



# Broadening Participation: The Why and the How

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**There are many reasons for striving to increase the representation of women in the computing field, but the most compelling one is the enhanced quality of the solutions diverse contributors can achieve.**

**W**e are honored to have been invited to address the “how” of broadening participation in computing by describing our experiences at a large, research-intensive public university.

We begin, though, by addressing the “why,” because having the right motivation is of critical importance. As eminent computer scientist Bill Wulf stated nearly 15 years ago, when he was president of the National Academy of Engineering:<sup>1</sup>

A lot of people argue for diversity in terms of fairness. We Americans are very sensitive to issues of fairness, but that’s not my argument. Others argue in terms of simple numerics: Male Caucasians will be the minority in the 21st century, and so to meet the need for engineers we will have to attract women and underrepresented minorities. That’s true too, but that’s not my argument, either.

I believe there is a far deeper reason why we require a diverse work force. Let me give you the argument in a nutshell, and then I’ll try to draw it out more carefully.

First, engineering is a very creative profession. That is not the way it is usually described, but down to my toes I believe that

engineering is profoundly creative. Second, as in any creative profession, what comes out is a function of the life experiences of the people who do it. Finally, sans diversity, we limit the set of life experiences that are applied, and as a result, we pay an opportunity cost—a cost in products not built, in designs not considered, in constraints not understood, in processes not invented. ...

Every time we approach an engineering problem with a pale, male design team, we may not find the best solution. We may not understand the design options or know how to evaluate the constraints. We may not even understand the full dimension of the problem.

In other words, while there are many reasons for striving to increase the representation of women in our field, the selfish reason is the most compelling one: the quality of the solutions we achieve is enhanced by the diversity of the individuals contributing to these solutions.

Having nailed the incentive angle with Wulf’s help, we can now focus on ideas that are broadly applicable and less obvious—describing what we’re doing at the University of Washington.

UW is a large research-intensive public university located in the heart of one of the nation’s most vibrant software industries. UW’s 28,000 undergraduate students have a range of interests and abilities, and they can choose from a broad array of technology-related majors. This differs significantly from the environment at smaller, more elite institutions. In this context, we feel that we do well, although certainly not nearly as well as we aspire to do: women comprise roughly 25 percent of both our undergraduate and graduate student populations in computer science.

## DUPLICATING OUR PROGRESS

Our efforts have three key components: outreach to K-12 teachers and students, enhancements to our introductory course sequence, and community building to make our program more welcoming to all students.

### Outreach to K-12

Our K-12 outreach program, DawgBytes ([www.cs.washington.edu/dawgbytes](http://www.cs.washington.edu/dawgbytes)), introduces both teachers and students to computing. Importantly, the vast majority of colleges and universities—including UW—have largely regional student bodies; changing the perception of the field in a relatively small number of K-12 schools can significantly impact the student population.

Historically, our outreach efforts have focused on teachers because of their influence on many generations of students. We provide professional development opportunities for teachers ranging from CS4HS (Computer Science for High School), a Google-sponsored summer workshop where math and science teachers learn about integrating computer science ideas into their classes, to workshops for advanced placement computer science teachers. All of our professional development opportunities offer strategies for attracting and retaining female students.

Providing recognition to teachers who send us strong students pays dividends in recruitment. When students enter our program, we ask them to nominate a teacher at a previous institution (secondary school or community college) who particularly inspired them. We then invite the teachers, their partners, and their nominating students to a dinner where they become reacquainted and learn a bit about computer science. Because young women are more likely to nominate teachers, this event provides a great opportunity to reach teachers who inspire strong female students. Year after year, we hear from new students that the teachers we previously recognized had encouraged them to aspire to our program.

Our student-targeted initiatives seek to increase diversity in our field with a specific focus on exposing young women to computing early on. We host the Washington State National Center for Women & Information Technology (NCWIT) Aspirations in Computing Award, which honors young women at the high school level for their computing-related achievements and interests. During the award event, we introduce winners to UW students doing interesting research and lead the recipients through hands-on activities. Last year's two NCWIT national winners from Washington state both entered UW as computer science majors this fall.

We also host "STEM Out!," an event where girls can learn about science, technology, engineering, and math (STEM) careers. This event is organized in collaboration with our local Computer Science Teachers Association chapter and Amazon's Hoppers group of women engineers.

Additionally, during the summer in 2012, we hosted three weeklong day camps for secondary school students; our advertising aggressively targeted girls, and there was a female majority in all of the sessions. We organized academic year follow-up activities with these students to keep them engaged in computing—some at UW, some hosted by local companies.

### Course sequence enhancements

Our two-quarter introductory course sequence serves many purposes, including acting as an attraction factor for our major. (Most students arrive at UW as pre-majors and choose majors after fulfilling prerequisites.) We've been philosophically committed to a single pathway—in our view, when it's taught well, just about everyone loves programming.

Enrollment in our introductory courses decreased after the dot-com bubble burst, dropping to 1,200 students a year in our first course and 650 in our second course. We subsequently redesigned the courses, and enrollments have now expanded to record levels. We serve more than 2,000 students a year in our first course and 1,300 in our second course (increases of more than 65 and 100 percent, respectively). In the same period, female enrollment has expanded at twice that rate, increasing approximately 120 percent in the first course and 180 percent in the second course (with 600 women taking the first course and 300 taking the second course in the most recent academic year).

The disproportionate success with women is due primarily to three factors that were central in the course redesign: instilling confidence, emphasizing community, and showing the breadth of computer science applications.

Most young women who take our introductory courses didn't have a chance to explore computer science in high school. They find it intimidating when they overhear male students talking about computer technologies they haven't heard of, leaving them with the impression that they're already behind the curve and can't succeed. We combat

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this by providing a tight course structure with integrated resources (textbooks, lectures, discussion sections, notes, online practice, videos), intellectually challenging assignments, and an elaborate support structure. Consequently, women learn that the greatest predictors of success in the course and in our field are hard work and organization—not esoteric knowledge of currently popular technologies or some innate gift.

We emphasize community in several ways. We offer a seminar that explores women in computing that students can take in parallel with the introductory courses. We offer small-group honors sections where students interact closely with a faculty member to explore computer science issues in greater depth. We also have a group of 40 to 50 undergraduate teaching assistants who staff our introductory courses. The introductory TA community is very strong, with 5 to 10 applicants for every available spot. Women make up 40 percent of our undergraduate

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TAs even though we give no special preference to them in hiring.

We find that to “seal the deal” and convince talented young women to major in computer science, we must use every opportunity to show them the breadth of the field. In the women’s seminar, they might visit Microsoft to see for themselves that a career in computing involves more than just programming. In a programming assignment, they might see that computer science is used in linguistics and biology. In an honors section, they participate in deep discussions about the interdisciplinary nature of computer science and its links to mathematics, statistics, linguistics, philosophy, biology, chemistry, and so on. We recently added a series of optional exploration sessions in which students in the introductory courses can learn about specific applications of computer science; we’ve found that women participate in these sessions more often than their male counterparts.

### Building up a community

UW has an active ACM-W chapter that provides a supportive community for women. ACM-W hosts social, academic, and career-oriented events to encourage networking with other students, faculty, and industry. ACM-W also provides leadership opportunities for women who serve as officers. The student ACM chapter helps to build a strong sense of community among all of our students.

We regularly send 15 to 20 undergraduate and graduate students to the Grace Hopper Celebration of Women in Computing, a conference where they can network and form a community with their peers and women already working in the field from across the country. The experience boosts confidence, provides role models, informs

women about the field, and encourages involvement in the computer science department.

We are fortunate to live in a region where there are many leading technology companies that have a strong interest in increasing the participation of women in the field. Microsoft and Google, in particular, run multiple events each year for our female students.

### TIMING

We often hear from women who eventually apply to our major that they had no idea they would be interested in computer science until they took one of our introductory courses. This anecdotal evidence is borne out by a survey students took at the start of the first introductory course. At that time, only 40 percent of the women who are now in our major agreed with the statement that they intended to apply to the major. Most of the rest said that they were “not sure/undecided” whether they would apply to the major, and 24 percent disagreed with the statement entirely; they had plans to major in a different field.

We’re particularly frustrated when we find that a woman who is a junior or senior has only recently discovered an interest in computer science because such students often conclude that they can’t rearrange their plans by switching majors. These students invariably say that they wish they had discovered computer science earlier so they could have majored in it. This is why so many of our efforts revolve around early exposure to computer science either in K-12 or the freshman year.

### COST

We’ve devoted significant resources to broadening participation, assisted by the generosity of alumni, friends, and companies. We don’t want to minimize the importance of this. However, many of the changes we’ve introduced aren’t particularly expensive, and help is available—focus is at least as critical as finances.

For example, we initiated CS4HS while working with colleagues at Carnegie Mellon University and the University of California, Los Angeles, but Google now funds the program at more than 100 colleges and universities. Hosting the NCWIT awards requires a bit of organization, but working with NCWIT makes it easy. There’s overhead in planning the first offering of a summer day camp, but these events can be made self-supporting in steady state. Switching to undergraduate TAs in introductory courses can actually save money.<sup>2</sup> Honors sections require additional teaching cycles, but instructors often volunteer to teach them because they enjoy working in a small-group setting with highly motivated students. Undergraduate TAs who are interested in motivating their younger peers staff exploration sessions. Scholarships are available for attendance at the Grace Hopper conference. In short, where there’s a will, there’s a way.

Neither UW nor the computing field as a whole is where it needs to be, but many of us are working hard to get there. Hopefully, the experiences we've described here offer some ideas that you can use in your own institution.

There's no silver bullet. Sometimes, it's one woman at a time—a student who has made a connection with an advisor, an instructor, or an undergraduate TA, or who gets hooked because of an honors section, the women's seminar, a cool assignment, or a great exploration session. Progress comes from a multiplicity of efforts, and every little bit helps.

Ultimately, remember why we are engaged in this effort: for fairness, yes; for workforce, yes. But, most importantly, because the diversity of the contributing individuals enhances the quality of the solutions we achieve. ■

## References

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