if any group differences
  – non-cogs are orthogonal variables to cognitive constructs (GPA, SAT/GRE)
PRESS RELEASE

FOR IMMEDIATE RELEASE:
December 6, 2014

Contact: Nate Thompson
(202) 223-3791 / nthompson@cgs.nche.edu

CGS Launches Study of Holistic Graduate Admissions Processes

Washington, D.C. — The Council of Graduate Schools (CGS), in collaboration with Hobsons, today announced a new initiative to better understand current holistic graduate application processes. With input from its member institutions, CGS will explore the implications of new technologies for achieving improvements in graduate admissions and student success rates.

As graduate institutions focus increasing attention on identifying and developing talent, the process of “whole-file” or holistic review is becoming more important. Holistic review of individual applicants is a process by which programs consider a broad range of admissions criteria when selecting applicants, including non-cognitive and personal attributes.

At the Council of Graduate Schools’ Annual Meeting in Washington, DC today, CGS President Suzanne T. Ortega announced, “With this project, CGS reaffirms its commitment to enhancing the quality of graduate education from admissions to completion and into careers. Understanding the practices and value of holistic review will help graduate institutions develop a broader understanding of the applicant qualities that translate into student success.”

Many leaders in graduate education believe that some version of holistic review has the potential to help universities achieve a more appropriate match between programs and students, to improve access to graduate education, and to improve the success rates of students who enter graduate programs at the master's and doctoral levels. A recurring discussion among graduate deans is how to encourage programs and departments to engage in the review of a broader range of admissions criteria, rather than focusing on a few indicators of potential student success.
Issues with the norm

• ill-defined protocols = haphazard review
  – Extra/Zero scrutiny for underrepresented folks
Non Cogs: Implements

• Coarse Grained Rubrics
  – can be implemented now!
  – guides review of statements/letters/interviews
    • can expedite the review process
    • reduce implicit bias (expectations based on race/gender/name/culture); combats reviewer fatigue
  – inter-rater reliability
  – develop in conjunction with a social scientist
  – add short answer items on app to probe non-cogs?
<table>
<thead>
<tr>
<th>Attribute</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Self-Concept</td>
<td>Expresses confidence they can complete challenging goals, makes positive statements about abilities</td>
<td>Shows confidence and independence but may be unsure about adequacy or skills</td>
<td>Is unsure they can complete the program, exhibits low self-esteem</td>
</tr>
<tr>
<td>Realistic Self-Appraisal</td>
<td>Can clearly and realistically delineate strengths and weaknesses, works on self development</td>
<td>Has trouble identifying strengths and weakness but appreciates/seeks both positive and negative feedback</td>
<td>Over or understates abilities, does little to no self-assessment, does not appear to have learned from experiences</td>
</tr>
<tr>
<td>Preference for Long vs. Short Term Goals</td>
<td>Clearly communicates long-range goals beyond the PhD</td>
<td>Primary goal is PhD completion</td>
<td>Is vague about long-term goals, or goals are short term such as coursework</td>
</tr>
<tr>
<td>Support Person Availability</td>
<td>Can define a professional support network including mentors</td>
<td>Expresses support from one individual, or family or community</td>
<td>Expresses little or no support from family or institution for goals</td>
</tr>
<tr>
<td>Leadership/Community Involvement</td>
<td>Demonstrates involvement and leadership ability in either academics, family, community, religious group, or athletics</td>
<td>Demonstrates involvement in groups in academia or extramural but has not shown leadership</td>
<td>Not involved in institutional or community group, no demonstrated leadership</td>
</tr>
<tr>
<td>Knowledge in a Field/Non-Traditional Learning</td>
<td>Has engaged in, and learned from, experiences outside the classroom, i.e. performed independent research, extramural activities, self-taught skills</td>
<td>Shows some evidence of non-traditional learning experience</td>
<td>Has not engaged in or indicated learning from experiences outside the classroom</td>
</tr>
<tr>
<td>Perseverance</td>
<td>Can describe a time they failed or encountered an obstacle and successfully coped.</td>
<td>Can identify a time they hit an obstacle but has trouble defining how they overcame the challenge.</td>
<td>Has little experience with failure/obstacles. Cannot provide an example or describe response</td>
</tr>
</tbody>
</table>

Modified from Sedlacek
Non-Cogs: Implements

• Situational Judgment Tests
  – could be implemented as part of the online application submission process (ease of use!)
  – ask the test taker to describe how they would act in a hypothetical scenario; or rank the efficacy of several potential actions
  – can be tailored to probe specific constructs or discipline-specific scenarios (hire an expert)
  – susceptible to faking
  – not terribly expensive
Mechanical Assembly of Data

• Normalize components
• Add them
• More effective and efficient than non-algorithmic methods
• non-cogs are orthogonal to cogs
  – weight these equally

http://en.wikipedia.org/wiki/Apgar_score
Major Take-Aways

• Traditional admissions process
  – No better than a coin toss
  – Strongly filters under-represented groups
    • Large race/gender gaps on standardized tests

And most importantly...

  – Increase the diversity of the applicant pool
  – Select students who will graduate

• Systematic evaluation protocols can
  – Limit implicit bias, increase diversity
  – Increase efficiency of screening applicants

• Get a social scientist to help!