The Gender Gap in STEM: The Unique Case of Computer Science

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Overview of Two STEM Projects

Gender Trends in STEM: 1971-2011

BRAID Initiative to Study Diversity in Computer Science

Building Recruiting And Inclusion for Diversity
Total Enrollment in Colleges and Universities (1966-2013)

Source: National Center for Education Statistics, 2015
Women Overrepresented Across All Fields, but Underrepresented in STEM

Proportions of Bachelor’s Degree Recipients, by Gender

- All Bachelor's Degree Recipients
  - Women: 57%
  - Men: 43%

- STEM Bachelor's Degree Recipients
  - Women: 35%
  - Men: 65%

Explanations for the Gender Gap in STEM

- Educational Settings
- Forces Beyond the Classroom
Women begin to opt out of STEM courses in middle and high school
- Women underrepresented in AP courses in STEM (Calculus, Physics, Chemistry, Computer Science)

Unwelcome climate in many college STEM majors
- Large lecture halls, grading on a curve
- Underrepresentation of women = Less opportunity for female friendship groups in STEM

Teachers/Faculty
- More traditional teaching practices (emphasis on lecturing, not student-centered methods)
- Faculty seen as intimidating (more impactful for female students)
- Lack of female role models and mentors in STEM
Forces Beyond the Classroom

* Sense of belonging in STEM
  - Science perceived as masculine domain by students and parents
  - Science careers perceived as competitive, unwelcoming and difficult to balance work-family
  - Societal benefits matter, but not clearly understood

* Women’s Lower Self-confidence

  (% rating “above average” or “highest 10%” in 2011):
  - Computer abilities (47.4% of men, 30.3% of women)
  - Math abilities (55.6% of men, 36.1% of women)
Enduring Gender Gap in Self-Rated Mathematical Ability
(% Above Average or Highest 10%)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
How Has the Gender Gap in STEM Changed Over Time?

Proportion of Students Intending to Major in STEM, by Gender

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Gender Gap Narrows... Then Widens

Difference in Men’s and Women’s Intention to Major in STEM

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Need to Consider Differences Across STEM Fields

- Computer Science
- Biological Sciences
- Math
- Physical Sciences
- Engineering
Women’s Relative Representation in STEM Varies by Field

Proportions of Bachelor’s Degree Recipients, by Gender (2014)

<table>
<thead>
<tr>
<th>Field</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological Sciences</td>
<td>58%</td>
<td>42%</td>
</tr>
<tr>
<td>Mathematics/Statistics</td>
<td>43%</td>
<td>57%</td>
</tr>
<tr>
<td>Physical Sciences</td>
<td>39%</td>
<td>61%</td>
</tr>
<tr>
<td>Engineering</td>
<td>18%</td>
<td>82%</td>
</tr>
<tr>
<td>Computer Science</td>
<td>18%</td>
<td>82%</td>
</tr>
</tbody>
</table>

Biological Sciences
Gender Gap Reversal

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Math/Statistics

No Gender Gap

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Physical Sciences
Diminished Gender Gap

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Engineering Stable(ish) Gender Gap

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Computer Science
Fluctuating Gender Gap

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Proportion of Prospective Computer Science Majors who are Female (1971-2011)

Women as % of all Computer Science Majors
Global demand for individuals with computer science training (valuable in any field)

Computer-related careers among the fastest growing and highest paying occupations

Number of colleges offering a CS degree has grown from 123 to 600 in past forty years

Women remain vastly underrepresented in CS occupations

- Women only 20% of software developers = women’s voices not reflected in many emerging technologies
In order to attract more women to CS, we need to better understand female CS majors

- How do they differ from male computer science majors?
- How do they differ from women in other STEM fields?
- How have they changed over the past four decades?
CIRP Freshman Survey

- Over 8 million students entering over 1,000 baccalaureate institutions

- Focuses on 5 STEM fields: Biological sciences, Computer Science, Engineering, Math/statistics, Physical Sciences

- Analyzes female and male STEM majors over the past 40 years (1971-2011)
Methods

- **Data Source:**
  - CIRP Freshman Survey
  - Over 8 million students entering over 1,000 baccalaureate institutions between 1971-2011

- **Key comparison groups**
  - 54,845 women and 149,766 men planning to major in CS
  - More than 1.7 million students planning to major in biological sciences, physical sciences, math/stats, and engineering

- **Summary of findings in:**
  - Background traits
  - Self-ratings
  - Community orientation
  - Career aspirations
Key Findings:
Background Traits
Racial/Ethnic Distribution of Female Computer Science Majors (1971-2011)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Percentage of CS Bachelor’s Degree Earners who are Female, by Race/Ethnicity

- White: 15.3%
- Hispanic: 17.9%
- American Indian: 20.6%
- Asian: 21.8%
- Black: 26.9%
Median Family Income (1971-2011)
(In 2011 Dollars)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
A+/A High School GPA, by Field and Gender (2011)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Key Findings: Self-Ratings
Self-Rating Academic Ability (2011)
(\% Indicating “Highest 10\%”)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Self-Rating Intellectual Self-Confidence (2011) (% Indicating “Highest 10%”)

Bar chart showing self-ratings for different subjects and genders.
Self-Rating Leadership Ability (2011) (% Indicating “Above Average” or “Highest 10%”)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Self-Rating Drive to Achieve (2011)
(% Indicating “Above Average” or “Highest 10%”)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Self-Rating Emotional Health (2011)
(% Indicating “Above Average” or “Highest 10%”)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Women’s Self-Rating Emotional Health (1985-2011) (% Indicating “Highest 10%” or “Above Average”)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Self-Rating Physical Health (2011) (% Indicating “Above Average” or “Highest 10%”)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Women’s Self-Rating Physical Health (1985-2011)
(% Indicating “Above Average” or “Highest 10%”)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Self-Rating Artistic Ability (2011)
(% Indicating “Highest 10%”)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Women’s Self-Rating Artistic Ability (1971-2011)
(% Indicating “Highest 10%”)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Key Findings:
Community Orientation
Goal: Become a Community Leader (2011) (% Indicating “Essential” or “Very Important”)

- CS
- Math
- Phys
- Eng
- Biology
- All

Men

Women
Goal: Become Involved in Environmental Programs (2011)
(% Indicating “Essential” or “Very Important”)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Will Participate in Community Service or Volunteer Work (2011)
(% Indicating “Very Good Chance”)
Key Findings:
Career Aspirations
Career Aspirations of Male and Female CS Majors

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<thead>
<tr>
<th></th>
<th>CS Women</th>
<th>CS Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Career</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Undecided Career</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>Computer Programmer</td>
<td>68</td>
<td>76</td>
</tr>
</tbody>
</table>

Legend:
- Other Career
- Undecided Career
- Computer Programmer
Proportion of Entering Female CS Majors Who Aspire to be Computer Programmers (1971-2011)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Proportion of Entering Female CS Majors Who Are Undecided about their Career Aspirations (1971-2011)

Source: Cooperative Institutional Research Program Freshman Survey, Higher Education Research Institute, UCLA
Conclusion and Implications

- **CS tends to attract women who...**
  - Have low ratings of their emotional and physical health
    - Need to understand which comes first (Chicken-egg phenomenon)
  - Are less committed to serving communities
    - How to rebrand CS to emphasize impact on society?
  - Are increasingly creative and artistic
    - Do these women stay in CS and what do they do?
  - Not necessarily planning on careers as programmers
    - What happens to these career plans over time?
Next Steps...

* Examines strategies to promote gender and racial/ethnic diversity in undergraduate computing
  * Revamp intro courses
  * Promote interdisciplinary CS
  * Build community
  * K-12 outreach
* $2.3 million in research funding
  * National Science Foundation, the Anita Borg Institute, Google, Facebook, Microsoft, Intel, and the Computing Research Association
* Mixed-methods study:
  * Five-year longitudinal study of students taking introductory CS courses nationwide
  * Surveys of computer science faculty
  * Interviews with department chairs