Chapter 36

cSELF (Computer Science Education from Life): Broadening Participation through Design Agency

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ABSTRACT

The phrase "broadening participation" is often used to describe efforts to decrease the race and gender gap in science and engineering education, and in this paper the authors describe an educational program focused on addressing the lower achievement rates and career interests of underrepresented ethnic groups (African American, Native American, and Latino students). However "broadening participation" can also describe the more general problem of a narrow, decontextualized form of education that can alienate all demographics. Broadening the scope of computing education can not only help address disparities in different social groups, but also make technical education more attractive to all individuals, and help us create a generation of science and engineering professionals who can better incorporate an understanding of the world into their technical work. The program the authors report on, Computer Science Education from Life (cSELF) takes a modest step in this direction. Using the concept of "design agency" the authors describe how this merging of abstract formal structures, material creative practice, and cultural knowledge can improve underrepresented student engagement, and foster learning practices in computing that offer broader forms of social expression for all students.

1. THE NEED FOR BROADENING PARTICIPATION

Underrepresented ethnic groups in the US consist of three groups: African American, Latino, and Native (which includes Native Alaskan, American Indians, and Pacific Islanders). Although they constitute about 45% of the college-age population, underrepresented ethnic groups comprised only 12% of engineering bachelor's degrees (NACME, 2008). This is not a problem that is simply resolving itself over time: the shares to black and Native

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students have remained flat since 2000. Graduate computer science is particularly troubling: students from under-represented ethnicities comprised only 3% of the total number of degrees granted in 2008 (Ladner, 2012).

The low representation of underrepresented ethnic groups (African American, Native American, and Latino students) in the STEM workforce in general, and computing specifically, has two root causes. One is career interest: as noted by Simard (2009) narrow perceptions of career paths and stereotypes about what is an "appropriate" profession contributes to the lack of diversity. But more problematic is the lower academic achievement, especially for low-income students. High school drop-out rates for African American and Latino students are double that of white students, and triple for Native Americans (Stillwell & Sable, 2013).

These lower levels of STEM achievement and interest are detrimental to these populations, resulting in lower income levels and even contributing to health disparities (academic achievement is correlated with lower rates for HIV infection and substance abuse, higher rates for vaccination, etc… (Bridges & Alford, 2010; Fields et al. (2007).

As noted in the introduction, the concept of "broadening participation" can also be applied to students in general. In computer science, the percentage of high school students taking computing courses has surprisingly dropped from 25% to 19% (Nord, et al. (2011). In recent years, the computer science advanced placement (CS AP) test has sustained the lowest participation rate in comparison with other STEM disciplines. The CS AP exam also shows a strong gender gap: only 19% of girls compared to 81% of boys comprise the CS AP test-takers (NCWIT 2012).

A broader approach to computing education could also improve the ability of the STEM workforce to address critical humanitarian and sustainability issues. The fiscal meltdown of 2008, for example, was a destructive force in much of the US economy, and precipitated a global recession. Many scholars attribute the incorporation of computational models of risk--for example the Gaussian copula function--as a key ingredient (Salmon, 2009). Similar issues in the role of computational risk modeling arise in environmental disasters; for example the engineering professionals in the 2010 Gulf Oil disaster (Deep Water Horizon Study Group 2011). Narrow conceptions of what it means to be a computational scientist are inculcated in our classrooms; it is this narrowness that allows these professionals to say "it's not my place to think about consequences, I'm just here to crunch the numbers." Broadening the *forms* of participation–educating students in the use of computation as an expressive medium with deep connections to the social world–can serve as a powerful counter-balance to this tendency to abdicate responsibility.

2. THE ROLE OF CULTURALLY SITUATED EDUCATION

Barriers to participation and achievement in STEM disciplines for underrepresented youth can be framed in three categories. The first concerns the barriers due to economic conditions, which are correlated with underrepresented ethnic groups, include lower quality schools, health care, and other aspects of the learning environment and experience. A 2010 study of California schools, for example, found that African American students were six times more likely than white students to attend one of the schools at the bottom third of the state ranking (Education Trust-West, 2010). The second category encompasses myths of genetic determinism: the belief that a "math gene" or some similar genetic construct prevents certain racial groups from STEM success. There is no evidence for such a phenomenon, but the myth itself can have strong negative consequences, discouraging students and diminishing their confidence (e.g. Geary, 1994) The third category covers myths of cultural determinism: conflicts with stereo-

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