Anatomy of an Enduring Gender Gap: The Evolution of Women’s Participation in Computer Science

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Women are Underrepresented in STEM

Proportions of Bachelor’s Degree Recipients in the U.S., by Gender

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

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

Underrepresentation of Women in Computer Science

Proportions of Bachelor’s Degree Recipients, by Gender

Background

- Background Characteristics
  - CS is more racially diverse than other STEM majors

- Family Influences and Expectations
  - Men have higher confidence in computing abilities than female peers
  - Men enter CS majors with more computing experience than women

- K-12 Experiences and preparation
  - Early exposure to computers in the classroom
  - Gender gap in CS AP exam

- Gender Socialization, Values, and Perceptions
  - Perception of lack of societal impact
  - Hacker, geek stereotypes
Social Cognitive Career Theory (SCCT)

- Personal Characteristics
  - Race/Ethnicity
  - Religion
  - Political View

- Learning Experiences

- Background Contexts
  - Family Income
  - Mother’s Education
  - Father’s Education
  - Mother’s Career
  - Father’s Career

- Self-Efficacy

- Outcome Expectations

- Interests

- Choice Goals

- Contextual Influences

- Choice Actions (e.g., majoring in computer science)

- Performance Domains and Attainments
1. How has the gender gap in incoming college students’ intent to major in computer science changed over the past four decades?

2. What are the determinants of women’s and men’s decision to major in computer science versus all other fields? To what extent have these determinants and/or their salience changed over time for women and men?

3. To what extent is the gender gap in the selection of computer science due to: (a) gender differences in student attributes, versus (b) gender differences in the salience of these attributes? How has this changed over time?
Data source & Methods

- CIRP Freshman Survey
  - RQ 1: Trend analysis
    - Data from 1971-2011
    - 8 million respondents across all majors
  - RQ 2: Logistic Regression Analyses
    - 18,830 first-year “intended” computer science majors
    - 904,307 first-year students from all other majors
    - Run separately by gender, Main Effect Model & Conditional Effects (IV*Time)
      - DV: Intent to major in CS
      - 41 IVs, blocked according to SCCT
  - RQ 3: Decomposition Analysis
    - Uses logistic regression and mean replacement to identify the extent to which gender differences in CS major choice can be attributed to:
      - differences in average characteristics between men and women
      - differences in the salience of those characteristics
RQ1- Trends in First-Year Students’ Computer Science major choice, by Gender

% of all men in CS | % of all women in CS

1971-2002

% of all men in CS
% of all women in CS
Proportion of Prospective Computer Science Majors who are Female (1971-2011)
RQ2- Selected Predictors Remaining Stable Over Time for Both Genders: Key Findings

<table>
<thead>
<tr>
<th>Positive</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Father’s Career in STEM</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Asian/Asian-American</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>African American</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Status Striving Orientation</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Negative</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Activist Orientation</td>
<td>-</td>
<td>-</td>
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</table>
RQ2- Select Predictors Changing in Salience Over Time: Key Findings

<table>
<thead>
<tr>
<th></th>
<th>BOTH GENDERS</th>
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</thead>
<tbody>
<tr>
<td><strong>Positive predictors</strong></td>
<td></td>
</tr>
<tr>
<td>Math Self-Ratings</td>
<td>Weaker positive</td>
</tr>
<tr>
<td>Scholarly Orientation</td>
<td>Stronger positive</td>
</tr>
<tr>
<td><strong>Negative predictors</strong></td>
<td></td>
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<tr>
<td>Family Income</td>
<td>Weaker negative</td>
</tr>
<tr>
<td>Leadership Orientation</td>
<td>Stronger negative</td>
</tr>
<tr>
<td>Goal: Raising a family</td>
<td>Stronger negative</td>
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<table>
<thead>
<tr>
<th></th>
<th>WOMEN ONLY</th>
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</thead>
<tbody>
<tr>
<td>Scientific Orientation</td>
<td>Stronger positive</td>
</tr>
<tr>
<td>Artistic Orientation</td>
<td>Weaker negative</td>
</tr>
</tbody>
</table>
RQ3- Regression Decomposition: Examining the Reasons behind the Gender Gap in Computer Science

<table>
<thead>
<tr>
<th>Source of Gender Gap</th>
<th>1976 (%)</th>
<th>1986 (%)</th>
<th>1996 (%)</th>
<th>2006 (%)</th>
<th>2011 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender Differences in Characteristics</td>
<td>78.5</td>
<td>44.1</td>
<td>39.1</td>
<td>35.5</td>
<td>34.9</td>
</tr>
<tr>
<td>Gender Differences in Coefficients</td>
<td>21.5</td>
<td>55.9</td>
<td>60.9</td>
<td>64.5</td>
<td>65.1</td>
</tr>
</tbody>
</table>

* The gender gap is increasingly explained by differences in the predictive power of the variables, rather than the mean values of the variables.
Women’s lower mathematical self-ratings

Women’s lower means in their commitment to making a theoretical contribution to science
- Explains between 4-15% of the gender gap.

Women’s higher means on social activist goals
- Explains between 7-10% of the gender gap.
Gender gap among CS majors has widened over the years, especially when interest in CS grows
  ◦ Must address pervasive gender stereotypes

Many longstanding deterrents to women majoring in CS
  ◦ Social activist orientations (persistent negative)
  ◦ Family orientations (increasingly negative)

Some explanations have changed in salience:
  ◦ Math self-confidence (less of a predictor)
  ◦ Artistic orientation (less of a deterrent)

How to rebrand CS?
  ◦ De-emphasize high-level math skills; emphasize creative opportunities in CS
  ◦ Highlight ways in which computer science positively impacts communities
  ◦ Promoting new majors that bring together computer science and other degree programs