

"YOU'RE HERE BECAUSE YOU'VE EARNED IT."

"WITHOUT DIVERSITY WE HAVE  
NO CONTEXT FOR USER NEEDS."

"YOUR GENDER DOES NOT  
DEFINE YOUR WORTH."

"YOU WOULDN'T BE HIRED IF THE COMPANY  
IDN'T BELIEVE YOU TO BE COMPETENT AND CAPABLE."

"I DON'T NEED TO JUSTIFY MY POSITION."

"I'M PROUD OF MYSELF FOR  
HOLDING MY OWN IN AN INDUSTRY  
WHERE I AM AN UNWELCOME MINORITY."

"IT BEGINS WITH CELEBRATING  
THE AWESOME WOMEN  
IN THE INDUSTRY TODAY."

"DON'T EVER ACCEPT THAT INJUSTICES  
LIKE THIS ARE ACCEPTABLE.  
DON'T EVER SIT STILL IF SOMEONE  
SAYS YOU GOT YOUR JOB BECAUSE OF  
GENDER/RACE/RELIGION."

# 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

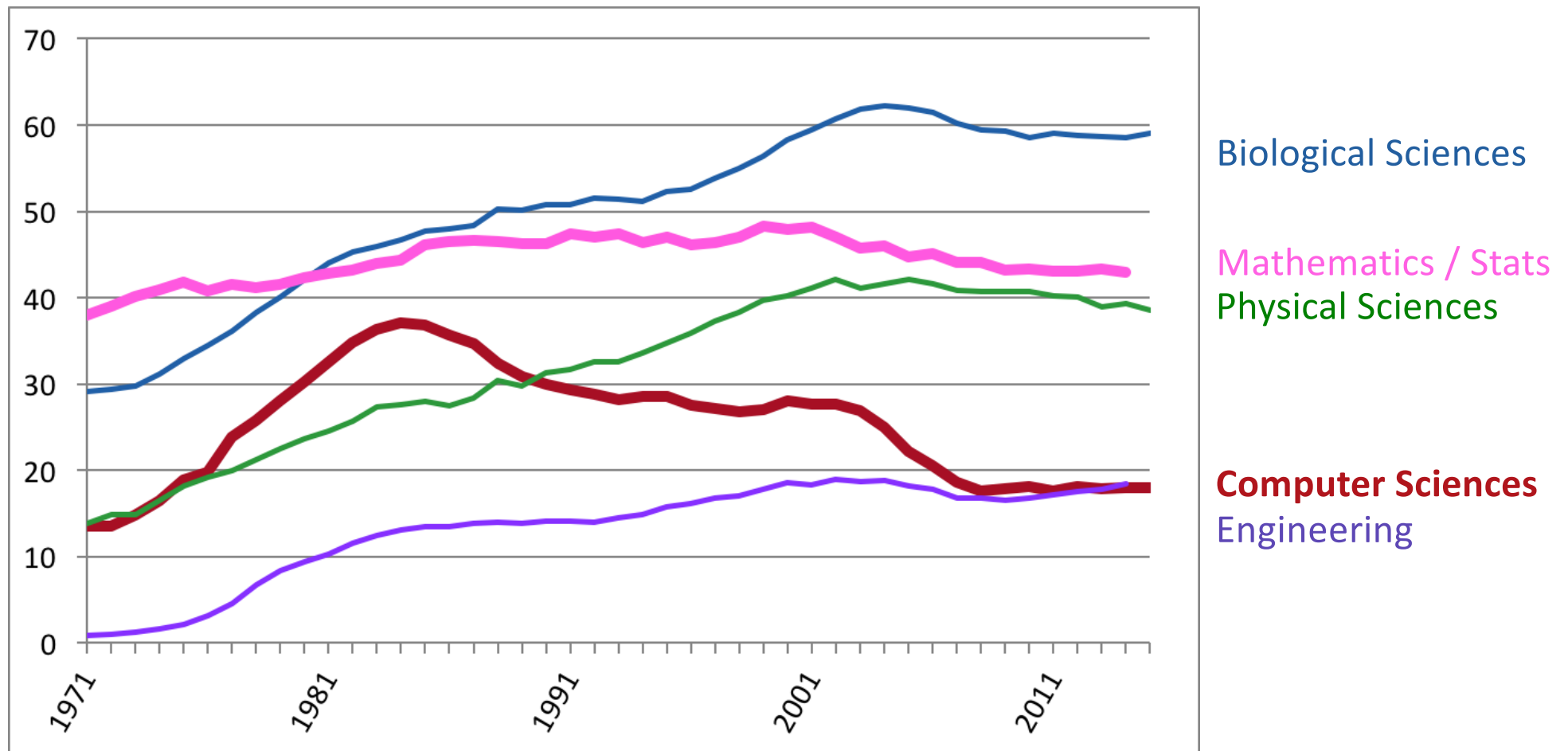


# Building, Recruiting, and Inclusion for Diversity (BRAID)

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.

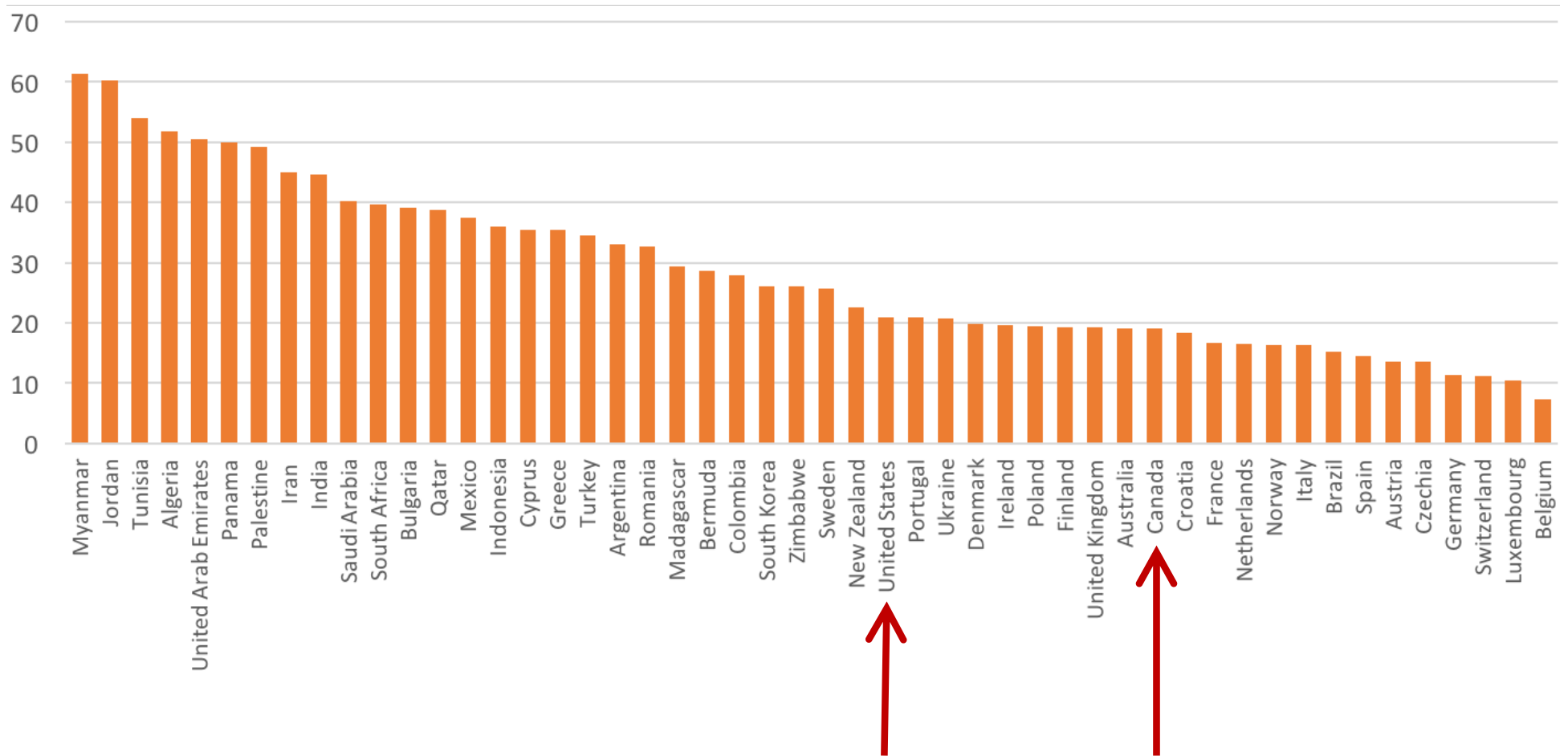
Some history: the Stats

# Women in University CS Programs



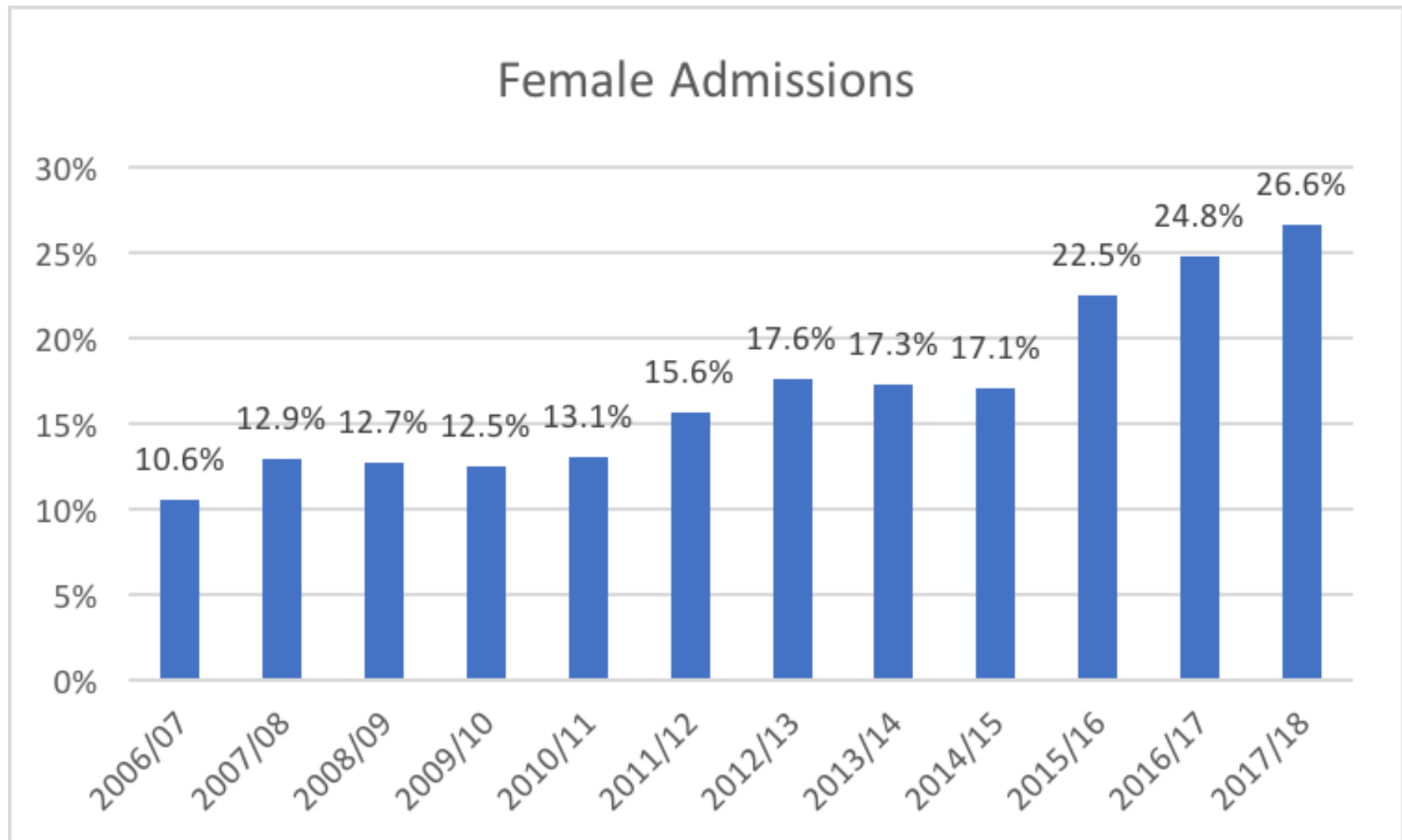
*US National Center for Education Statistics, Statistics 1971-2015*

# WORLD – Female Enrolment in CS (2015)

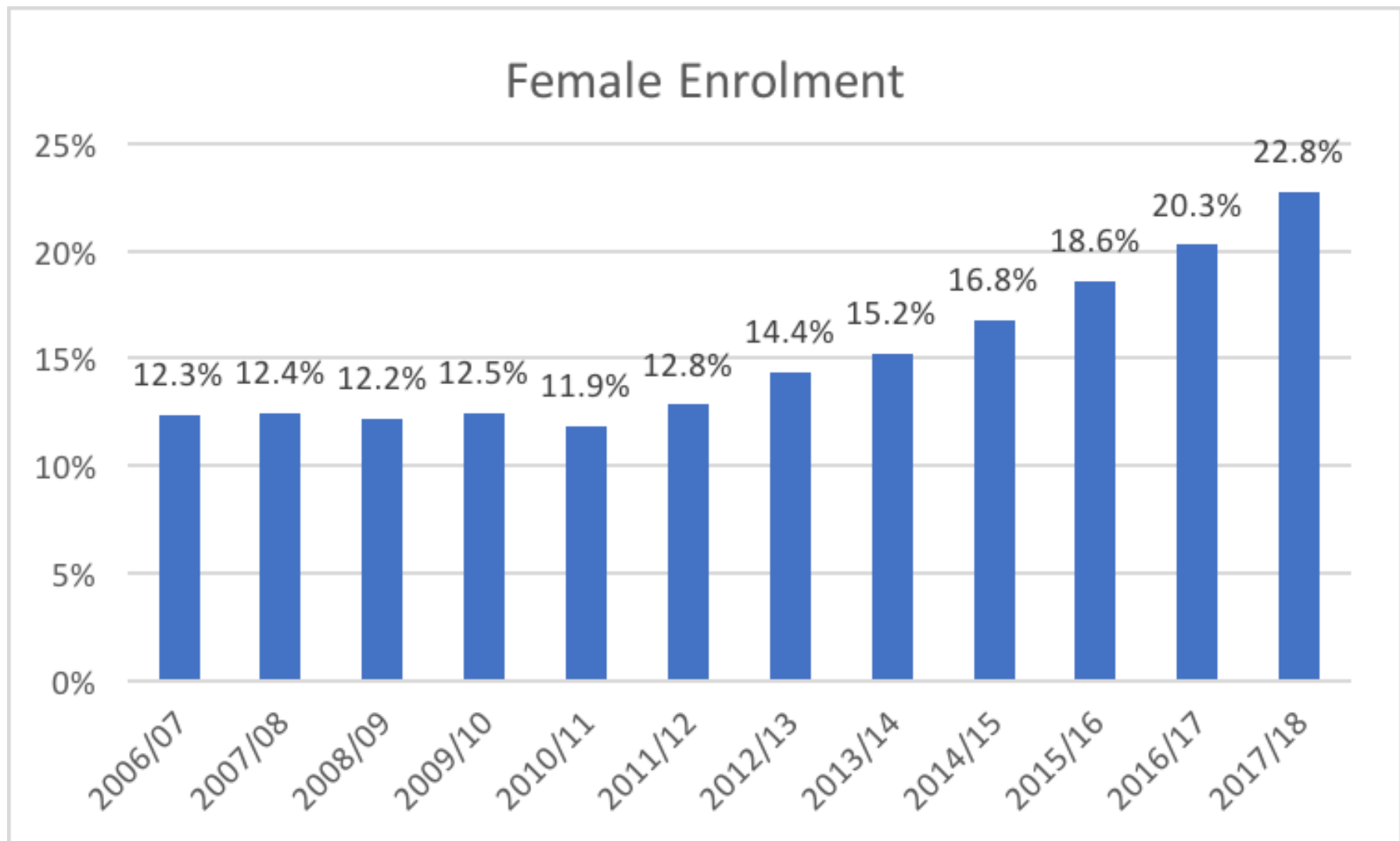


*United Nations Educational, Scientific, and Cultural Organization, Statistics 2015*

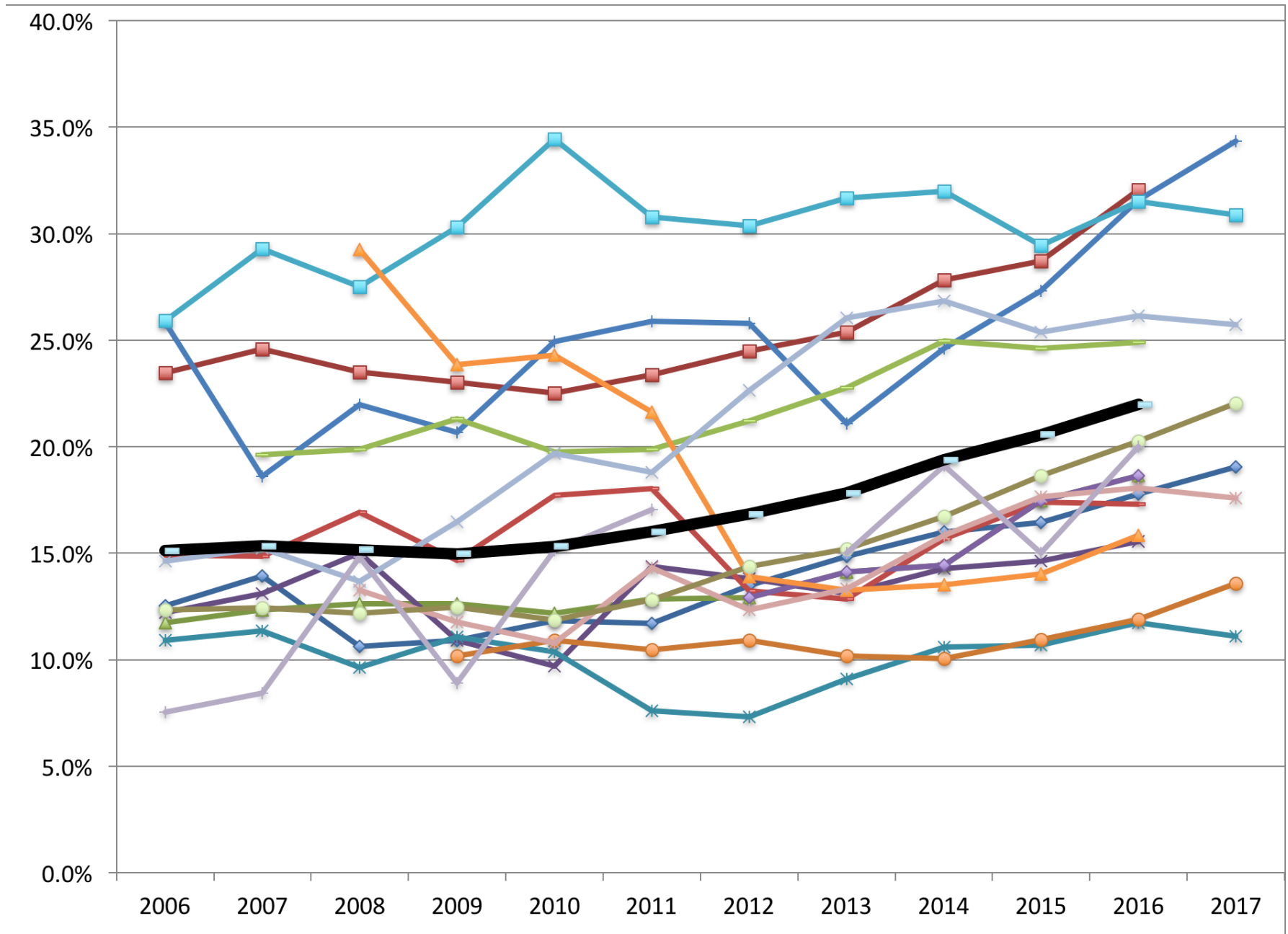
# UW – Female Admissions to CS



# UW – Female Enrolment in CS



# CANADA – Female Enrolment in CS





# Beacon Schools

School	Years	Change in Representation	Unit of Measurement
Cal Poly-SLO			ted to
Harvey Mudd College	2006-2016	12% to 47.5%	Women majoring in computing
University of British Columbia			
University of Washington	2007-2015	19% to 33%	Women majoring in computing

What do these schools do??

Are their techniques and successes transferable to other institutions??

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

# Harvey Mudd College

## 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)



**BRAID**

Building Recruiting And  
Inclusion for Diversity

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)



**BRAID**

Building Recruiting And  
Inclusion for Diversity

## 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

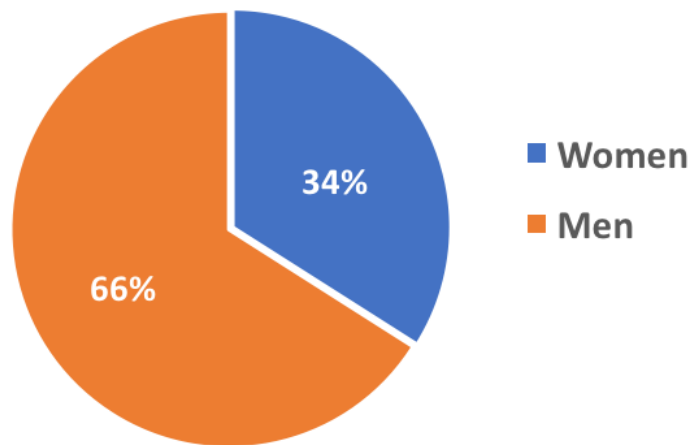
**committed to major changes to increase diversity, and to participate in research that studies the impact of the changes**

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

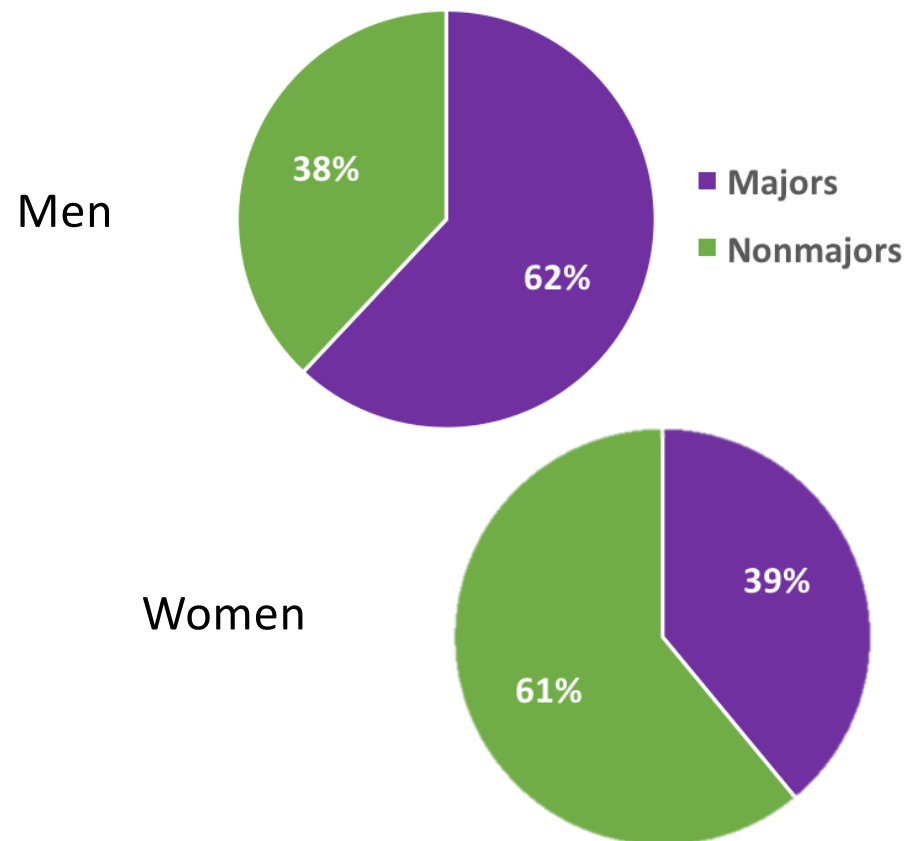
# Nationwide Baseline Student Surveys

## Demographics of students in introductory CS courses

### Gender



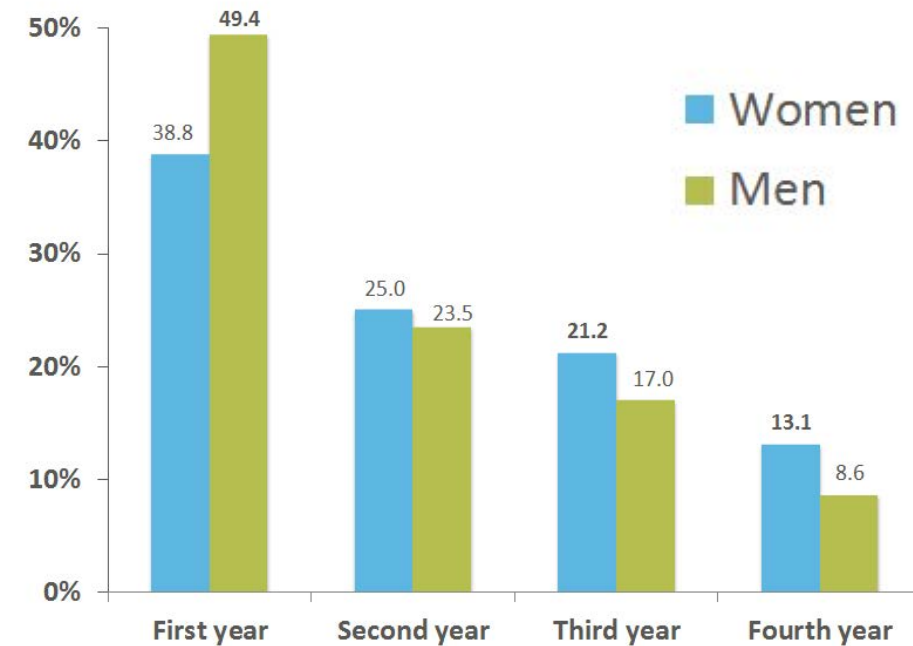
### Majors vs. Nonmajors, by Gender



# Nationwide Baseline Student Surveys

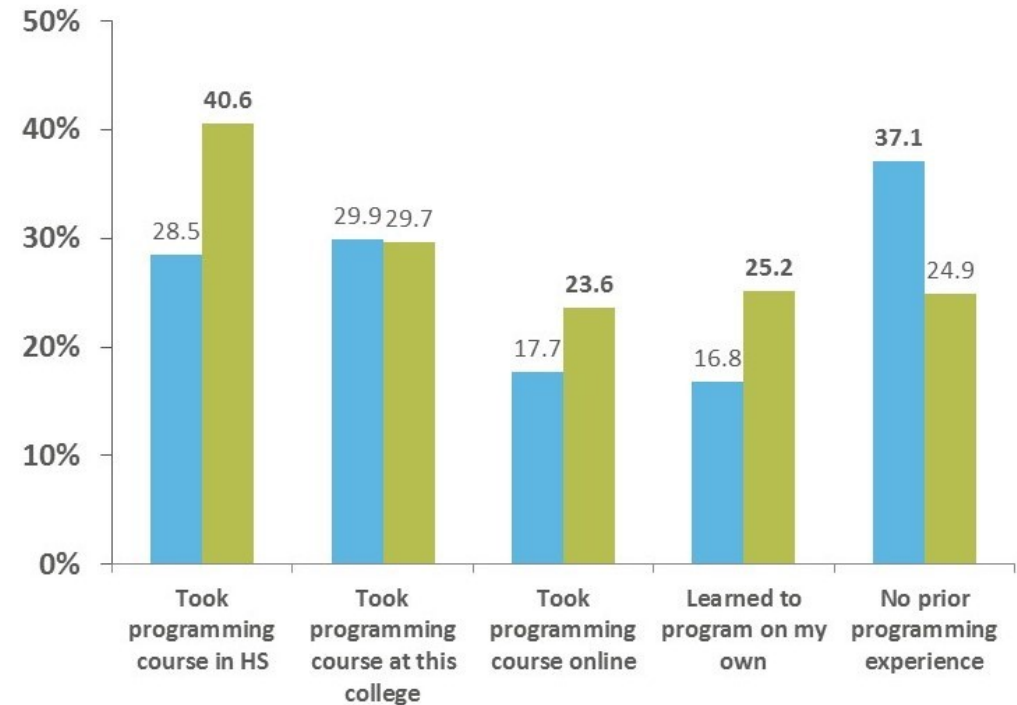
## Demographics of students in introductory CS courses

### Class Standing, by Gender



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

### Prior CS Experience, by Gender

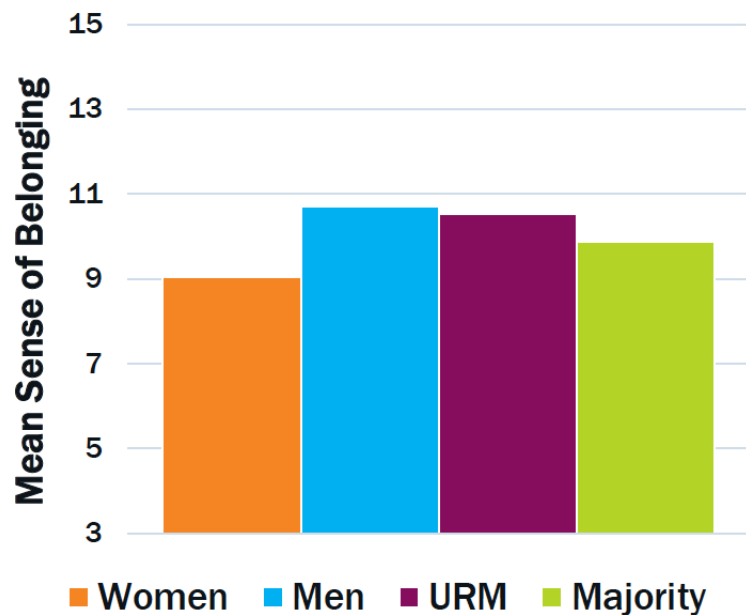


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# Nationwide Baseline Student Surveys

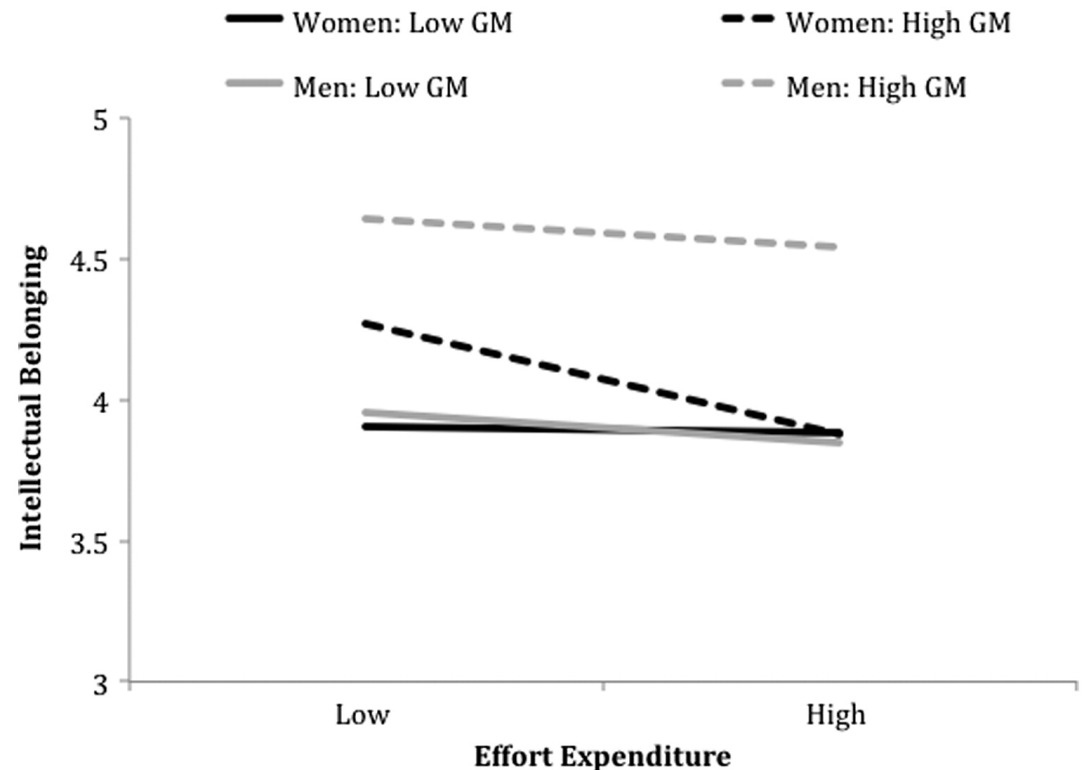
## Sense of Belonging in CS

Sense of Belonging, at end of introductory CS course



Sax, L. J. & Blaney, J. M. (2017, October). "BRAID research: Updates on introductory computing students from year two of data collection." Presentation at the Grace Hopper Celebration of Women in Computing, Orlando, FL.

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



Stout, J. G., & Blaney, J. M. (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* (pp. 1–14).

# Nationwide Baseline Student Surveys

## Sense of Belonging in CS

	Women		Men	
	n = 440		n = 1191	
	Mean	SD	Mean	SD
Major GPA (out of 4)	3.5	0.48	3.47	0.49
Intellectual belonging (1-5)	3.97	0.98	4.22	0.9
Growth mindset (1-5)	3.7	0.91	3.78	0.93
Time spent studying (hr/wk)	5.66	1.47	5.31	1.54
Have thought about leaving (% of respondents)	18%		13%	

# 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

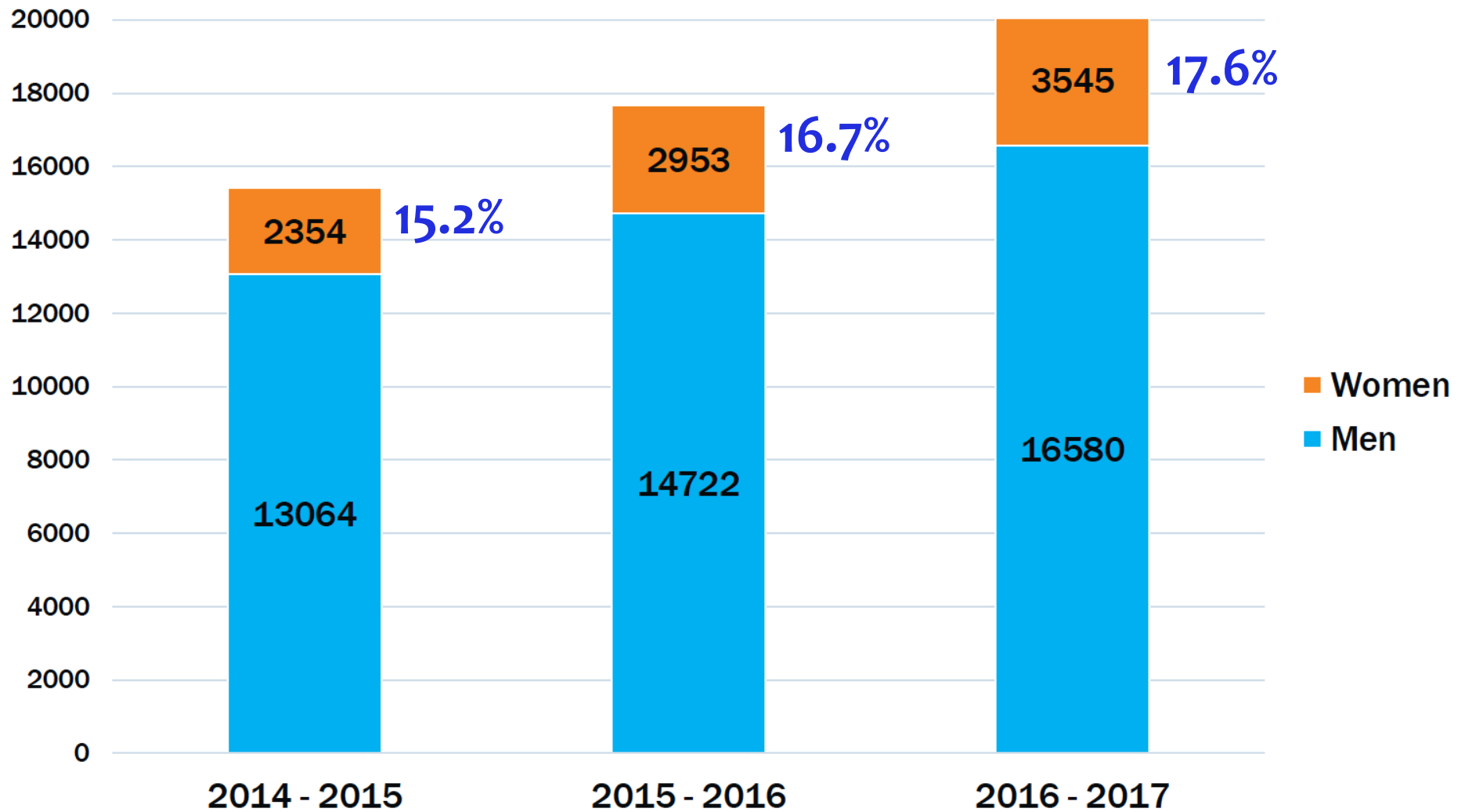
## 67% run programs for girls, and 53% run programs for high school teachers

- 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)

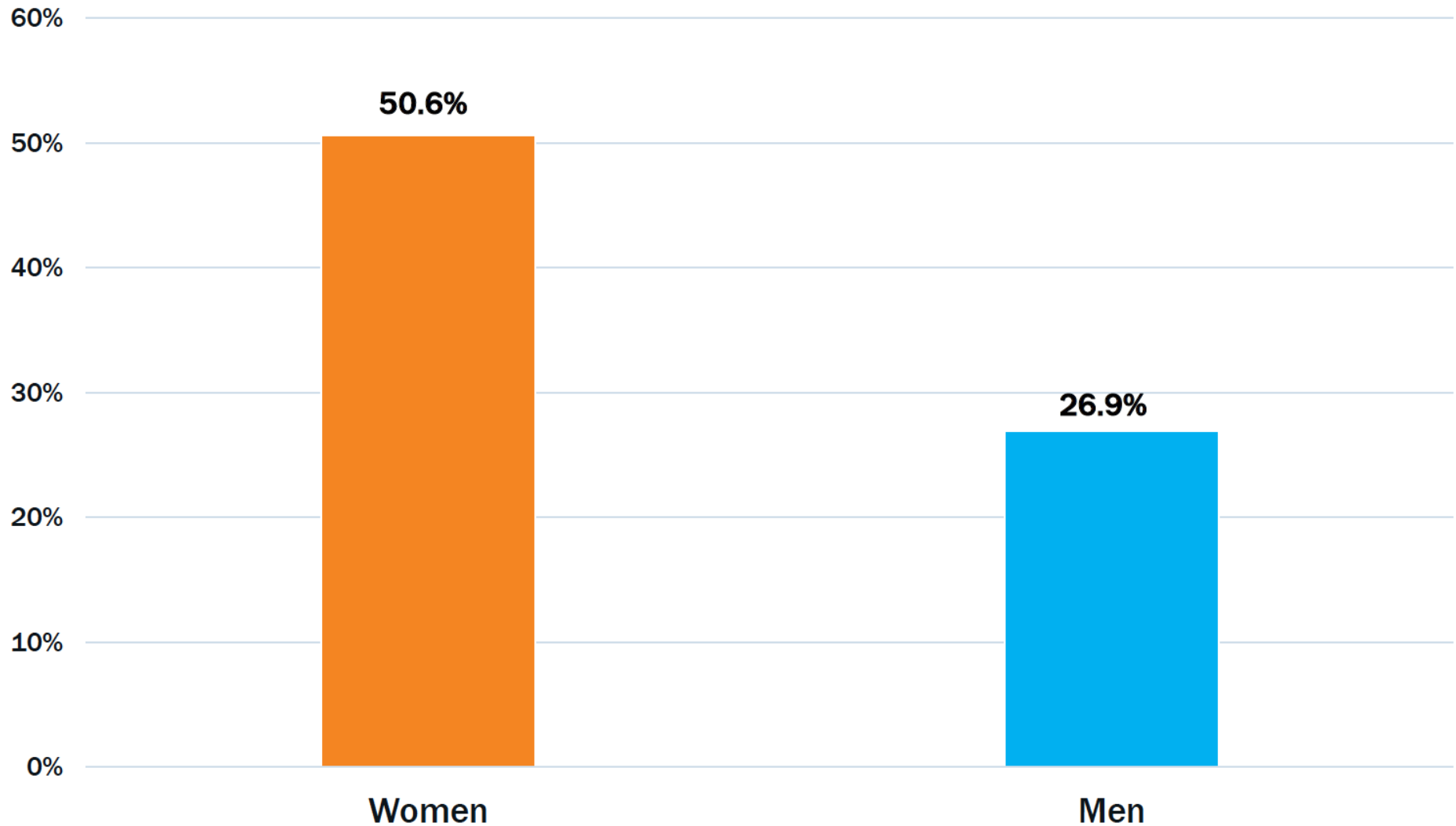
# Preliminary Results

*Sax, L. J. & Blaney, J. M. (2017, October). "BRAID research: Updates on introductory computing students from year two of data collection." Presentation at the Grace Hopper Celebration of Women in Computing, Orlando, FL.*

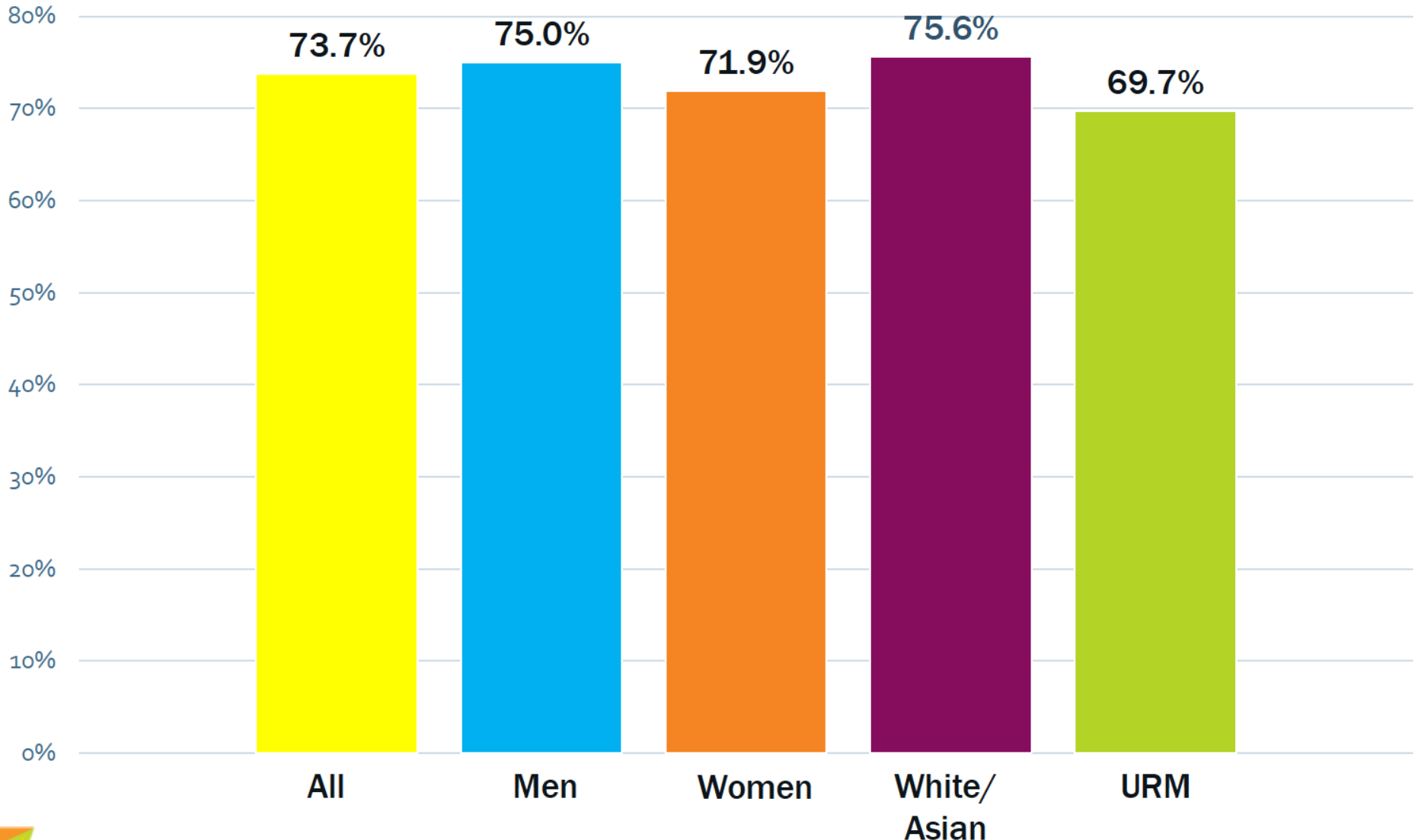
# Number of Students Enrolled in Computing Majors at BRAID Institutions, by Gender (2014-2017)



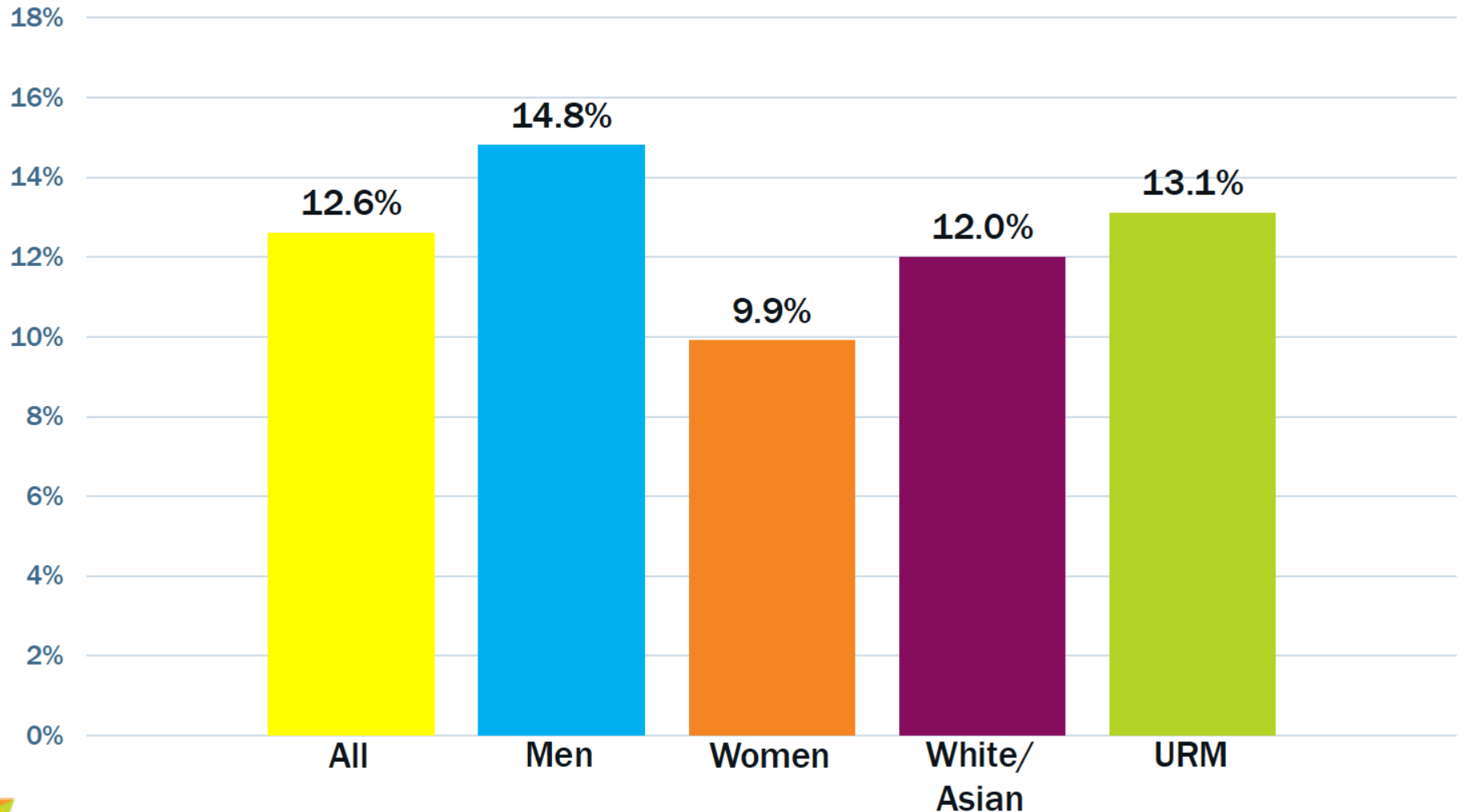
# Percentage Increase in Computing Enrollment at BRAID Institutions, by Gender (2014-2017)



# Computing Majors: Persistence One Year Later



# Non-Computing Majors Choosing Computing One Year Later



# Computing Students' Top Career Aspirations



**BRAID**

	Rank Among Men	Men	Women	Rank Among Women
Software developer or programmer	1	35.3%	31.6%	1
Business owner/Entrepreneur (Computing related)	2	9.9%	4.7%	5
Computer or information analyst	3	8.9%	9.7%	2
Game developer	4	7.5%	4.4%	6
Database or systems administrator or network architect	5	6.3%	2.7%	8
Computer or information research scientist	6	4.3%	4.1%	7
Management role in computing	7	4.1%	6.8%	3
Web developer	8	2.3%	5.0%	4



# Summary and Next Steps

# Departmental Change Process



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

Mobilization

Implementation

Institutionalization

### YEAR ONE

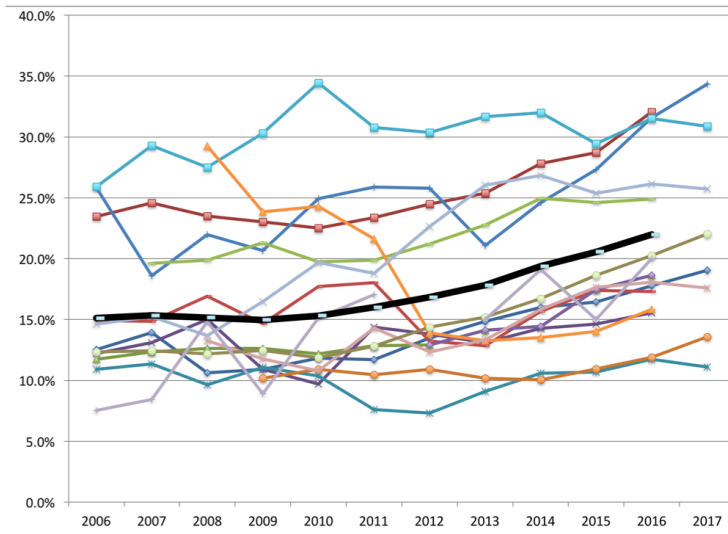
- **Raising awareness of diversity needs**
  - Departments were starting to implement new programs and services, and test out new ideas
  - Focus primarily on gender diversity
- **Many dept. chairs were grappling with the challenges and barriers that limit diversity efforts**

### 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

## CANADA – Female Enrolment in CS



## Beacon Schools

School	Years	Change in Representation	Unit of Measurement
Cal Poly-SLO	2008-2016	8% to 27% (Computer Science) 9% to 29% (Software Engineering)	Women admitted to programs
Harvey Mudd College	2006-2016	12% to 47.5%	Women majoring in computing
University of British Columbia	1997-2016	16% to 32%	Women majoring in computing
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## Building, Recruiting, and Inclusion for Diversity (BRAID)



### Fifteen universities

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

**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

## We're Making Progress

