The BRAID Initiative
A Wide-Scale Assessment of Promising Practices to Increase Diversity in Computing

Prof. Joanne Atlee
Director of Women in Computer Science
University of Waterloo
Building, Recruiting, and Inclusion for Diversity (BRAID)

BRAID is a multi-year, multi-institutional study of the impact of a number of promising practices that aim to increase representation of women and students of colour in university computer-science programs.
Some history: the Stats
Women in University CS Programs

WORLD – Female Enrolment in CS (2015)
UW – Female Admissions to CS
UW – Female Enrolment in CS

Female Enrolment

- 2006/07: 12.3%
- 2007/08: 12.4%
- 2008/09: 12.2%
- 2009/10: 12.5%
- 2010/11: 11.9%
- 2011/12: 12.8%
- 2012/13: 14.4%
- 2013/14: 15.2%
- 2014/15: 16.8%
- 2015/16: 18.6%
- 2016/17: 20.3%
- 2017/18: 22.8%
CANADA – Female Enrolment in CS
Beacon Schools

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<tr>
<th>School</th>
<th>Years</th>
<th>Change in Representation</th>
<th>Unit of Measurement</th>
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<td>Cal Poly-SLC</td>
<td>1999-2016</td>
<td>7% to 47%</td>
<td>Women majoring in computing</td>
</tr>
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<td>Harvey Mudd College</td>
<td>2006-2016</td>
<td>12% to 47.5%</td>
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</tr>
<tr>
<td>University of British Columbia</td>
<td>2011-2015</td>
<td>0% to 22%</td>
<td>Women majoring in computing</td>
</tr>
<tr>
<td>University of Washington</td>
<td>2007-2015</td>
<td>19% to 33%</td>
<td>Women majoring in computing</td>
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Sources: BRAID Beacon school chairs, publicly reported data, and report on Beacon school rate of change by Kaitlin Splett, UCLA.

https://anitab.org/braid-building-recruiting-and-inclusion-for-diversity/
Beacon Schools: what do they do??
Harvey Mudd College

Implemented three major changes focused on first-year students:

1. Revised the first-year computer science course to present applications of CS (science and engineering) in addition to the basics of programming

2. Provided research opportunities for women immediately after their first year of college, to expose them early to real computer science problems

3. Gave first-year students opportunities to attend the annual Grace Hopper Celebration of Women in Computing conference
Changes to introductory computer science

1. Java → Picobot and Python
2. Separate section for experienced students (Black vs. Gold)
3. Course concepts structured into six independent modules
4. Optional weekly lab staffed by faculty
5. Fun assignments, choice of assignments
6. Early intervention of braggarts
University of British Columbia

**Outreach K-12**
- Girls Learning Code workshops and summer camp (grades 5-12)
- Girlsmarts4Tech workshop (grades 6-7)
- Girls@Explore the WWWorld (grades 8-9)
- Physics and CS summer camp for girls (grades 8-10)
- Broadridge Parent’s workshop

**UBC students (non CS majors)**
- Meet and greet event for female students in intro CS course
- Send weekly FoWCS newsletter to female non-CS students taking intro CS courses
University of British Columbia

UBC students (CS majors)
  - Women in CS socials
  - Professional development events with companies
    – e.g., resume critique, networking, mentoring
  - Female scholarships and awards
  - Send female students to Grace Hopper Celebration
  - Recruit female TAs
  - All TAs receive gender and diversity sensitivity training
  - BCS – 20-month second degree program (50% women)
  - Special tutorials and designated tutors for BCS students
  - Discourage companies from holding events that are not gender sensitive
    – 48-hour hackathons, gaming nights, game jams

Alumni
  - Inspiring Girls in Tech (IGT) group for CS female alumni to build community and work together on K-12 recruitment
Are their successes transferable?
Building, Recruiting, and Inclusion for Diversity (BRAID)

A multi-year, multi-institutional study of the impact of promising practices that aim to increase representation of women and students of colour in university CS programs.

Led by the Anita Borg Institute and Harvey Mudd College

Funded by Facebook, Google, Intel, Microsoft, and Qualcomm

Additional research funds provided by the Computing Research Association (CRA) and the National Science Foundation (NSF).

The National Center for Women & Information Technology (NCWIT) and the Center for Minorities and People with Disabilities in IT (CMD-IT) are nonprofit partners on the BRAID initiative.
Building, Recruiting, and Inclusion for Diversity (BRAID)

Fifteen universities

Arizona State University  
Missouri University of Science and Technology  
New Jersey Institute of Technology  
University of California-Irvine  
University of Illinois at Chicago  
University of Maryland, Baltimore County  
University of Maryland, College Park  
University of Nebraska-Lincoln  
University of North Texas  
University of Rochester  
University of South Carolina  
University of Texas at El Paso  
University of Vermont  
University of Wisconsin-Milwaukee  
Villanova University

committed to major changes to increase diversity, and to participate in research that studies the impact of the changes

– revamping introductory CS courses
– offering interdisciplinary computing degrees
– building community among underrepresented students
– outreach to K-12 students and teachers
Nationwide Baseline Student Surveys

Demographics of students in introductory CS courses

Gender

- Women: 34%
- Men: 66%

Majors vs. Nonmajors, by Gender

Men
- Majors: 62%
- Nonmajors: 38%

Women
- Majors: 61%
- Nonmajors: 39%

Nationwide Baseline Student Surveys

Demographics of students in introductory CS courses

Class Standing, by Gender

Prior CS Experience, by Gender

Note: Percentages in bold are significantly higher at p<.05.

Nationwide Baseline Student Surveys

Sense of Belonging in CS

Sense of Belonging, at end of introductory CS course

Impact of growth mindset and effort expenditure on sense of belonging, by gender


# Nationwide Baseline Student Surveys

## Sense of Belonging in CS

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 440</td>
<td>n = 1191</td>
</tr>
<tr>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Major GPA (out of 4)</td>
<td>3.50 ± 0.48</td>
<td>3.47 ± 0.49</td>
</tr>
<tr>
<td>Intellectual belonging (1-5)</td>
<td>3.97 ± 0.98</td>
<td>4.22 ± 0.90</td>
</tr>
<tr>
<td>Growth mindset (1-5)</td>
<td>3.70 ± 0.91</td>
<td>3.78 ± 0.93</td>
</tr>
<tr>
<td>Time spent studying (hr/wk)</td>
<td>5.66 ± 1.47</td>
<td>5.31 ± 1.54</td>
</tr>
<tr>
<td>Have thought about leaving (% of respondents)</td>
<td>18%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Jane G. Stout & Jennifer M. Blaney (2018) “But it doesn’t come naturally: how effort expenditure shapes the benefit of growth mindset on women’s sense of intellectual belonging in computing”, Computer Science Education (14 pages)
Assess Practices that Aim to Increase Diversity

BRAID schools are required to commit to three of the following promising practices:

• Modify introductory CS courses to make them more appealing and less intimidating to underrepresented students.

• Lead outreach programs for high school teachers and students to build a diverse pipeline of students.

• Build confidence and community among underrepresented students.

• Develop and/or promote joint majors in areas like CS and biology that are attractive to underrepresented students.
Changes: Revamp Introductory CS Courses

80% Modified intro CS courses to make them more appealing and less intimidating to underrepresented students.

- Flipped classroom, cooperative learning approach (UT El Paso)
- Different versions of course for students of different background (UC Irvine)
- Revised division of content between lecture and lab (UMD)
- Switched to Python (Villanova, NJIT)
- Incorporated pair programming (USC)
- Different sections of course for students with less experience (UMD-BC)
- More cross-disciplinary examples and assignments (UNL, Missouri S&T)
- Tutoring program for underrepresented students in CS (UMD)
- Optional study groups facilitated by upper-class students (UC Irvine)
- Recruit TAs, peer mentors from underrepresented groups (UNL, UofR, UNT)
- Recruit instructors who excel at teaching (NJIT, UWM)
Changes: Joint Majors

73% Developed new interdisciplinary majors, joints, or courses in areas like CS and biology that are attractive to underrepresented students.

- University-wide “Informatics Initiative” to create interdisciplinary majors (UNL)
- New programs in Data Science (Vermont, UWM, Villanova, UT El Paso, USC, UCI)
- New Bioinformatics major (UIC, UMD, UT El Paso, UNT)
- New joint major with Business (UC Irvine)
- New joint major with Humanities (NJIT, UMD-BC, UCI)
- New minors in Applied Computing (USC)
- New MS in Information Systems Technology (UWM)
- New interdisciplinary courses (Villanova, UofR)
Changes: Build Community

100% have student groups for women in computing

- Live-and-learn community (UMD-BC)
- Industry mentoring program (UC Irvine)
- Peer mentoring program (UC Irvine, UofR)
- Send students to Tapia, Grace Hopper (UCI, USC, Villanova, Vermont, UWM, UNT)
- Hosted all-female hackathon, codefest (UMD, Vermont)
- Hosted Diversity in Computing Summit (UMD)
- Career development workshops (UC Irvine, Vermont)
- Innovation through Diversity and Inclusion Film Series (UT El Paso)
- Run social community-building events (Arizona State)
- Company visits (NJIT)
Changes: K-12 Outreach

67% run programs for girls, and 53% run programs for high school teachers

- Trained computer-science teachers (UMD, UC Irvine, UNL, NJIT, Arizona State, UWM, UNT, UT El Paso, Missouri S&T)
- Created programs, camps, courses for girls/kids (UMD, UC Irvine, UNL, NJIT, Arizona State, UWM, UNT, Missouri S&T)
- Started Girls Who Code chapter (Vermont, UWM, NJIT)
- Host CS Fair for high school students (Vermont, UIC)
- Visited high schools (NJIT, Villanova, UMD-BC, UT El Paso, USC. UofR)
Preliminary Results

Percentage Increase in Computing Enrollment at BRAID Institutions, by Gender (2014-2017)

Women: 50.6%
Men: 26.9%
Computing Majors: Persistence One Year Later

- All: 73.7%
- Men: 75.0%
- Women: 71.9%
- White/Asian: 75.6%
- URM: 69.7%
Non-Computing Majors Choosing Computing One Year Later

- All: 12.6%
- Men: 14.8%
- Women: 9.9%
- White/Asian: 12.0%
- URM: 13.1%
<table>
<thead>
<tr>
<th>Role</th>
<th>Rank Among Men</th>
<th>Men</th>
<th>Women</th>
<th>Rank Among Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software developer or programmer</td>
<td>1</td>
<td>35.3%</td>
<td>31.6%</td>
<td>1</td>
</tr>
<tr>
<td>Business owner/Entrepreneur (Computing related)</td>
<td>2</td>
<td>9.9%</td>
<td>4.7%</td>
<td>5</td>
</tr>
<tr>
<td>Computer or information analyst</td>
<td>3</td>
<td>8.9%</td>
<td>9.7%</td>
<td>2</td>
</tr>
<tr>
<td>Game developer</td>
<td>4</td>
<td>7.5%</td>
<td>4.4%</td>
<td>6</td>
</tr>
<tr>
<td>Database or systems administrator or network architect</td>
<td>5</td>
<td>6.3%</td>
<td>2.7%</td>
<td>8</td>
</tr>
<tr>
<td>Computer or information research scientist</td>
<td>6</td>
<td>4.3%</td>
<td>4.1%</td>
<td>7</td>
</tr>
<tr>
<td>Management role in computing</td>
<td>7</td>
<td>4.1%</td>
<td>6.8%</td>
<td>3</td>
</tr>
<tr>
<td>Web developer</td>
<td>8</td>
<td>2.3%</td>
<td>5.0%</td>
<td>4</td>
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Summary and Next Steps
Departmental Change Process

Theory of Institutional Change (Curry, 1992; Kezar, 2007)

**YEAR ONE**
- Raising awareness of diversity needs
  - Departments were starting to implement new programs and services, and test out new ideas
  - Focus primarily on gender diversity
- Many dept. chairs were grappling with the challenges and barriers that limit diversity efforts

**YEAR TWO**
- Positive energy towards change initiatives
  - Implementation of new courses, activities and support systems
  - Still more focus on increasing women’s participation
- Departments starting to consider:
  - How do institutional factors, geography, admissions, etc. impact diversity?
  - What does optimal diversity look like?
Summary

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- Missouri University of Science and Technology
- New Jersey Institute of Technology
- University of California-Irvine
- University of Illinois at Chicago
- University of Maryland, Baltimore County
- University of Maryland, College Park
- University of Nebraska-Lincoln
- University of North Texas
- University of Rochester
- University of South Carolina
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We’re Making Progress

Number of Students Enrolled in Computing Majors at BRAID Institutions, by Gender

- 2014-2015: 2354 Women, 13064 Men (19.4% Women, 15.2% Men)
- 2015-2016: 2953 Women, 14722 Men (20.6% Women, 16.7% Men)
- 2016-2017: 3645 Women, 16580 Men (22.0% Women, 17.6% Men)