Current Status and Future of the Nuclear Workforce

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Outline

- Current status of nuclear workforce
- Efforts to increase engagement (K-Grad)
- From engagement to increasing workforce

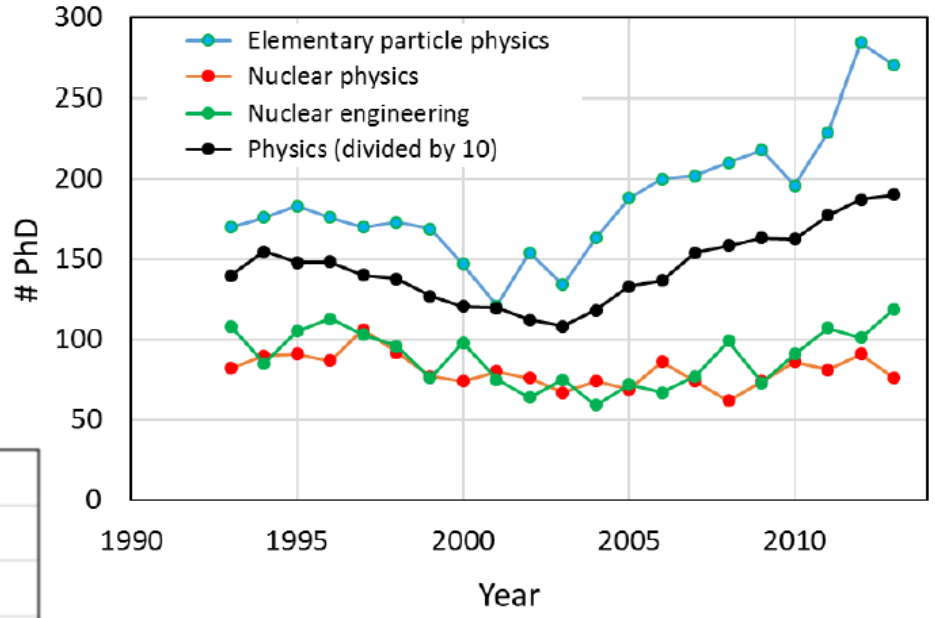
Nuclear Workforce

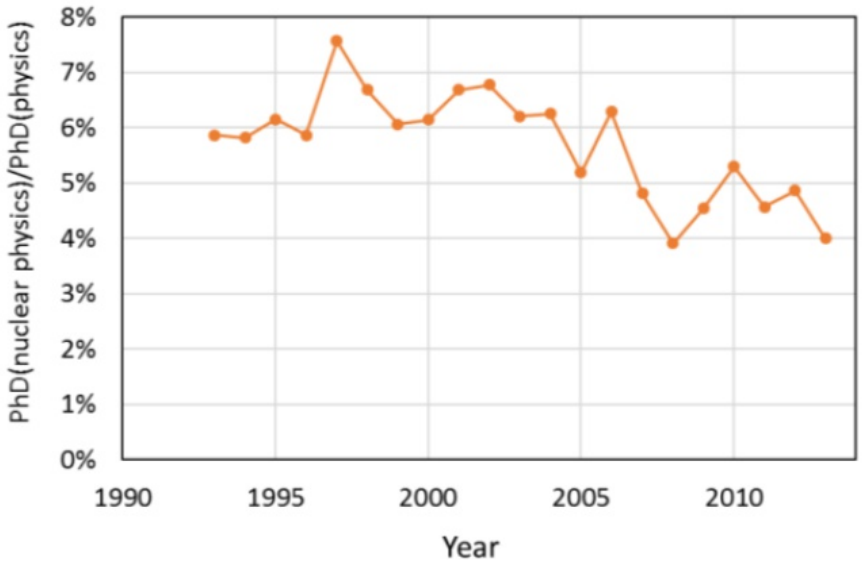
- 80% of PhD students work in applied fields (medicine to homeland security) while only 20% continue in fundamental research in nuclear science
- The 2012 NRC report stressed that the increasing needs for a nuclear workforce for medicine, health physics, and energy come at a time when the nuclear force is shrinking

Report from the DNP town meeting on Education and Innovation. Thoennessen, Peaslee

Nuclear Workforce Status

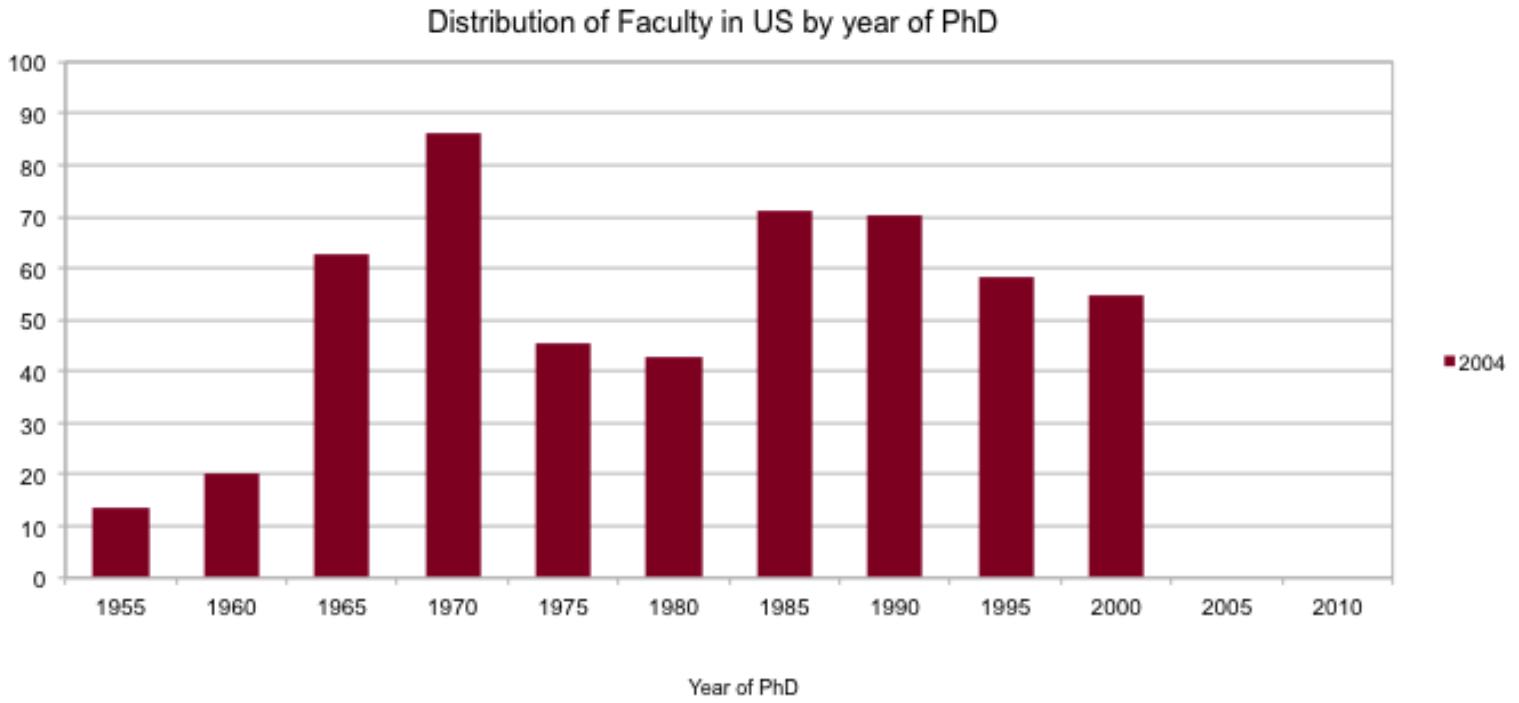
Figure 2.1.1 Number of PhD degrees awarded in elementary particle physics, nuclear physics, nuclear engineering and in physics overall [9].





http://www.nsf.gov/statistics/sed/2013/data-tables.cfm

US Workforce Status



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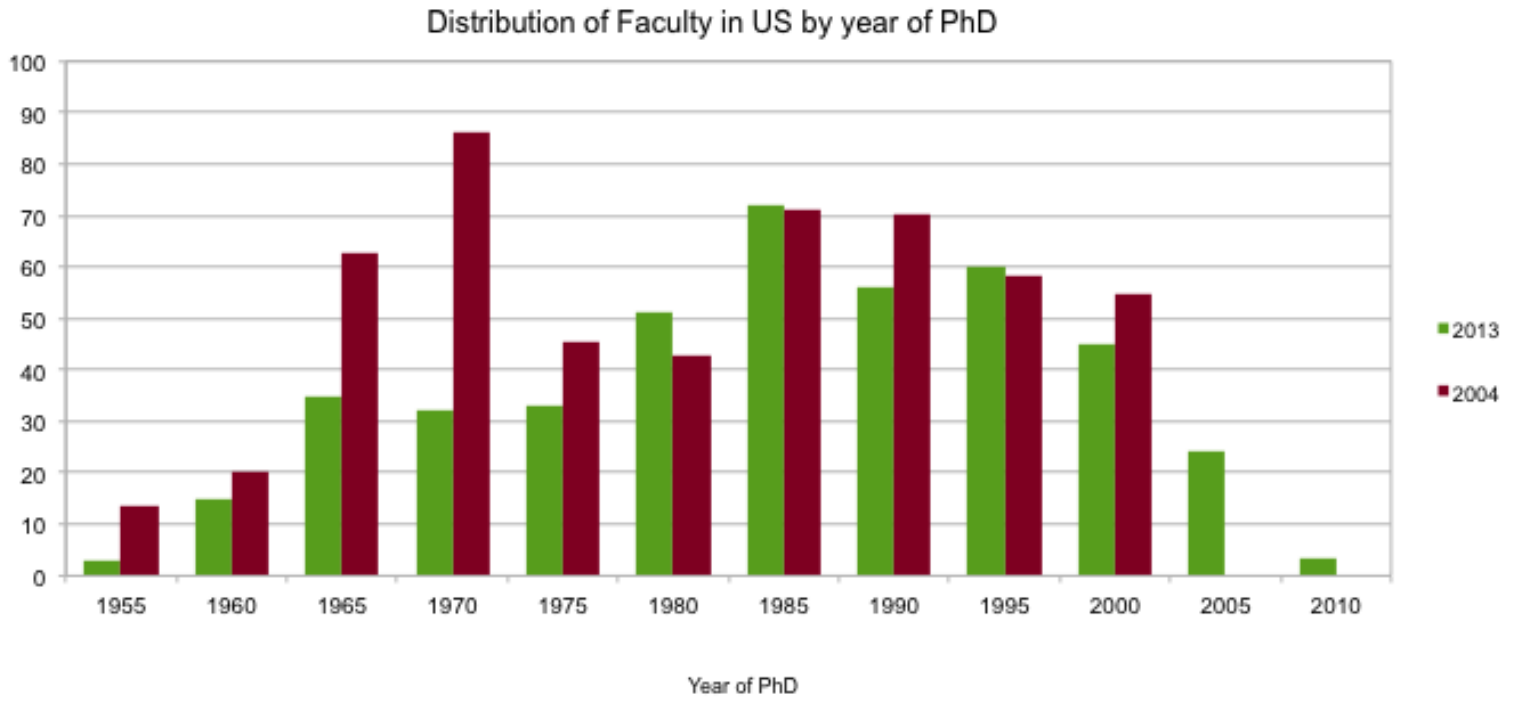
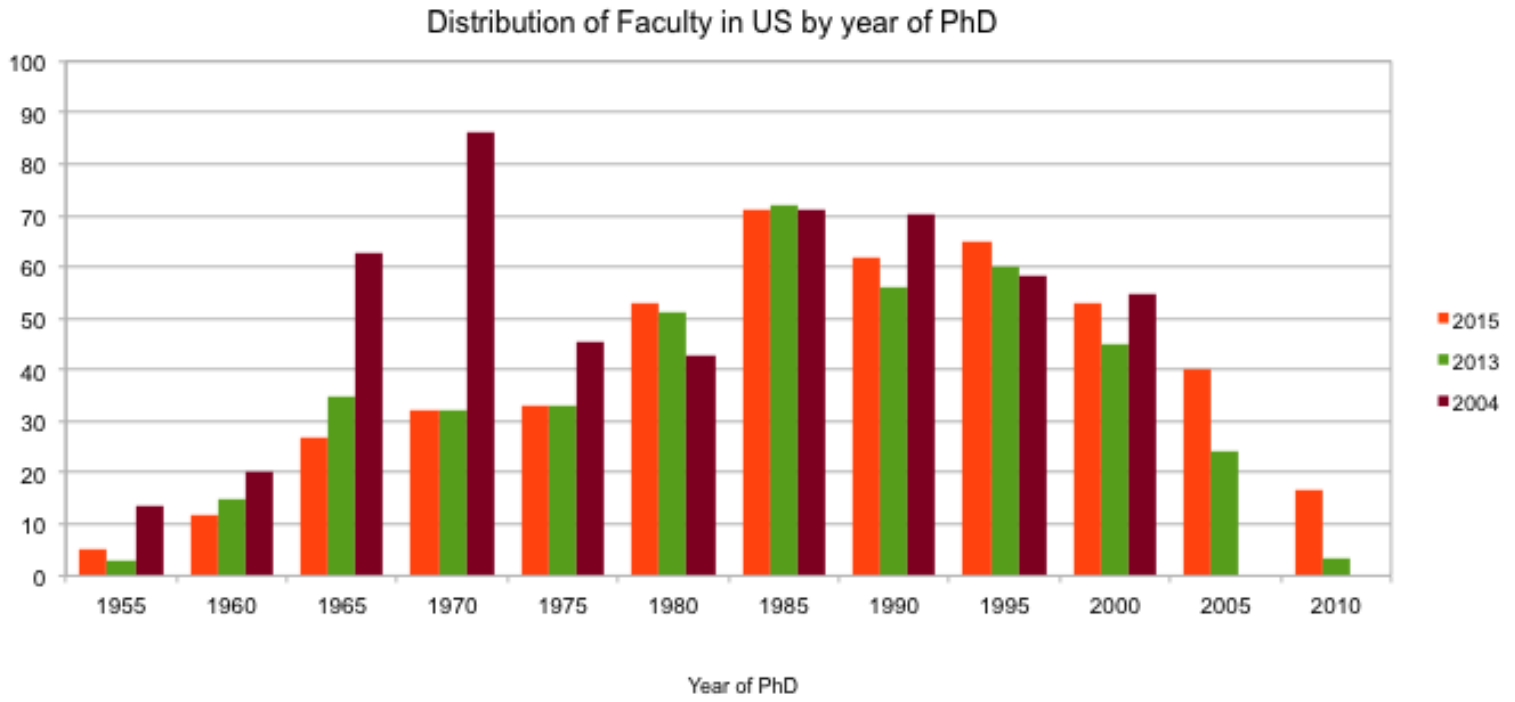


US Workforce Status



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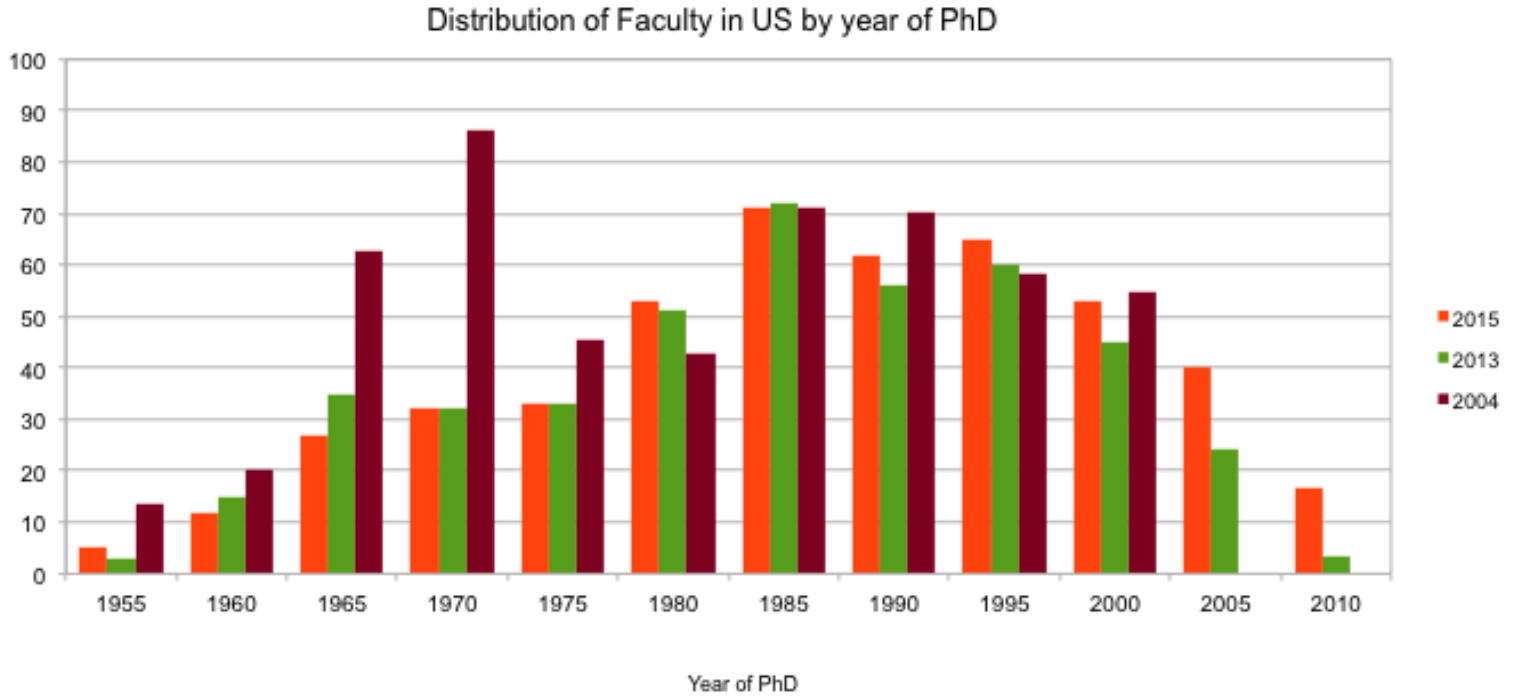
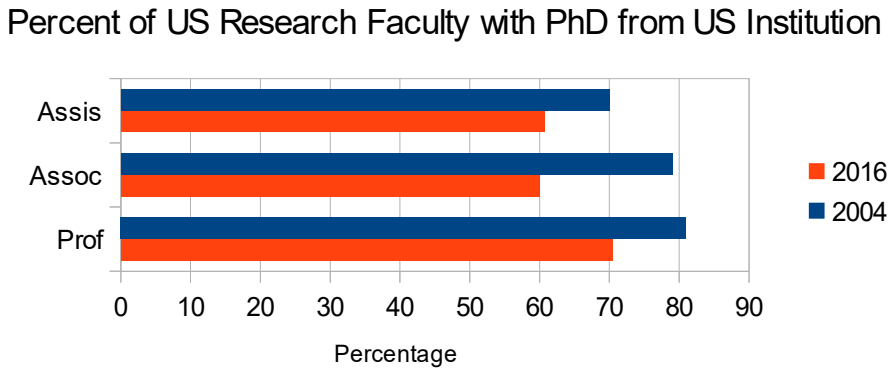
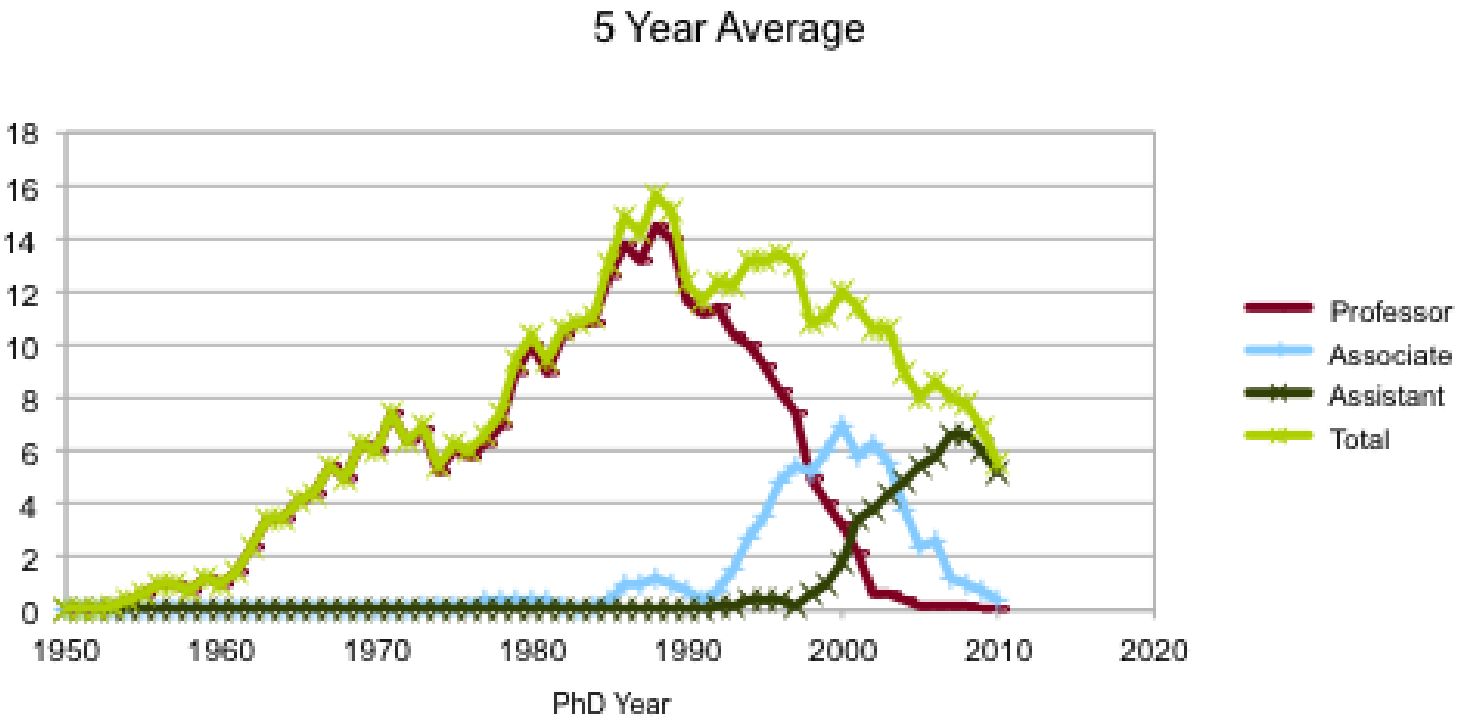
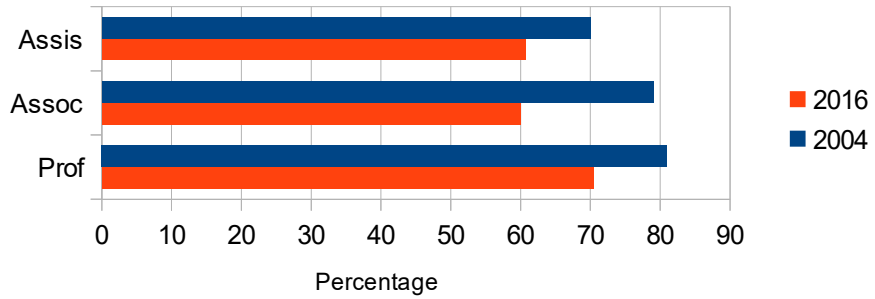




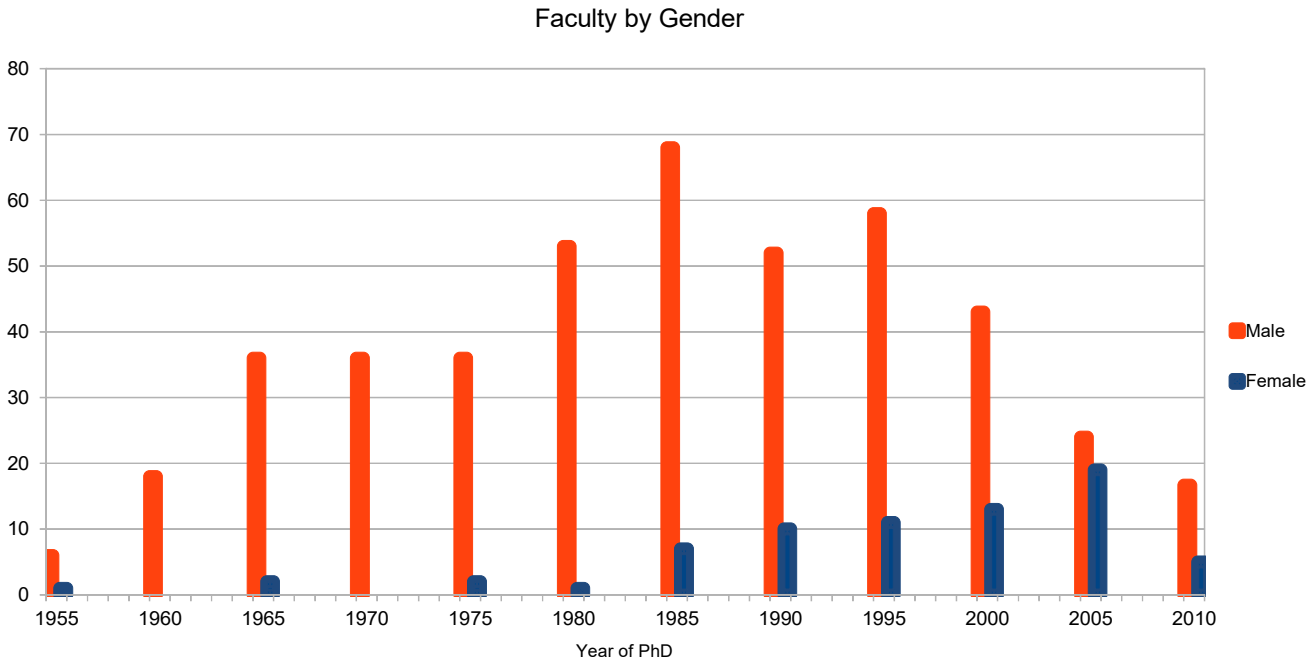
US Workforce Status

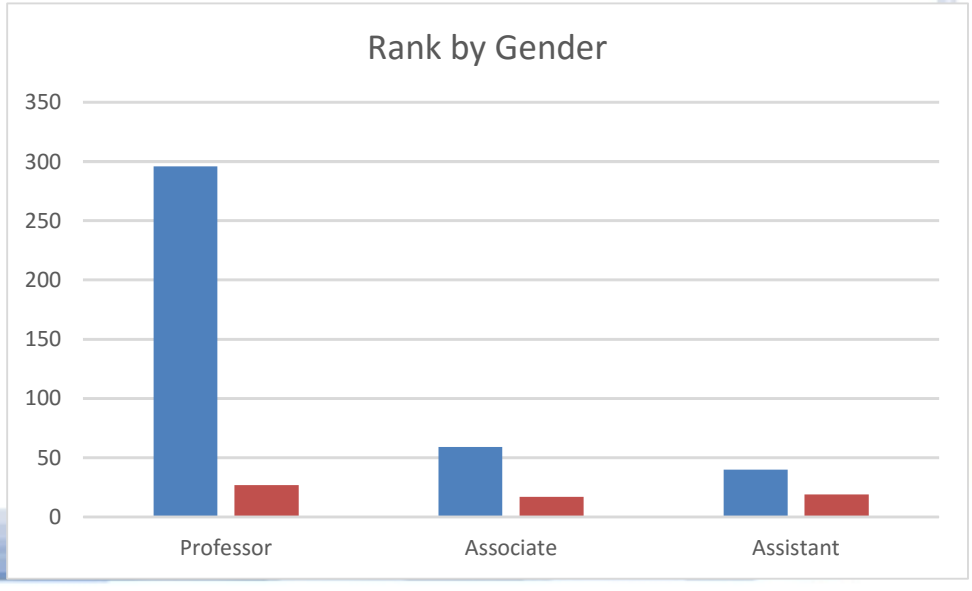


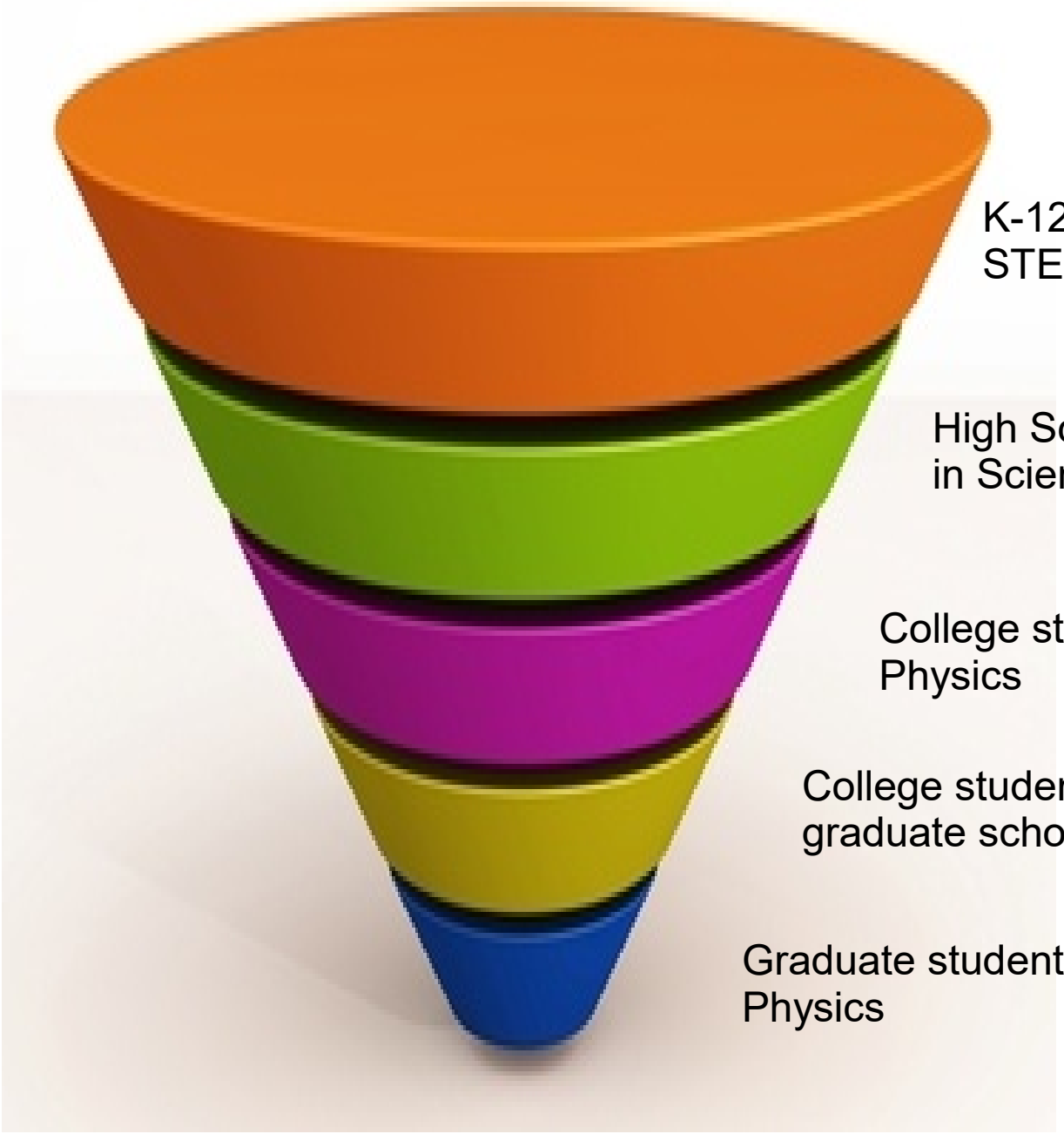
Percent of US Research Faculty with PhD from US Institution



Faculty Diversity







K-12 students interested in STEM

High School students interested in Science

College students majoring in Physics

College students going to graduate school in Physics

Graduate students in Nuclear Physics

Common Outreach & Education

- Public Lectures, Cafes
- Lab Tours, Open Houses
- Science Festivals, Science Days, Street Physics
- Videos, games, sounds, art
- Summer camps, workshops, schools

Art 2 Science Camp

Large-enrollment camp @ ND

- Science based art & Creative science projects
- Sliding Scale fee
- Ages 8-12
- Teens serve as junior counselors

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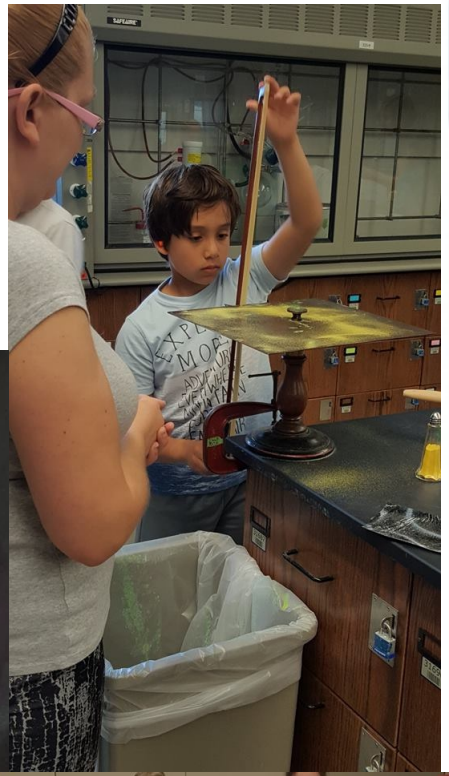
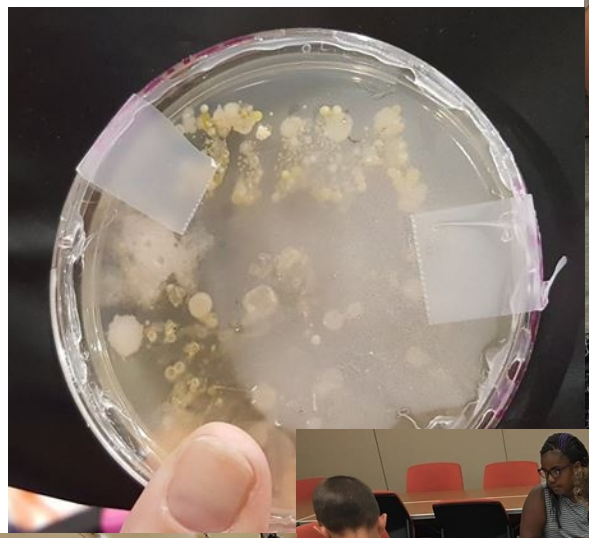
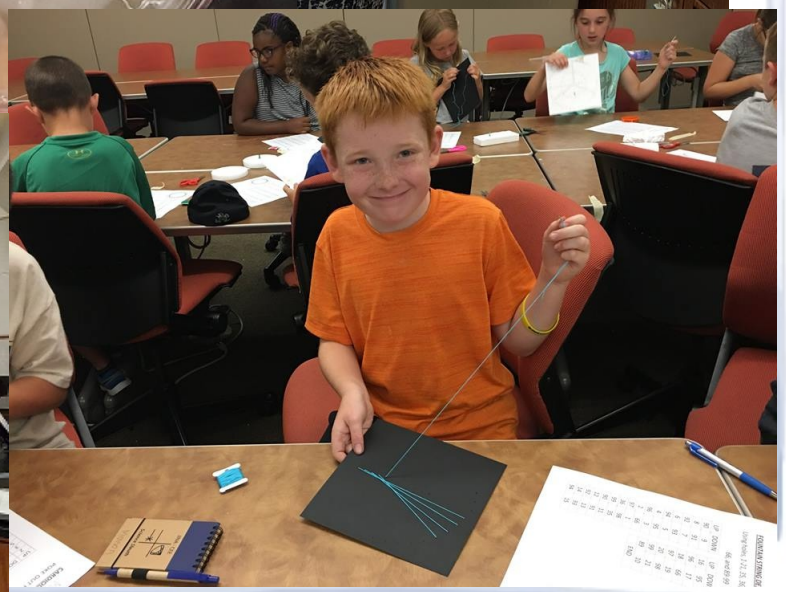






Nuclear Modeling w/ Magnetic Marbles

Proton

Neutron

Electron

Positron

Magnet to hold it all together

Isotope BINGO!

(board made from Chart of the Nuclides)

P	4	5	6	7	8	
8	O 12 <0.001s 2 protons	O 13 0.009s	O 14 70.5s	O 15 0.122s	O 16 99.758%	Oxygen
7	N 11 <0.001s	N 12 0.011s	N 13 9.97m	N 14 99.63%	N 15 0.37%	Nitrogen
6	C 10 19.3s	C 11 20.3m	FREE SPACE	C 13 1.11%	C 14 5730y	Carbon
5	B 9 <0.001s	B 10 20%	B 11 80%	B 12 0.020s	B 13 0.017s	Boron
4	Be 8 <0.001s	Be 9 100%	Be 10 >1 million years	Be 11 13.8s	Be 12 0.011s	Beryllium

N Neutron number (Isotopes)

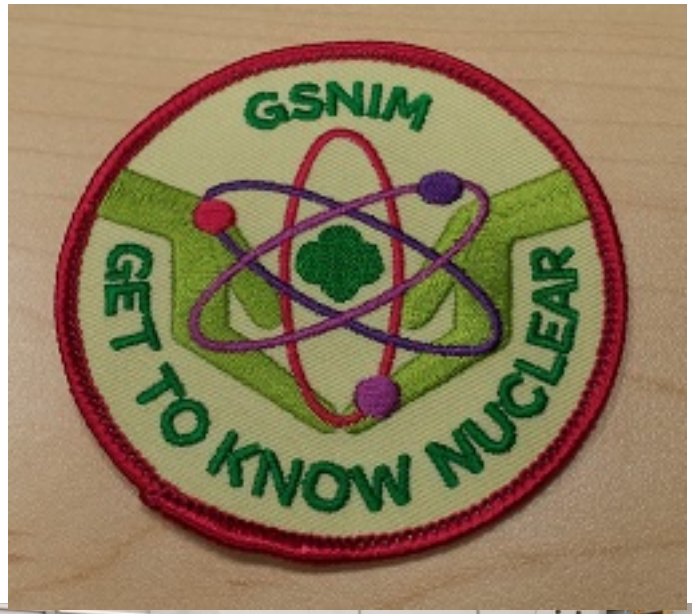
Proton number (Elements)

BSA Nuclear Science Badge

- 5 hr workshop
  - Introduction
  - Lab Tour
  - Cloud chambers
  - Lunch
  - Electroscope
  - Applications/Careers
- Grad student as merit badge counselor

“Getting to Know Nuclear” GS Badge

- Same format as BSA Badge workshop
- Less defining terms, more applications
- Replace less popular activities with XRF activity



Importance of Social Aspects

- Margolis and Fisher (2002) Women are attracted to fields with **broad social impacts**
- Marini (1996) women place more importance on **intrinsic, altruistic, social rewards**
- Colorado School of Mines **Humanitarian Engineering program** (2003) – Popular with females

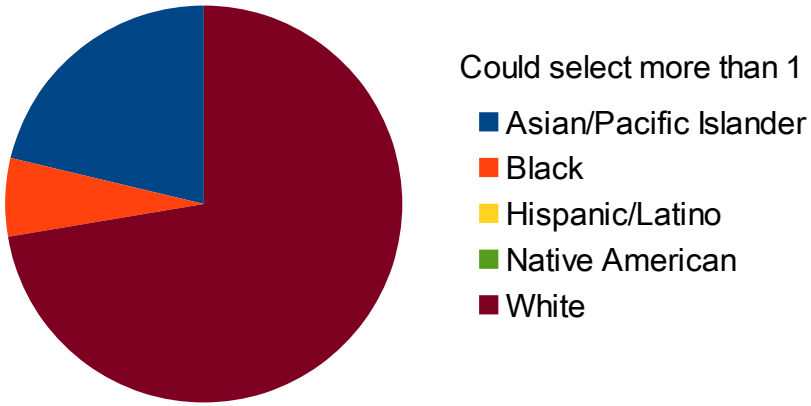
Physics of Atomic Nuclei

- Training camp for highly interested HS students (and HS teachers)
  - 23 years at MSU
  - 8 years at ND
- Free, week-long, residential program
  - Lectures from experts and experiments
- 200+ applicants
  - Accept 24 MSU, 20 ND
  - Average 25% female applicants

Accept almost half!

PAN Applications

Acceptance by Raw Scores



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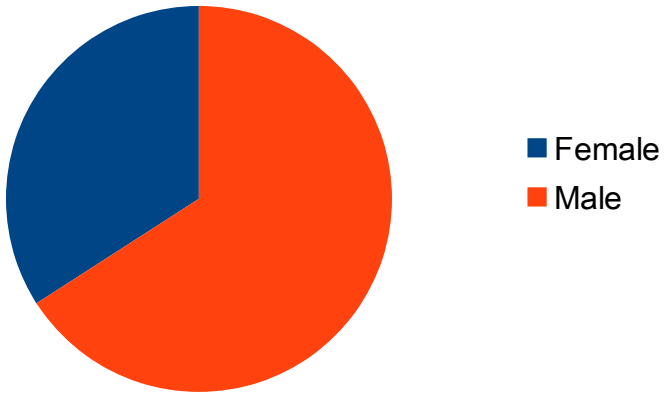

PAN Applications

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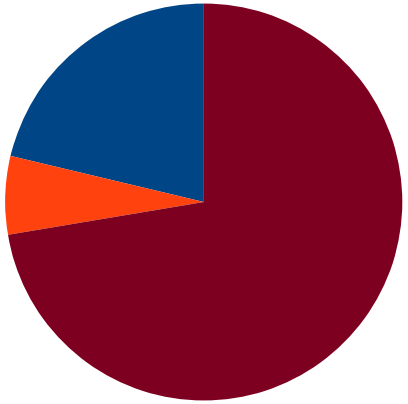


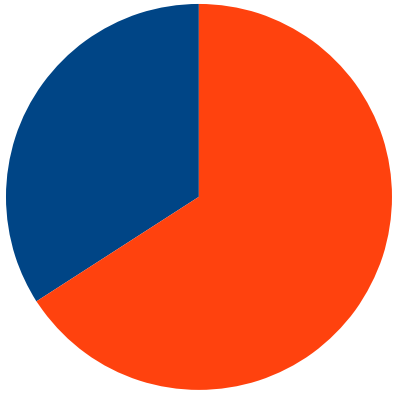
Could select more than 1

- Asian/Pacific Islander
- Black
- Hispanic/Latino
- Native American
- White

Method:

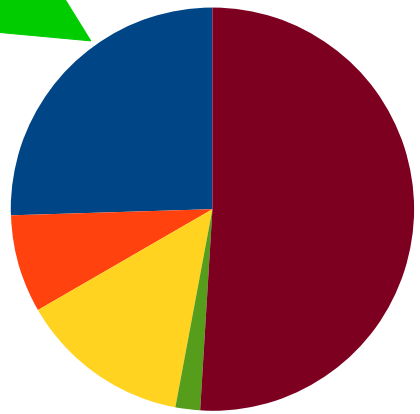
1) Find 'cut-off' for success
2) Accept all URM above cut-off
3) Then impose gender balance

Acceptance by Raw Scores



- Female
- Male

Final PAN Acceptance



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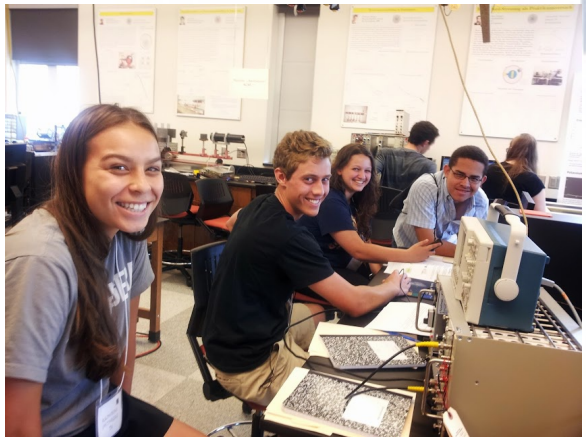
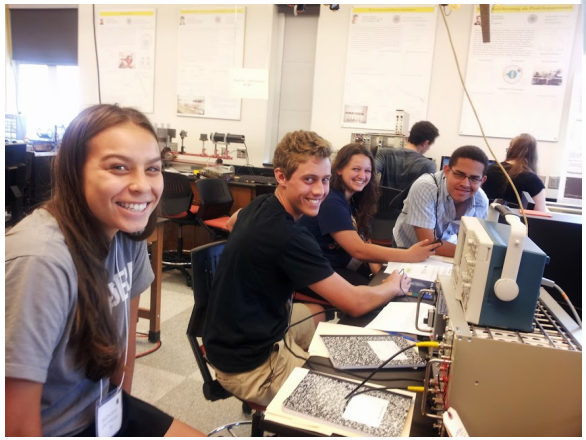
PAN Research



- Longitudinal Study
  - 8x more likely to major in STEM
  - Being able to ***see themselves doing science*** is key
  - Students score equally on knowledge pre/post test but female students ***rate own ability lower***

PAN Research



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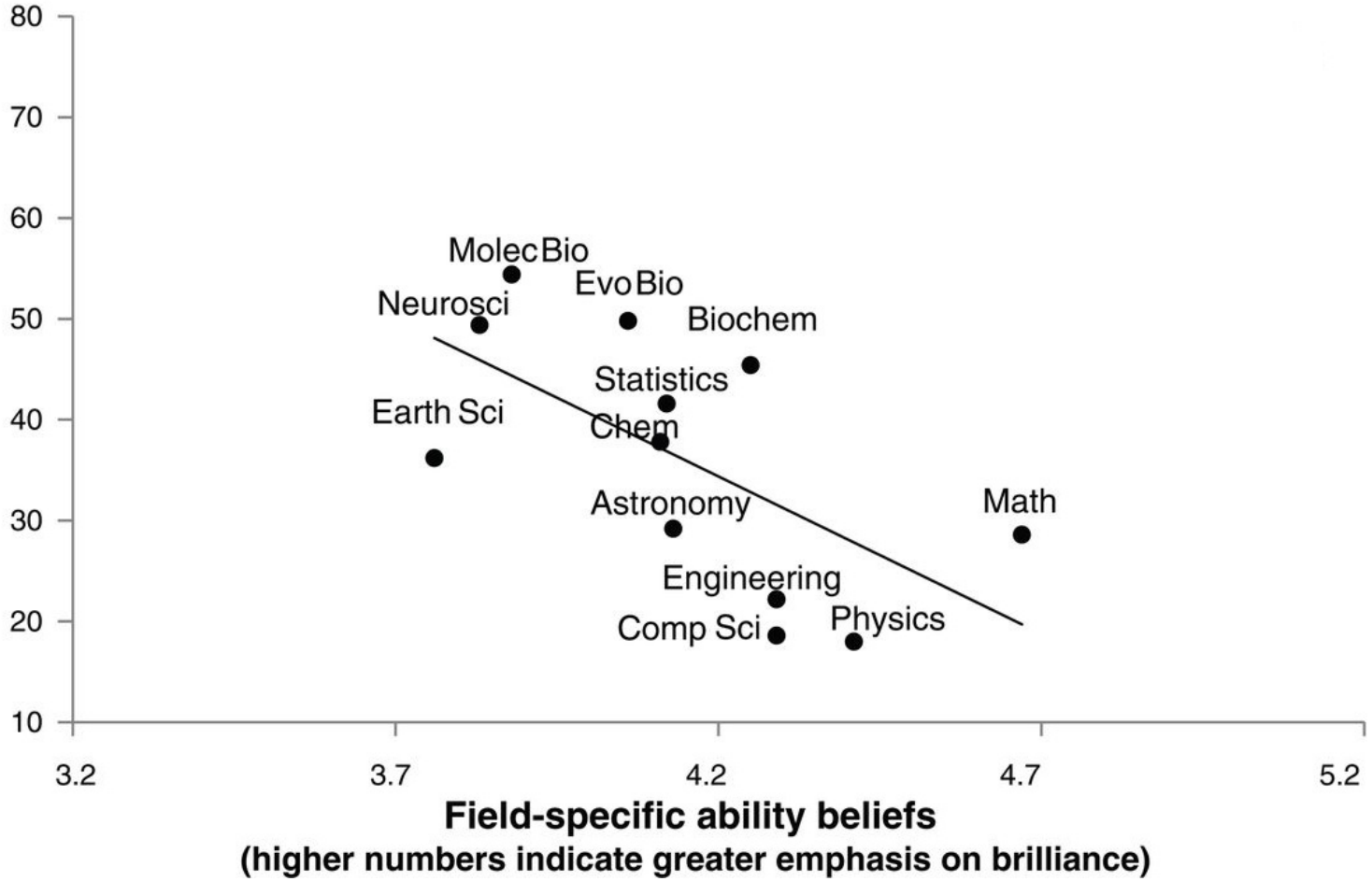
- Study on implicit bias in recommendation letters
  - Males described as having innate talent/ability
  - Females described as trying hard
  - Comments on females' personality
  - Not enough statistics for racial analysis

Brilliant or Dedicated?



Sarah-Jane Leslie. Andrei Cimpian, Meredith Meyer, Edward Freeland
Science 16 Jan 2015: Vol. 347, Issue 6219, pp. 262-265 DOI: 10.1126/science.1261375

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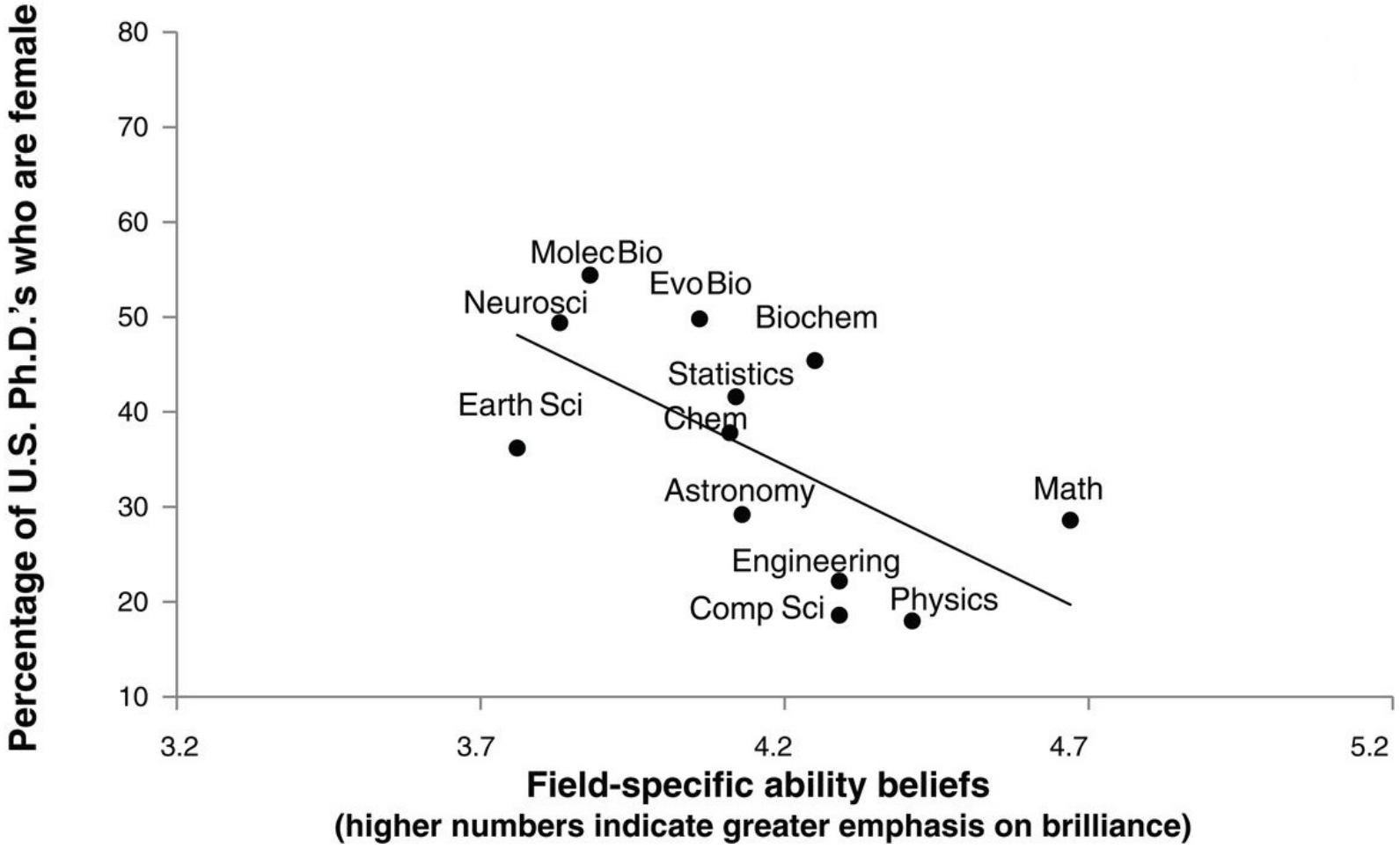

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Recommendation Request

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- His heartwarming smile and endearing personality....

College → Post-Doc

Undergraduates

- Nuclear Physics (Chemistry) Summer Schools
- Research
  - MoNA
  - REUs
  - CEU

Graduate Students

- Summer Schools
  - TALENT
  - SHIP
- MOOC (EFT)
- Mentoring

Conference Experience for Undergraduates

Unique to Nuclear Physics

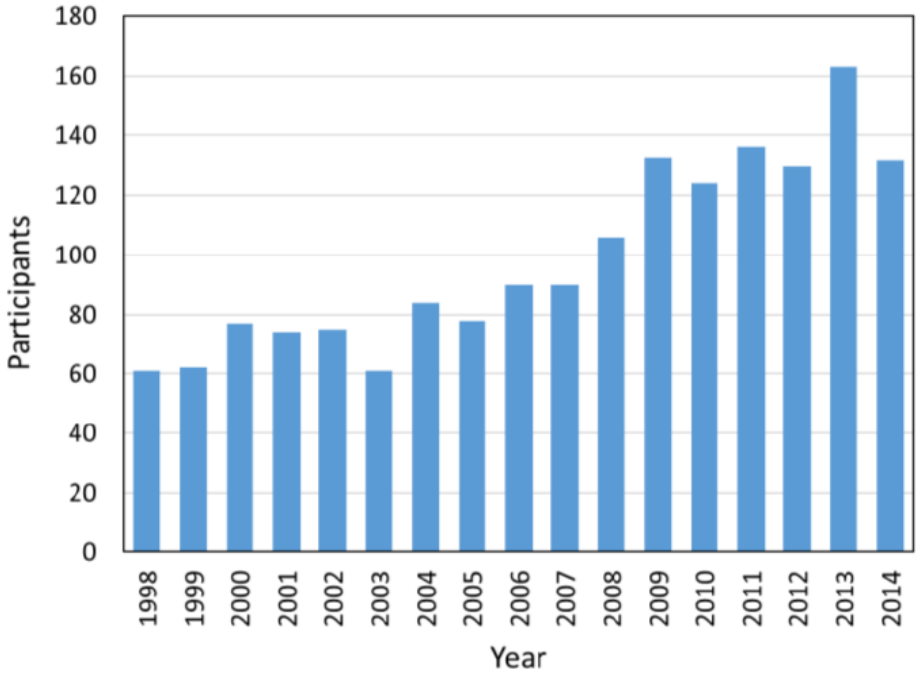
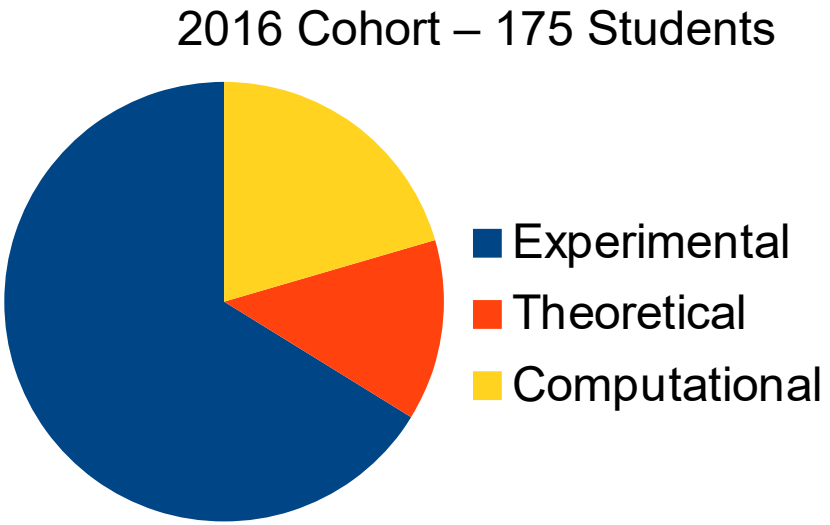
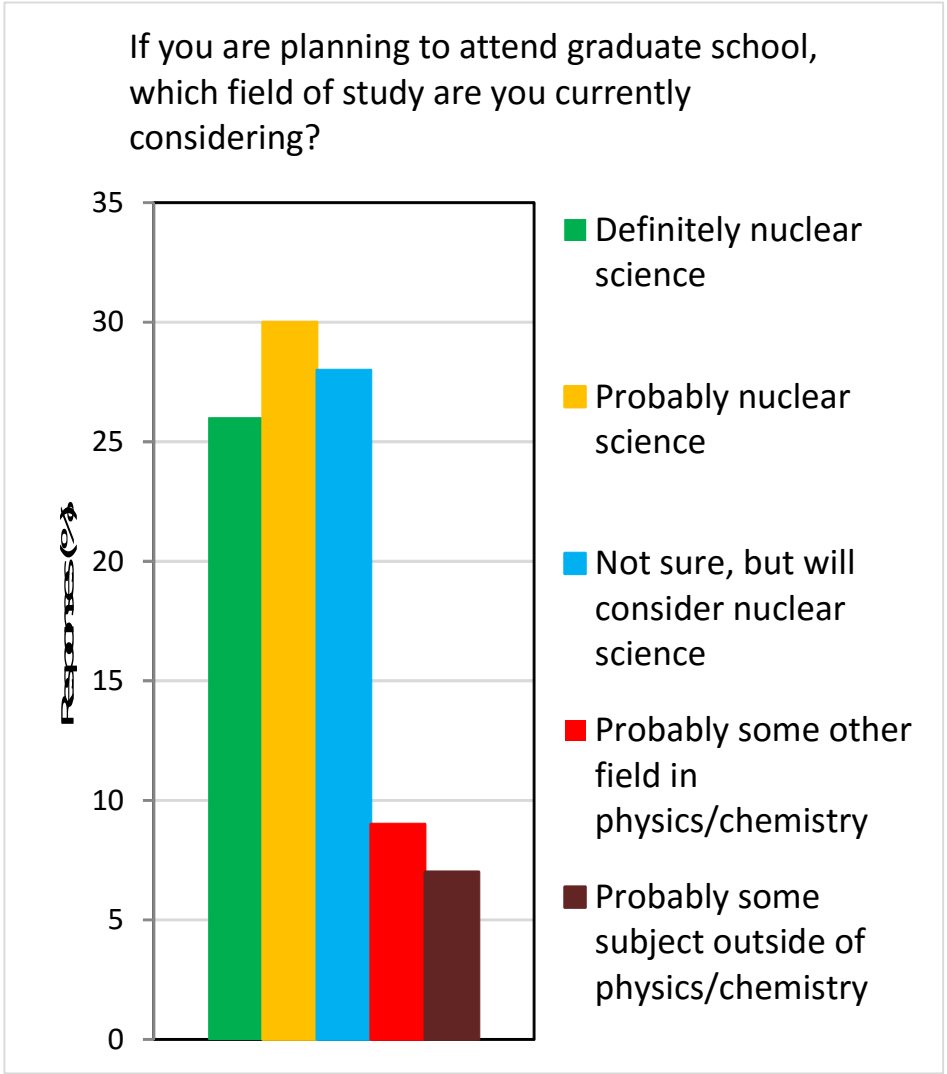
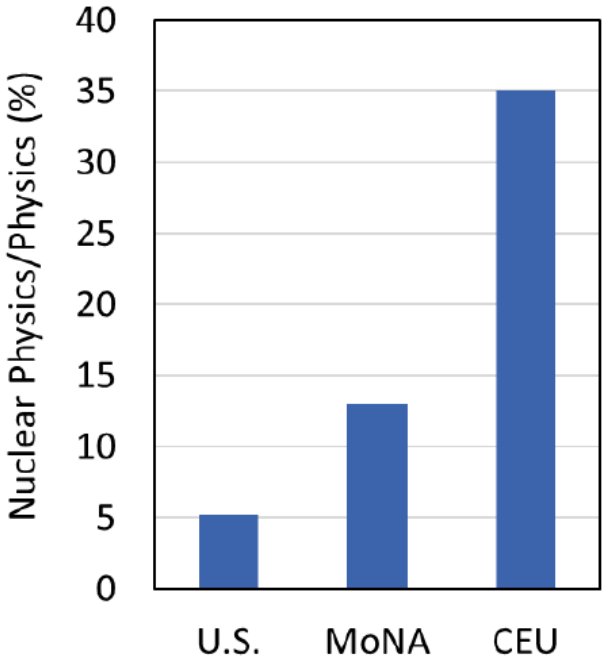


Figure 2.3.2 Number of undergraduate students participating in the DNP CEU program [12].



The CEU Effect





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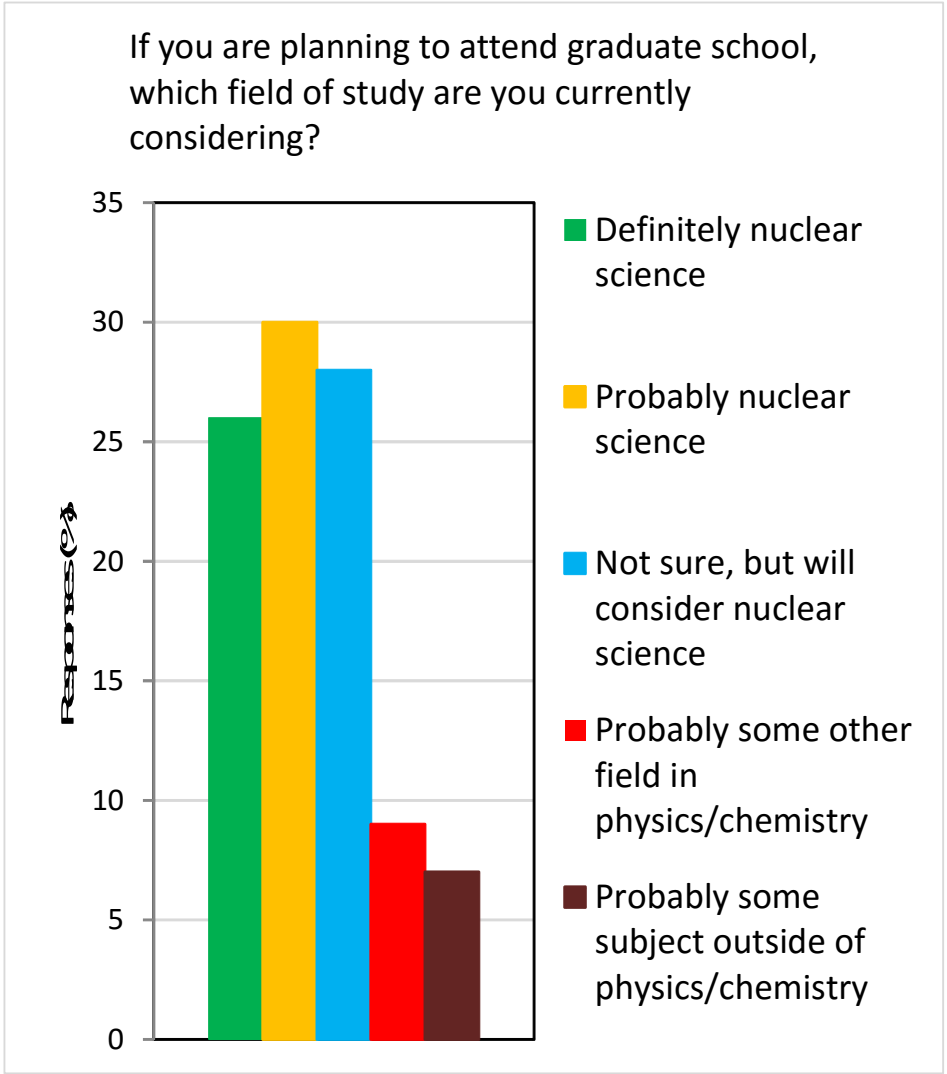

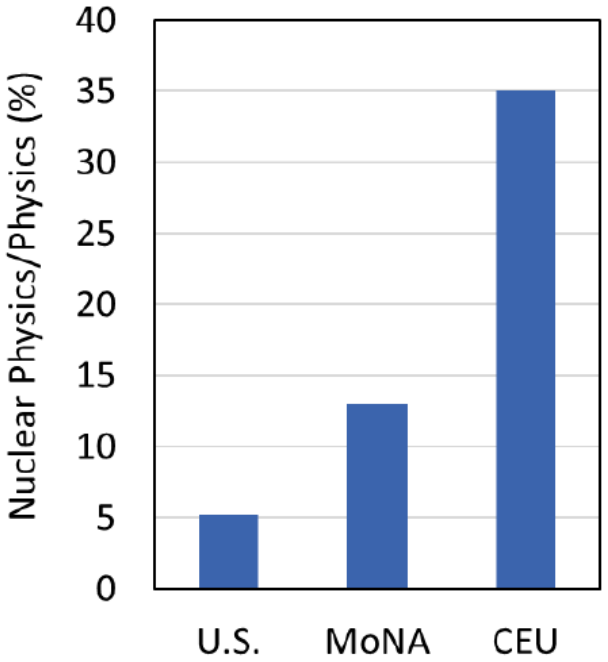

Longitudinal study planned for 20th anniversary 2017
Shelly Lesher is looking for info about your past students!

Retaining Workforce

- Be mindful of implicit bias
  - Professors are most likely to reply to emails from non-Hispanic White males (Milkman 2014)
  - Recommendation letters show gender biases (eg. Medical - Trix 2003, Chem - Schmader 2007)
  - Students evaluate female professors lower in natural sciences (Centra 07)
- Avoid over-commitment (service)
  - Women and URM are over-represented on committees
  - Female students are more likely to volunteer
- Promote equity in terms of pay, family leave, tenure clock stoppage, etc

Recommendations from Town Meeting (2014)

Education and mentoring of the next generation nuclear scientists as well as dissemination of research results to a broad audience are integral parts of research. Scientists should be encouraged to engage in and be rewarded for these activities that go beyond basic research.

Nuclear science is an active and vibrant field with wide applicability to many societal issues. It is critical for the future of the field that the whole community embraces and increases its promotion of nuclear science to students at all stages in their career as well as to the general public.

Researchers in nuclear physics and nuclear chemistry have been innovative leaders in the full spectrum of activities that serve to educate nuclear scientists as well as other scientists and the general public in becoming informed of the importance of nuclear science. The researchers are encouraged to build on these strengths to address some of the challenges in educating an inclusive community of scientists as well as those on the path to future leadership in nuclear science.

The interface between basic research and exciting innovations in applied nuclear science is a particularly vital component that has driven economic development, increased national competitiveness, and attracts students into the field. It is critical that federal funding agencies provide and coordinate funding opportunities for innovative ideas for potential future applications. Where applicable they should explicitly support concurrent development of innovation from the basic research mission.

Report from the DNP town meeting on Education and Innovation. Thoennessen, Peaslee

Thank You

Implicit Bias in Hiring

Yale researchers asked 127 Bio, Chem, Physics Faculty to rate identical application materials from John/Jennifer for a laboratory manager position

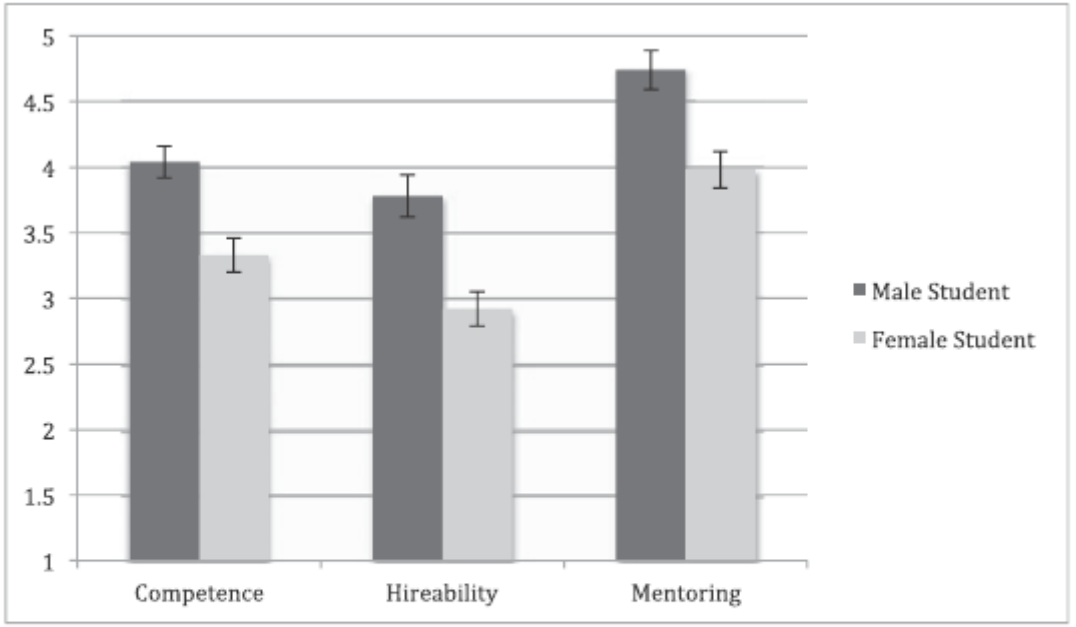

Fig. 1. Competence, hireability, and mentoring by student gender condition (collapsed across faculty gender). All student gender differences are significant ($P < 0.001$). Scales range from 1 to 7, with higher numbers reflecting a greater extent of each variable. Error bars represent SEs. $n_{\text{male student condition}} = 63$, $n_{\text{female student condition}} = 64$.

Moss-Racusina,et al. PNAS, October 2012

CEU Demographics