Beyond Leaky Pipes: Fostering Pathways and Persistence in the Mathematical Sciences

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The status quo is unacceptable.

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Saxe, K., & L. Braddy (2015) *A Common Vision for Undergraduate Mathematical Sciences Programs in 2025.* Mathematical Association of America.
Available at: https://www.maa.org/sites/default/files/pdf/CommonVisionFinal.pdf

fuentek

Diversity in STEM Workforce

Problem: The pipeline is leaky

Engage Grades K - 9

Recruit Grades 7 - 12

Retain BS - PhD

Sustain Career

Introduction: US resident population and labor force, 2017

	White women	Asian women	Black or African American women	Hispanic or Latina women	Other women	White men	Asian men	Black or African American men	Hispanic or Latino men	Other men
Population	34.5	2.6	6.3	7.0	1.1	32.6	2.3	5.4	7.2	1.0
Labor force	29.0	2.9	6.3	7.6	1.2	32.8	3.2	5.7	10.0	1.3

Data from: National Science Foundation, National Center for Science and Engineering Statistics. 2019. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019.* Special Report NSF 19-304. Alexandria, VA. Available at **https://www.nsf.gov/statistics/wmpd**.

Women and Math

Mathematics degrees awarded to women: 1997, 2006, 2016

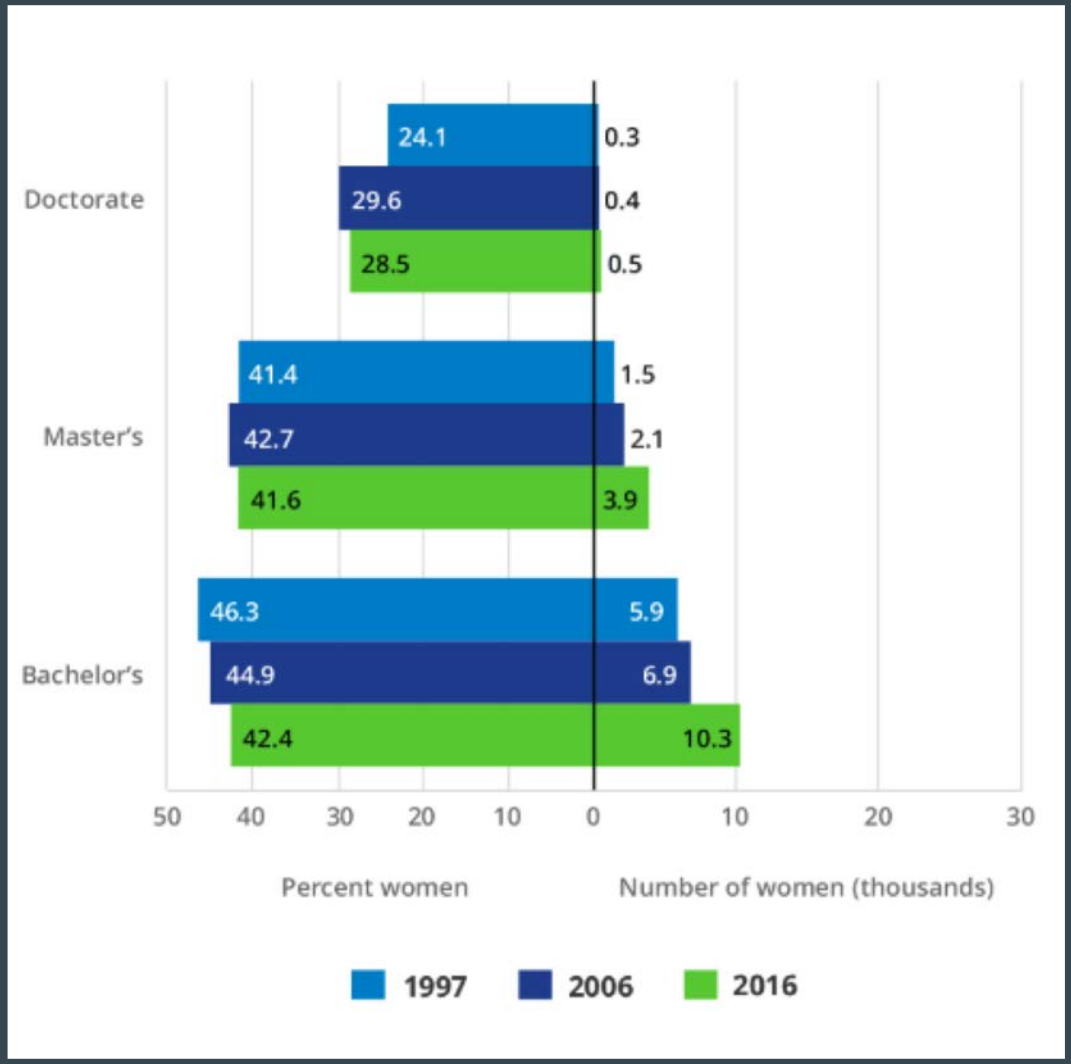
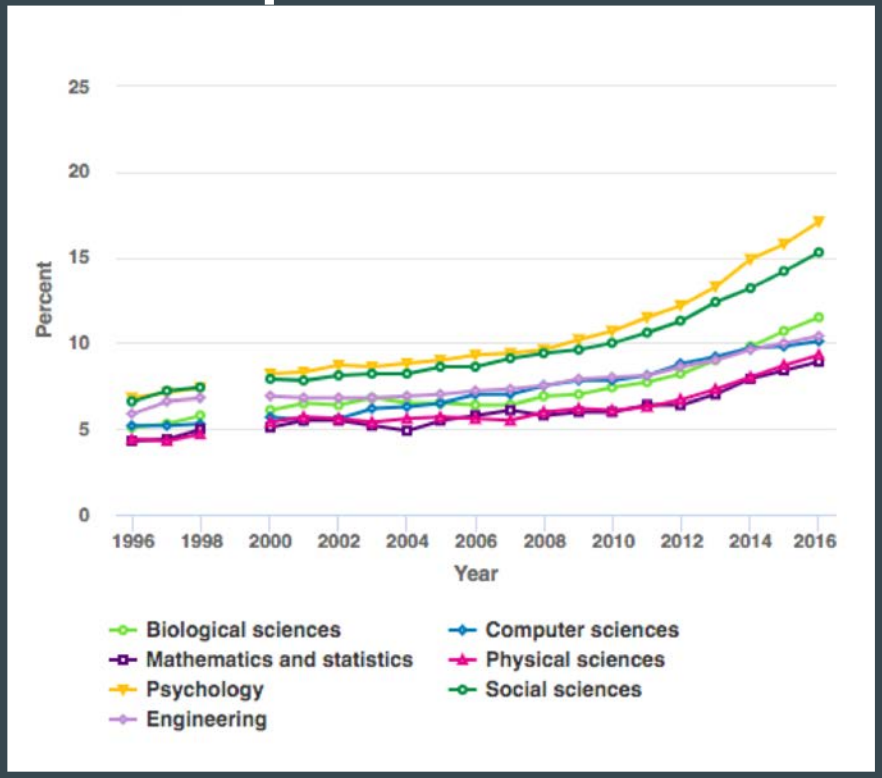
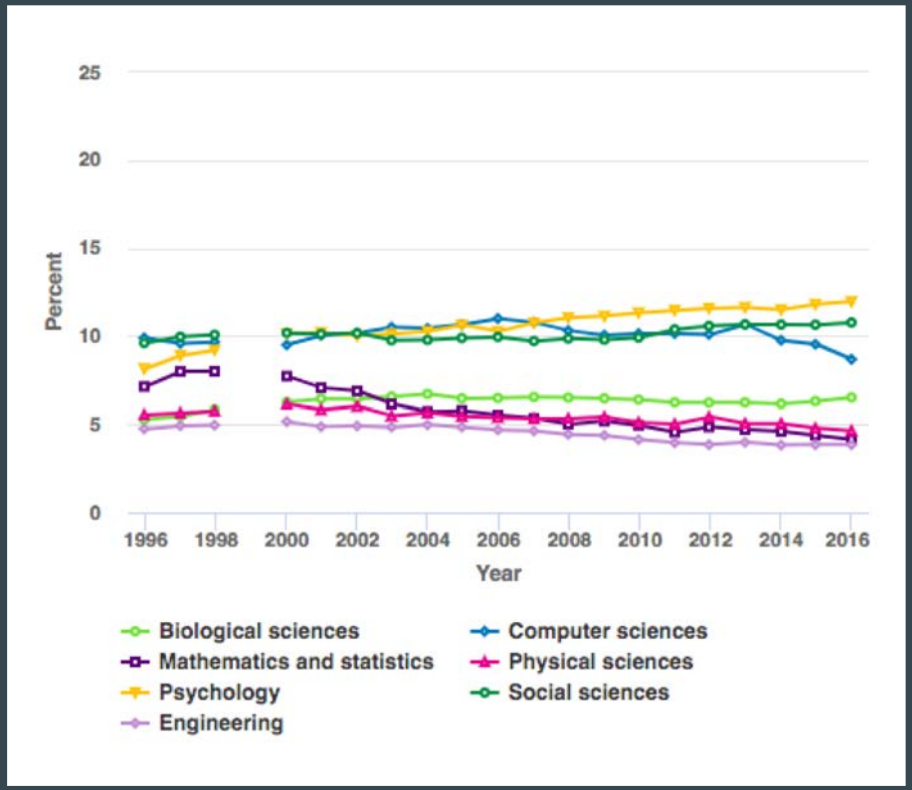


Chart from: National Science Foundation, National Center for Science and Engineering Statistics. 2019. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019.* Special Report NSF 19-304. Alexandria, VA. Available at **https://www.nsf.gov/statistics/wmpd**.

Underrepresented Minorities and Math



Bachelor's Degrees earned by Hispanics

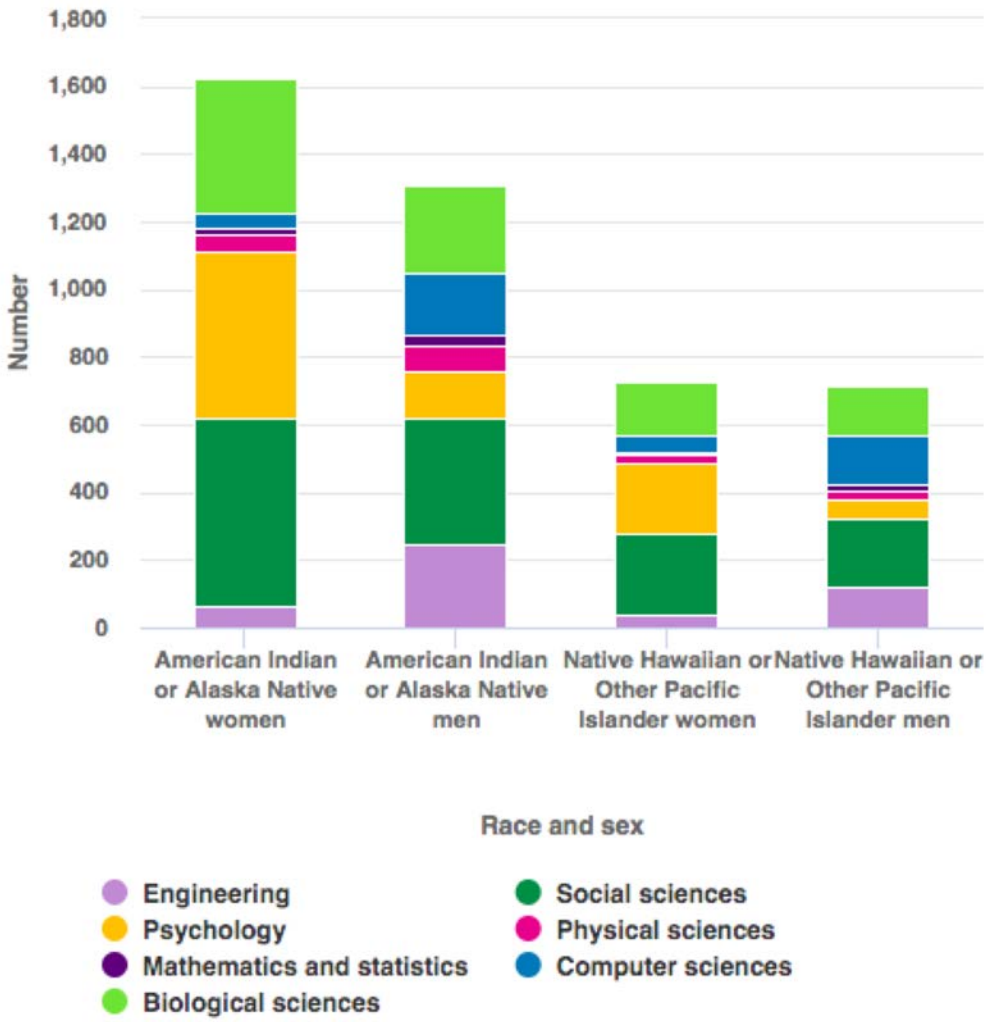


Bachelor's Degrees earned by blacks or African Americans

Graphs from: National Science Foundation, National Center for Science and Engineering Statistics. 2019. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019.*

Underrepresented Minorities Continued

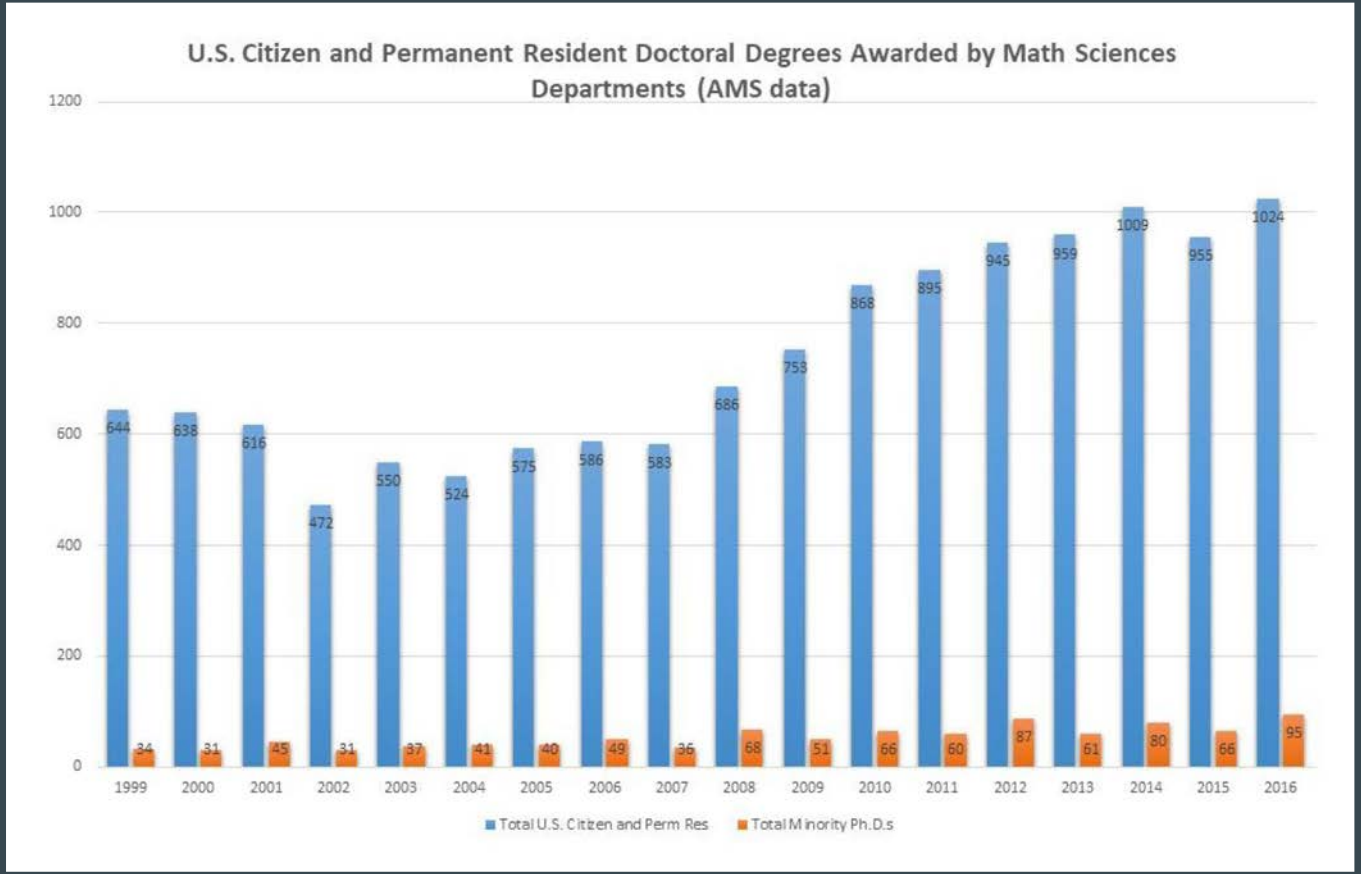
Bachelor's Degrees Earned by American Indians or Alaska Native and Native Hawaiian or Other Pacific Islander, by sex and field



Charts from: National Science Foundation, National Center for Science and Engineering Statistics. 2019. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019.* Special Report NSF 19-304. Alexandria, VA. Available at **https://www.nsf.gov/statistics/wmpd**.

Underrepresented Minorities and Doctoral Degrees

AMS Data on URM PhDs in the Math Sciences since 1999



First-Generation

Percentage of 2003–04 beginning postsecondary students who had attained a degree or were still enrolled 6 years after entering postsecondary education, by parents' highest level of education and level of first institution: 2009

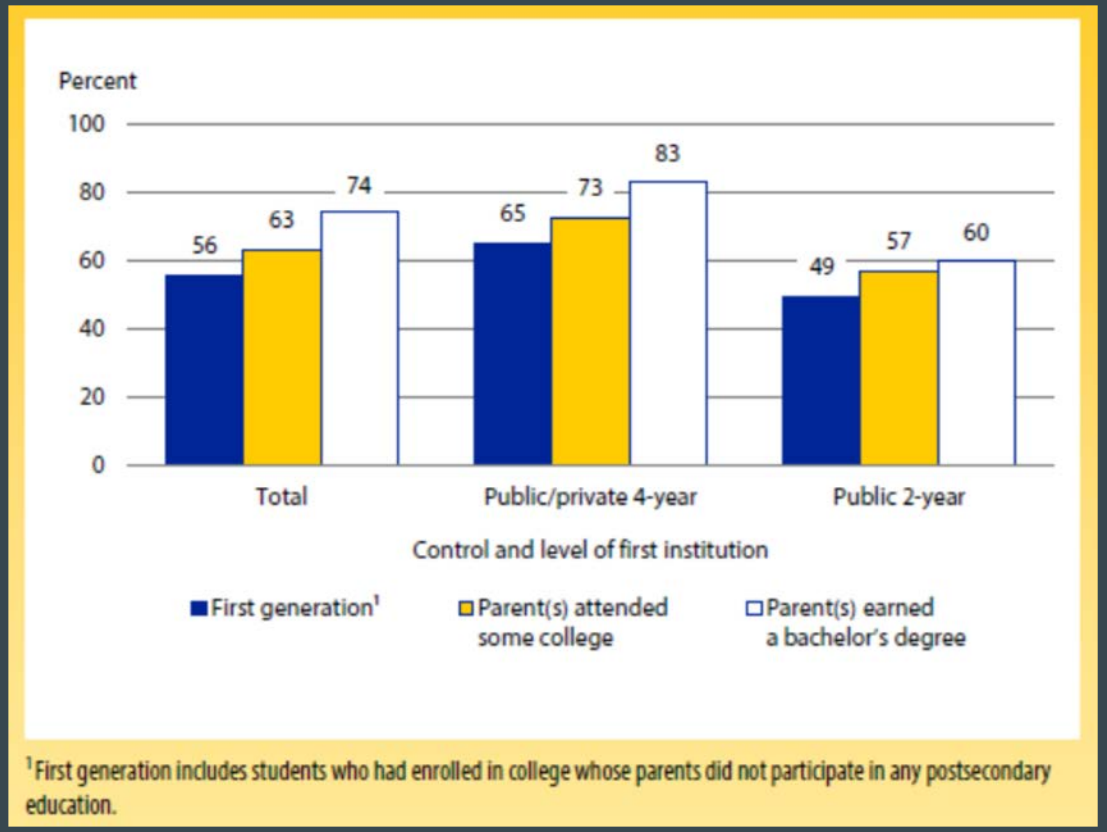


Chart from: Stats in Brief, U.S. Dept of Education, NCES, 2018. *First-Generation Students: College Access, Persistence, and Postbachelor's Outcomes.* Available at: https://nces.ed.gov/pubs2018/2018421.pdf

First-Generation

Percentage distribution of 2007–08 bachelor's degree recipients' highest degree enrollment after the bachelor's degree, by parents' highest level of education: 2012

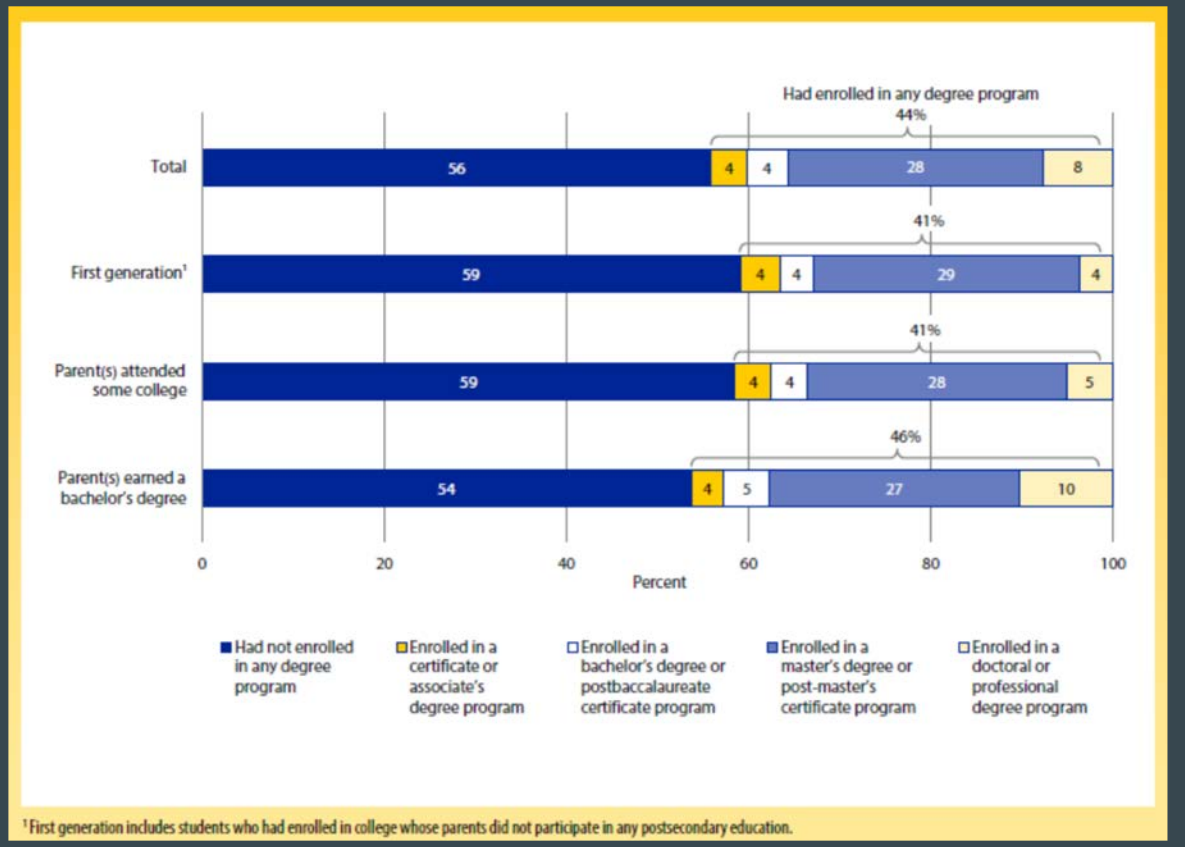


Chart from: Stats in Brief, U.S. Dept of Education, NCES, 2018. *First-Generation Students: College Access, Persistence, and Postbachelor's Outcomes.* Available at: https://nces.ed.gov/pubs2018/2018421.pdf

Income and Equity

Cohort College Participation Rates by family income quartile for dependent 18-to 24-year-olds: 1970 to 2017

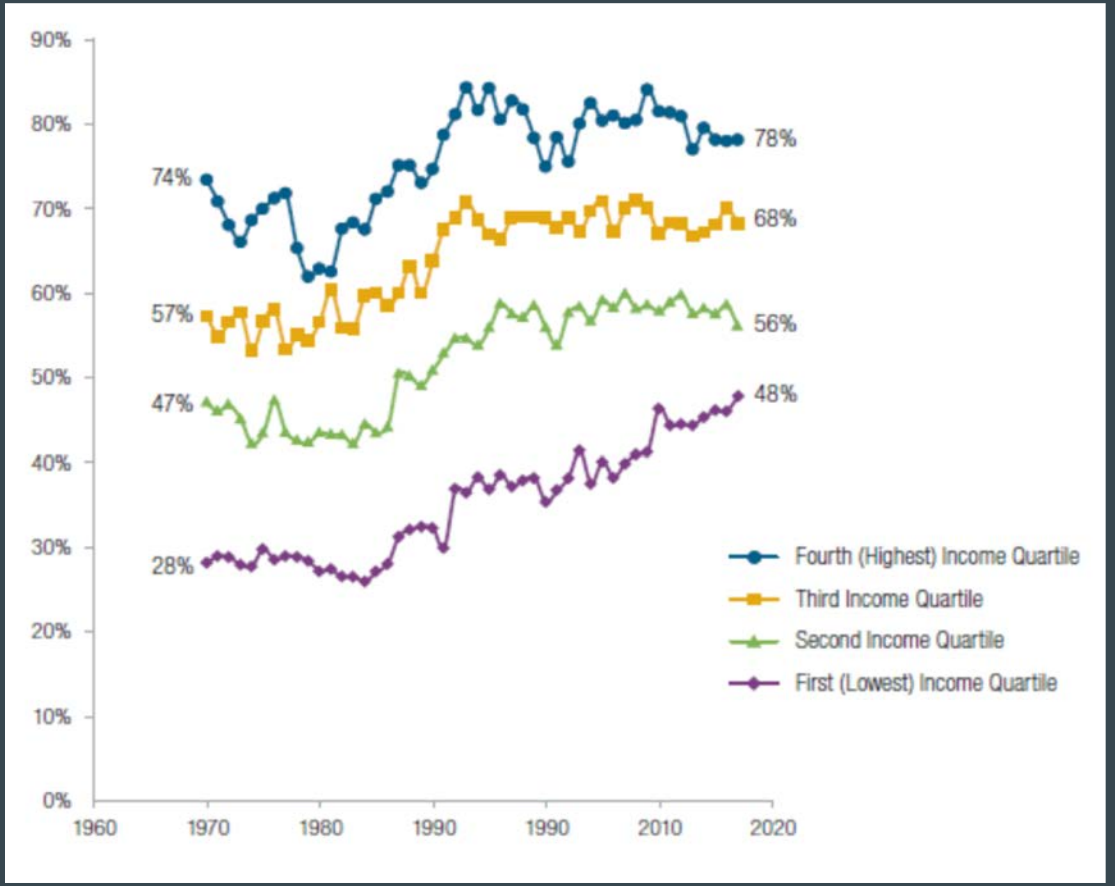


Chart from: The Pell Institute, 2019. *Indicators of Higher Education Equity in the United States: 2019 Historical Trend Report.* Available at: http://pellinstitute.org/indicators/reports_2019.shtml

Income and Equity

Estimates of Bachelor's Degree Attainment by Age 24 for Dependent Family Members by Family Income Quartile: 1970 to 2017

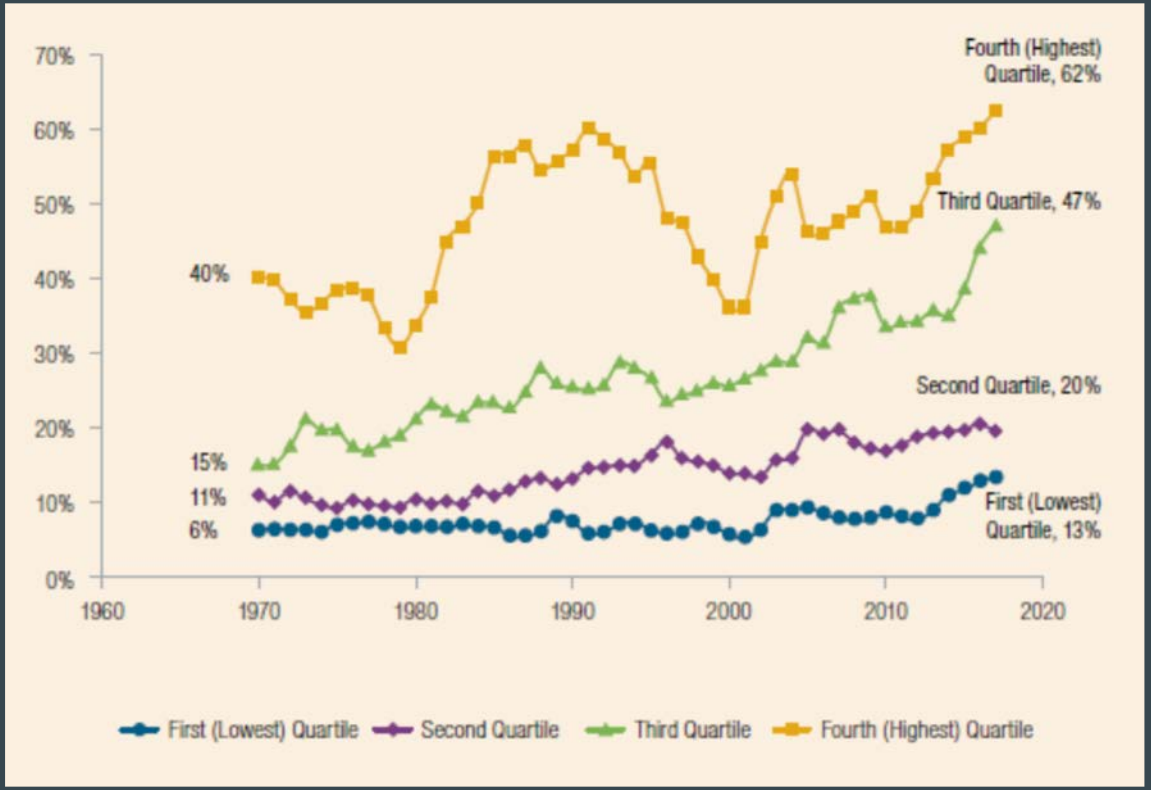
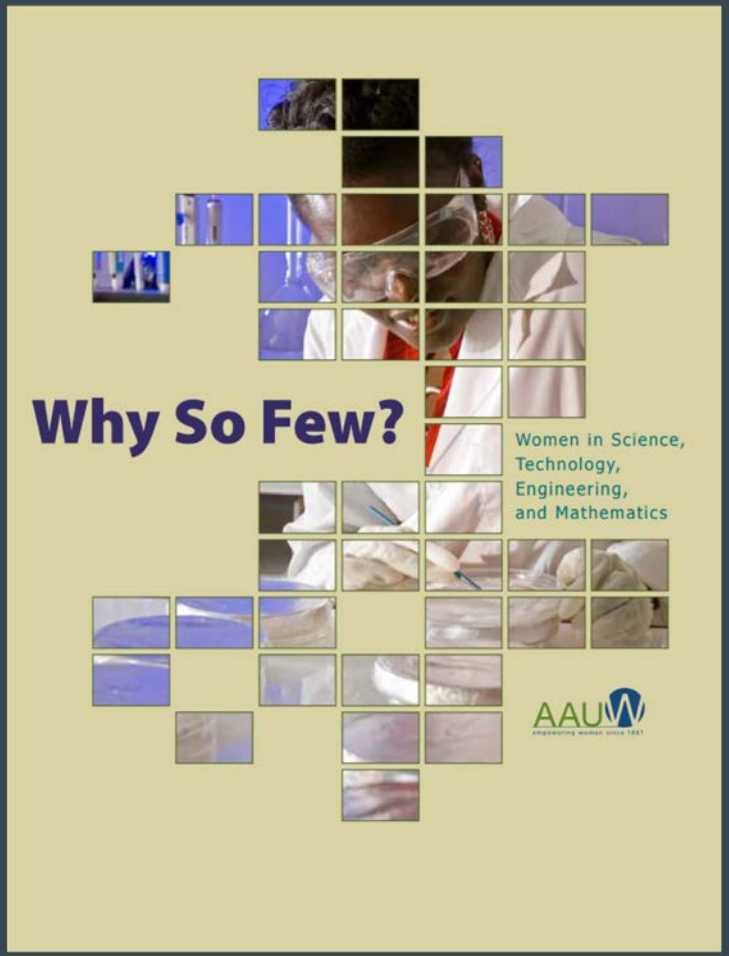


Chart from: The Pell Institute, 2019. *Indicators of Higher Education Equity in the United States: 2019 Historical Trend Report.* Available at: http://pellinstitute.org/indicators/reports_2019.shtml

Why So Few?

- Stereotypes affecting social beliefs from a young age
- Academic environment unfriendly
- Conscious and unconscious bias
- Lack of mentoring
- Lack of role models

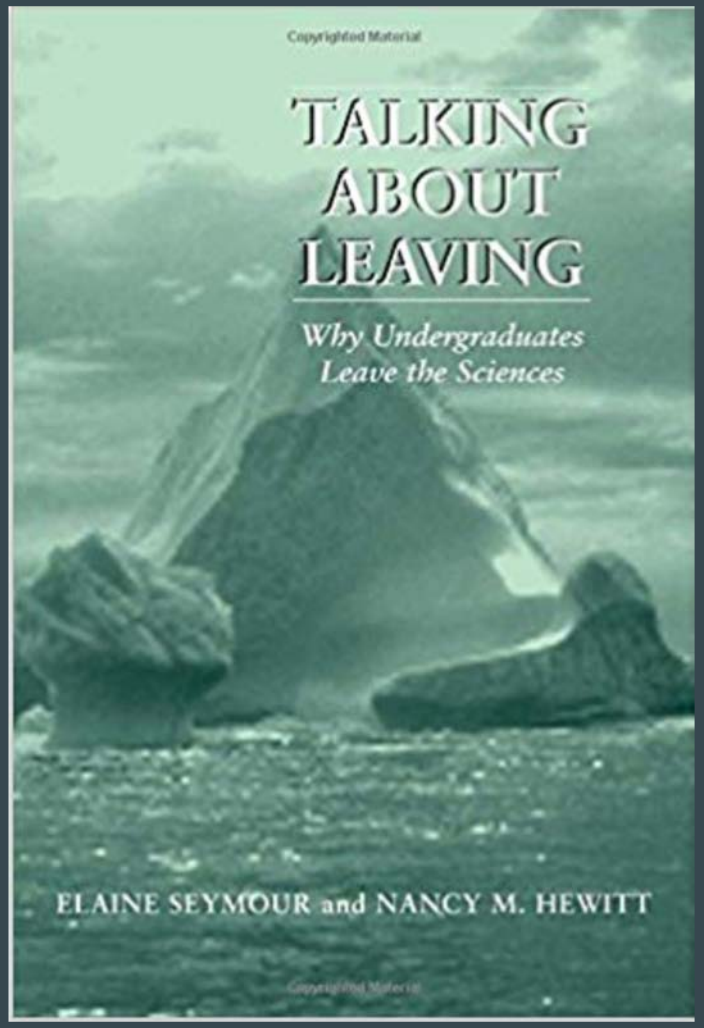


Hill, C., Corbett, C., St. Rose, A. Why So Few? Women in Science, Technology, Engineering, and Math, AAUW, 2010

Why Undergraduates Leave the Sciences

- Poor teaching by STEM faculty
- Non-STEM majors are more interesting
- “Turned off” by STEM
- Inadequate Preparation or Study Skills
- Inadequate Help with Academic Problems

From 2000, ISBN: 081-336-6429



What can we do? Evidence-based strategies

We'll hear about a lot more ideas today, but some big ideas::

- Mentoring
- Early access to research opportunities
- Inclusive pedagogy
- Active/inquiry-based learning
- Co-requisite courses
- Updating Curricula

Programs with documented success

We'll hear about more programs today, but some well-known ones:

- **Math Alliance**
  - Field of Dreams Conference
  - F-GAP Program
  - Network of Scholars and Mentors
  - 45 Math Science PhDs from 2005-2017

Programs with documented success

- EDGE
  - Started in 1998 by Rhonda Hughes and Sylvia Bozeman
  - Has produced almost (this summer?) 100 female PhDs
  - Received Presidential Award for STEM Mentoring in 2015

What have we done?

- Calculus Re-envisioned
  - Re-envisioned calculus sequence with more applications, sequence that steadily increases with difficulty
  - Will pilot at Centre College in Fall 2019 and Southwestern University in Fall 2020
  - Funded by grant from Associated Colleges of the South

- Hidden No More Lecture Series
  - Speakers are female PhDs from underrepresented minority groups
  - Time to engage with speaker (dinner, tea, reception)
  - Tell their personal story AND talk about their research
  - Funded by NSF INCLUDES WATCH-US mini-grant and MAA Tensor Women and Math Grant

What have we done?

- Hidden Figures Course
  - Students will investigate local ‘Hidden Figures’
  - Understand mathematical tools used in the Space Race
  - Community service with local libraries via STEM programming
  - Explore intersectionality in mathematical communities
  - Supported by two internal grants at OSU

What have we done?

- **Value-Writing Exercise - a small “handful of minutes” change**
  - Write about something that is personally important to you.
  - It may or may not have anything to do with “math”.
  - This could be “friends” or “family” or “sports” or “music” or “health” or “knowledge” or “faith” or something else.
  - Whatever you write is confidential, for your eyes only.

- 2010 Reducing the Gender Achievement Gap in College Science: A Classroom Study of Values Affirmation by Miyake et al at https://www.colorado.edu/ftep/sites/default/files/attached-files/miyake_-_gender_achievement_gap.pdf
- 2006 Reducing the Racial Achievement Gap: A Social-Psychological Intervention by Cohen et al http://msan.wceruw.org/documents/resources_for_educators/Race/Cohen%20et%20al%202006.pdf

The status quo is unacceptable.

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Available at: https://www.maa.org/sites/default/files/pdf/CommonVisionFinal.pdf

Call to Action

Be inspired by what you see and hear over the next two days.

Our collective efforts can make a difference. It will take all of us to make our community better.

Find an idea that you can take back to your institution/community and implement it in a way that works for you and your institution.