Why Are English Majors Studying Computer Science?

Ed Lazowska (University of Washington) and David Patterson (UC Berkeley)

Ten years ago, professors in computer science departments everywhere wondered how undergraduates from a broad range of fields could be attracted to CS. We were convinced that this material would be vital for their careers, but we were up against negative stereotypes of programmers, and the prediction that most software jobs were about to be outsourced to the third world.

The tide has turned! Figure 1 shows annual enrollments over the past decade for the introductory computer science courses at Berkeley, Stanford, and the University of Washington. At each of these schools, and at colleges and universities across the nation, the introductory computer science course is now among the most popular courses on campus, and demands for advanced computer science courses are at record-breaking highs. At Stanford, where more than 90% of undergrads take computer science; English majors now take the same rigorous introductory CS course as Computer Science majors.

So what happened?

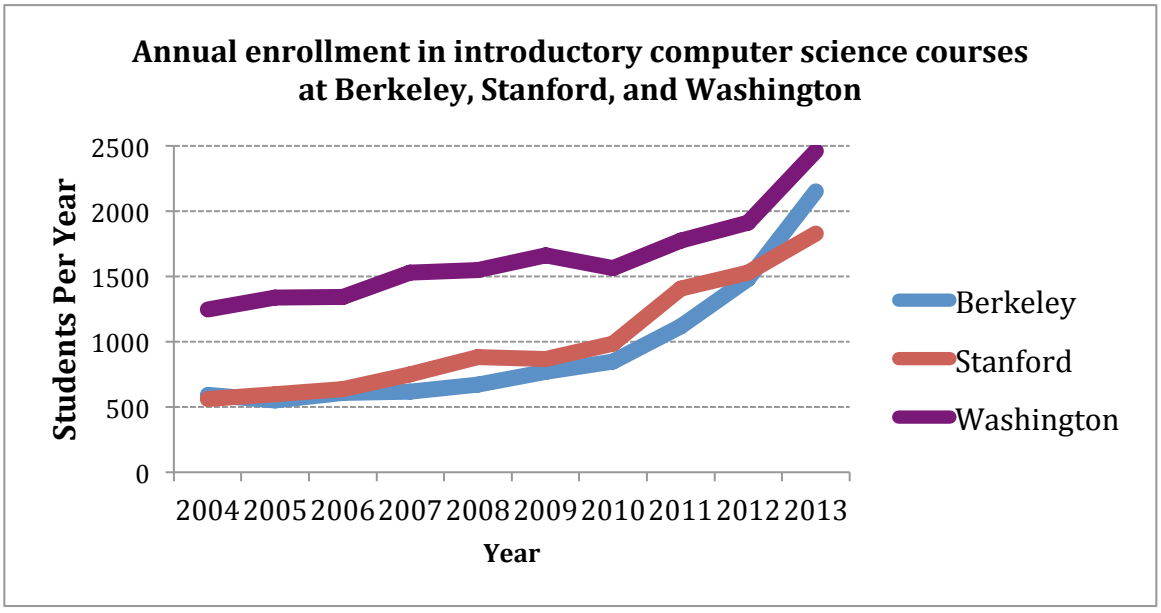

Figure 1. Annual enrollment in the introductory computer science course at Berkeley (CS61A), Stanford (CS106A), and Washington (CSE142). All three schools have gentler introductions to computing intended for less technical students, which makes these trends even more startling. (The sizes of the freshman classes at these institutions are 4100, 1700, and 6000, respectively.)

First, today's students recognize that "computational thinking" — problem analysis and decomposition, algorithmic thinking, algorithmic expression, abstraction, modeling, stepwise fault isolation — is central to an increasingly broad array of fields. Programming may be a valuable skill, but the hands-on, inquiry-based way in which one learns to think computationally is priceless. Those who can practice computational thinking, and who can wield the power of computer science effectively, will be in the position to make greater contributions in all fields than those who can't. Indeed, the 2013 Nobel Prize in Chemistry was for computer models, and the official press release said[1]:

> *Today the computer is just as important a tool for chemists as the test tube.*

This perspective was echoed in the recent remarks of Richard Dawkins[2], author of the classic book *The Selfish Gene*:

> *Biology nowadays is a branch of computer science.*

Fields from art to zoology are becoming information fields, which is why students from all over campus are taking CS courses.

In addition to enhancing prospects within a chosen field, surely some of the reason for interest in computer science as a major or as a minor is to enhance employment opportunities after graduation. Figure 2 shows projections by the US Bureau of Labor Statistics for job growth during this decade in all Science, Technology, Engineering, and Mathematics (STEM) fields. There is some debate about whether there will be a workforce shortage in STEM overall.[3] There can be no such debate where computer science is concerned. According to BLS, 70% of STEM job growth will be just in computing. While there is uncertainty in all such projections, students wanting to keep their options open for in careers in computing have the best available data to support their decisions.

A significant barrier continues to be the lack of opportunity to study computer science before college. In 1983, the report *A Nation At Risk* recommend that every high school student in the US receive at least half of year of computer science to graduate from high school.[4] In 2013, a 65-page report on K-12 STEM education[5] has just one sentence that mentions computer science. Two-thirds of the states today do not give academic credit for a high school computer science course; CS is lumped in

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[1] The Nobel Prize in Chemistry, press release, October 9, 2013. http://www.nobelprize.org/nobel_prizes/chemistry/laureates/2013/press.html

[2] Remarks made as part of Dawkin's presentation on his new book *An Appetite for Wonder* in Redmond WA on October 14, 2013, as reported by Bill Bolosky.

[3] Anft, Michael. "The STEM Crisis: Reality or Myth?," *Chronicle of Higher Education*, November 11, 2013.

[4] Gardner, David P. *A Nation At Risk*. Washington, D. C.: The National Commission on Excellence in Education, US Department of Education (1983).

[5] Committee on Evaluation Framework for Successful K-12 STEM Education, *Monitoring Progress Toward Successful K-12 STEM Education: A Nation Advancing?*, National Academies Press, 2013.

with shop courses. Thus, we've *reduced* the pre-college opportunity to learn CS in the last three decades!

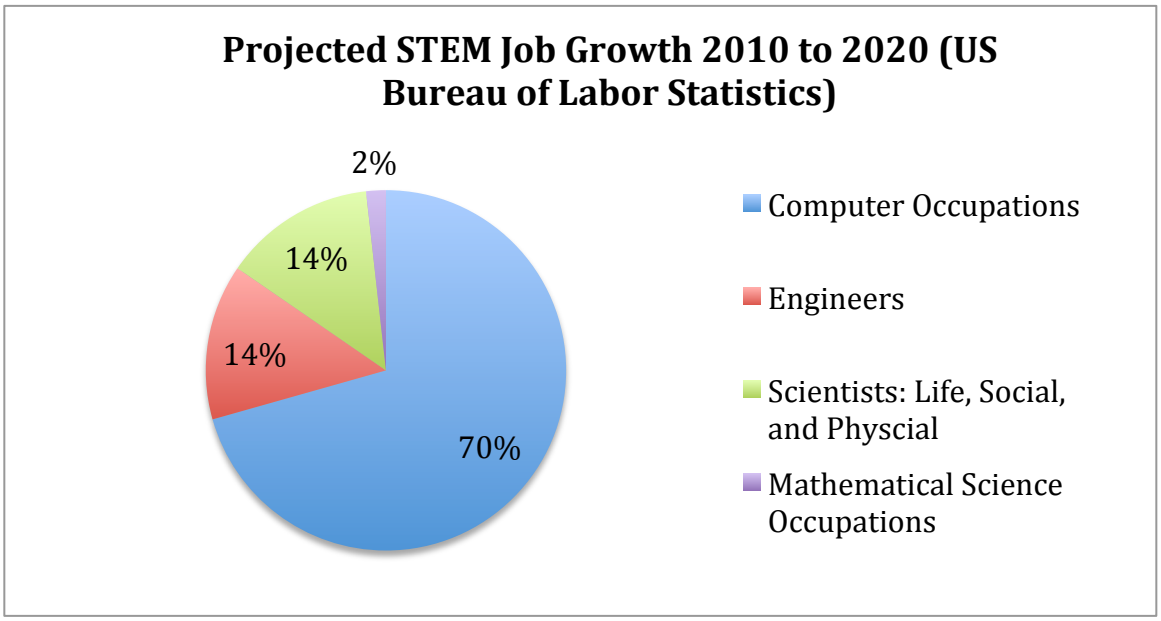

Figure 2. US Bureau of Labor Statistics projections for new jobs in the STEM fields between 2010 and 2020.[6]

What is academic leadership doing, given the "new normal" in the demand for computer science education?

K-12 is starting to respond, driven by efforts such as Code.org[7].

In higher education, the response has been sluggish at best. Computer Science is usually found in colleges of engineering — as is the case at Berkeley, MIT, Stanford, and Washington — so one indicator of accommodation is the fraction of engineering faculty in the field. Less than a fifth of the engineering faculty at these schools teach computer science courses[8], a fraction nearly unchanged in the last decade.

What should the stakeholders do?

- *Current and Future Students* – Enroll in computing courses by hook or by crook, as we believe they are intellectually challenging and will prove to be vital no matter what career path you choose.

[6] We used the BLS classifications to define fields: 15-1100, 17-2000, 19-1000, 19-3000, 19-2000, and 15-2000, respectively.

[7] http://code.org/

[8] The percentages of computer science faculty at four colleges of engineering are Berkeley 18%, MIT 16%, Stanford 17%, and Washington 16%.

- *Alumni* – If you wish to get up-to-speed mid-career, Massive Open Online Courses (MOOCs) appear to be a good and affordable path to continuing education in computer science.

- *Computer Science Faculty* – Given the importance of the field for students' careers, we applaud the heroic efforts of many who opened the doors to their already impacted classes to handle the surge in demand.

- *Academic Leadership* – Depending on faculty heroism is an unwise long-term strategy. We understand that universities should not rush, but this explosive demand must be met with resources.

Student demand and employer demand are often cyclical, and computer science has seen bubbles in the past. But everything we know points to the fact that what we see now in campuses everywhere is not a tsunami, but a sea change: *Students from all fields want to learn computer science so they can change the world*.