Why Women (and Everyone Else) Should Code

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Stuart Reges' recent article entitled "Why Women Don't Code" elicited strong reactions. I am a colleague of Reges' in the Paul G. Allen School of Computer Science & Engineering at the University of Washington (UW). Like a number of my colleagues, I found myself surprised and troubled by his article.

Specifically, I was surprised that Reges could take such a multi-faceted question (why the number of women studying computer science is currently so low), conjecture that it is largely explained by a single factor (that women are simply less likely to *want* to major in it), and conclude that the percentage of women in computer science is unlikely to ever top 20%.

My own reasons for writing this article are the following:

- I want to point out some of the highly dynamic factors influencing the enrollment of women in computer science (CS) that are *not* addressed by Reges' article and make the case that significantly different conclusions are also possible.

- I want to strongly encourage undergraduates at UW and elsewhere to take CS courses. I especially want to make sure that UW students know that all of our instructors, including Reges, care deeply about recruiting **all** talented and passionate students into CS, regardless of who or what they are, and are 100% behind the agenda of "encouragement and removal of artificial barriers" (a quote from Reges' article).

- I want to reach out to other computer science educators to say that we need to actively encourage **all** students to learn CS and programming. If we want the very best students to be entering our field, we need to compete for them (both women and men). It is *not* easy to identify the most talented and passionate students.

I see absolutely no reason to believe we have reached some sort of ceiling in the CS participation of women, because there are so many varied, complex and dynamic factors that affect whether a student studies CS. These factors include parental encouragement, pressure and expectations; socioeconomic factors; existence of role models; access to technology and exposure to programming at an early age; the quality of K-12 education; the culture of the field; self-confidence; gender norms; knowledge of what CS is; the impact technology is having on the economic, scientific and social aspects of our society; and the tyranny of low expectations.

Reges makes the argument that women's representation among CS majors is low because women are simply less interested. He says, "women *can* code, but often they don't *want* to." As one of his supporting arguments, Reges cites an article describing the career choices that 12th graders make [Wang et al]. This article observes that students who are good at both math and English choose to go into STEM fields at a lower rate than those who are only good at math, and that women are more likely to be good at both.

Wang et al.'s research is based on a study of students who graduated from high school in 1992. Twenty-six years is a long time for any STEM field, but for CS, this study is practically prehistoric. Those 1992 graduates went off to college having never held a cellphone, having never seen a website, having never shopped online, having never done a search on Google, and having never used social media. Quite possibly, many of the subjects of this study now have daughters in middle school and high school whose comfort level with technology would have been unthinkable to their parents. Do we really believe that the massive changes our society is experiencing because of CS and technology are not going to have an impact on women's choices?

It also strikes me as indisputable that K-12 education plays a significant role in career choices. According to a recent Gallup poll, only 40% of schools in the US offer *any* computer programming classes. Moreover, in 14 states, CS classes do not count towards math or science graduation requirements. Talk about insufficient encouragement to take CS in high school!

But we are in a period of tremendous flux. In 2007, according to this data, 14,529 students took an AP Computer Science exam, of whom 2,665 were female. By 2017, the total number of AP CS test takers had risen to 111,262 students of whom 29,708 were female. In other words, during this 11-year period, the number of males went up by a factor of 7 whereas the number of females went up by a factor of 11. In fact, just from 2016 to 2017, the number of males taking the test went up by a factor of 1.95, whereas the number of females went up by a factor of 2.34. If these percentage increases continue to hold, girls will outnumber boys among AP CS exam takers by 2023! Now admittedly, 2017 was a year of phenomenal growth for the AP CS exam, not likely to be repeated, but it

remains true that small differences in rates of exponential growth lead to radically different outcomes in a short time period.

Additionally affecting growth, a huge new pipeline of teachers is being trained to *teach* CS at the middle school and high school levels. In an email from Hadi Partovi to Code.org facilitators in June, he spoke of kicking off the 2018 summer workshops to prepare over 10,000 teachers to begin teaching CS for the first time this fall.

I was particularly amazed to discover that 45% of the students taking Code.org's CS courses are female. Moreover, the vast majority of these students are in K-8. In other words, getting an early start! More generally, the scale at which Code.org is operating is mind-blowing: roughly 66% of *all* 11-year-olds in the US have accounts on Code.org.

I do not know how many of these students will end up pursuing CS in college. But as the quality and quantity of K-12 CS offerings increases, we can certainly expect to see effects at the college level. It is my belief that the impact will be greater on female enrollment than on male enrollment, because boys are getting involved in programming at a much greater rate and at a much younger age than girls, even without training in a classroom setting.

Reges himself notes that 50% of the "women in our undergraduate major are `interest changers,' which means they weren't intending to apply to the major when they started our first course. For men the figure is closer to 20%, so there is a big gender gap." In other words, a much larger percentage of women drawn to the field ***discover*** their interest in CS when they take their first CS course in college. This is consistent with the assertion that significantly fewer girls than boys learn about programming or CS before college.

In fact, many students come to college having a total misconception about CS. Some of them have been playing video games their whole lives and think that this is what CS is about; others imagine themselves getting rich by becoming the next Mark Zuckerberg. These types of motivations for studying CS in college attract some students but leave others cold. It is incumbent upon *us*, the educators at every level, to reach out to these latter students, to expose the intellectual depth of the field and to convey the excitement that comes from solving a complex programming challenge.

I'm convinced that many students would be motivated by the deep intellectual challenges the field is addressing and by the potential CS has to affect and improve *millions* of lives. For example, using CS, we can extend the reach of education to every community in the world (via platforms like Coursera), we can accelerate our understanding of cancer, and we can illuminate the mysteries of the brain. Using CS, we can create agricultural, economic, and medical infrastructure for developing countries, thereby attacking crippling poverty. Some of the most beautiful and exciting open problems in mathematics are in fact problems in CS. Even art, music, and film-making are being revolutionized by CS. The possibilities for leverage and positive impact using CS are endless.

There are also many difficult challenges ahead that computer scientists need to address including privacy, cyber-crime, information overload, widespread malicious misinformation, our ever-increasing reliance on machine learning for decision-making (and the resulting loss of understanding as to how decisions are made), etc. Awareness about the pivotal role that CS will play in the solutions to these problems might also inspire students to enter the field.

So, while many talented women in the US might be choosing *not* to explore CS in college, it is often an **uninformed** choice and herein lies the problem**.** The majority of women starting college do not know how exciting and fun CS is. They may not appreciate the extent to which just being able to program will greatly expand the opportunities available to them, even if their primary passion is a field other than CS. Unfortunately, it seems that many women with no background or experience in CS simply *assume* they would not be good at it, and therefore don't even bother trying. A little bit of encouragement to just check out a CS course can go a long way towards addressing this lack of confidence.

Confidence is affected by both internal and external expectations. In my opinion, the most insidious bias that pre-college girls face, from both teachers *and* parents, is low expectations for them to excel in subjects like CS, math, physics and engineering. This is changing; but even if change is slow, as US education catches up to 21st century standards, more girls will study CS *before* college. Interestingly, women are already 43% of math majors in the US**.** I believe this is a simple consequence of the fact that math is mandatory in K-12. CS also *needs* to become mandatory in middle school and high school.

While I have only touched on a few of the factors that could affect the participation of women in CS in the long run, I am convinced that we are in an era of enormous fluidity. The combined effects of these factors have the potential to significantly move the needle.

Let me be clear. I am *not* saying that we should push any student into a field they are not interested in or that anyone (including me) knows what the "ultimate" proportion of women in CS will be. I am also *not* saying that proportional representation is a goal in and of itself. And, *of course,* I am *not* saying there are no differences between the genders. However, how these differences relate to behavior and decision-making is complicated, and how these gender differences will evolve as our society changes is an open question. In particular, we are far from understanding the complex interplay between genetics and socialization.

What I *am* saying is that there are many students out there who do not know enough about CS to make an informed decision as to whether or not to pursue it. I would hate for **any** student to miss out on exploring CS simply because they have not been properly exposed to its potential or because they don't have the confidence to try it. And I would hate for this deeply important field to miss out on the contributions and perspectives of so many talented and creative students.