Introduction

The Myth of Technology as the "Great Equalizer"

This book reports the findings of a study investigating why so few African American and Latino/a high school students are learning computer science. Yet unexpectedly, our perspective was sharpened toward the end of the research project by stumbling on a newspaper article about a program designed to teach more African American children to swim. The *New York Times* article, titled "Everyone into the Water" (Zinser 2006), was accompanied by a large color photograph of children of different races by the side of a pool. It described the program at a fitness center tucked away on the Upper East Side of Manhattan, Asphalt Green, where "for at least one day a year, the overwhelmingly white world of swimming gets turned on its ear." Asphalt Green sponsors the "Big Swim," the culmination of a larger program fighting to close the racial gap in swimming. Our thinking about what we observed in our study of why so few African American and Latino/a students are learning computer science would never be the same after reading this article.

We recognized swimming as a sport with mostly white athletes, but it was the article's subtitle, "Closing Swimming's Deadly Racial Gap," and the statistics in the opening paragraph that grabbed our attention: African American children are as much as *three times more likely* than white children to drown.[1] This number shocked us and disrupted our linear pattern of thinking. The issue was not solely about integrating another activity such as tennis or skiing, or for that matter computer science. Because of the racial gap in swimming, some children lose their lives.

The article went on to explain how the racial gap in swimming was born during slavery, continued on through the violence of Jim Crow, and has created a world of higher numbers of African American children drowning as well as a competitive sport that is "bereft of minorities." But what was the historical connection all the way back to slavery? And how had this persisted for so many years? We began to read all we could to learn more about the history of swimming, the reasons behind these tragic drowning statistics, and why swimming continues to be a "white sport."

We share what we learned about these issues in chapter 1, because they have become for us a big part of the "why we write this book." We were appalled when we learned about the historical legacy that follows swimming today, the toll it has taken—not only on the African American community, but also on other communities of color—and the belief systems that have arisen over the years to justify the segregated state of this sport. Simultaneously, the themes that emerged from the history of swimming segregation clarified for us the larger patterns we were seeing in our study of computer science. The unexpected parallels between segregation in swimming and underrepresentation in computer science then became the central metaphor of our work.

To be sure, computer science and swimming are vastly different activities—swimming is a physical activity with a long and violent past, and computer science is a cognitive activity and one that has emerged in the post–civil rights era—but the race gaps in the two arenas are parallel in many ways. The study of each field shows how access denied, combined with belief systems that rationalize this lack of access, translate—over the short and long term—into inequalities in knowledge, interest, and ultimately participation. And while a lack of participation may at first appear benign, closer study reveals the harm that can come from it. So the more we can learn by seeing the same processes at work across varied and dramatically different activities, the more insights we obtain about inequality and segregation, and how they are fueled in our society.

This, then, explains our title. Through our study of why so few African Americans and Latino/as are learning computer science, we have learned how in computer science, as in swimming, people of color have been denied access (and in the case of swimming, *violently* so) to facilities, resources, and critical learning opportunities. Further, in both cases, the underrepresentation is rationalized, and made to seem as if it is based on a "natural sorting" process of innate propensities and capabilities, instead of deep structural inequities (Kao 2000). As a result, lives continue to be at risk, and in education as in swimming, too many young people are tragically and unconscionably "stuck in the shallow end."

Our investigation at three Los Angeles high schools reveals how these inequities are created and reproduced. We identify "virtual segregation" as an insidious phenomenon that occurs when we are led to believe that we are moving toward equality, and pretend that everyone has a chance and a choice. In reality the histories have been so different, the playing fields so uneven, the chasm so deep and wide, that people are living in two different worlds, receiving two different and very unequal types of educations, opportunities, and levels of knowledge.

A Lens on a Much Larger Issue

We are talking with Jontille, an African American eleventh grader, about why so few African American and Latino/a students are enrolled in computer science classes at her predominantly African American Los Angeles public high school.[2] "The minorities—Hispanics, African American kids," she surmises, "they're not really interested in it." Reflecting on the issue a bit longer, however, Jontille digs deeper to detect an underlying cause, adding:

> But I think that's only because they haven't been really shown how to work with computers. So, therefore, their interest lies elsewhere. But I noticed that a lot of the Caucasian students, they're into technology, and a lot of the Asian students [too]. . . . But I think that if they [African American and Hispanics] knew that they had more access to it, that they would do it, you know?

Her friend, Nia, also African American, offers another perspective on the racial and ethnic makeup of the world of computing: "I think minorities are . . . are scared, you know, to jump into the future because what it looks like is only Caucasians should be in that industry."

Jontille and Nia are 2 of the 185 students we interviewed for our study into why so few African American and Latino/a high school students are learning computer science. The responses and narratives provided by these students as well as their teachers raise fundamental questions about inherent interest, access to resources and appropriate classes, images of a field like computer science, and issues of race and ethnicity. These are issues we worked to understand and disentangle in our investigation of who does—and does not—study computer science.

Commenting further about "not knowing enough" about computers, Jontille reflects on what this means: "I think I'm going to have to take another computer class because . . . with all the technology moving so fast, I don't know enough. I don't know enough about computers, I think, and I think I'm going to get left behind in that area and I do not want to be behind."

Technology is "moving so fast." Computer science is a discipline that is serving as a critical instrument of innovation from the sciences to the arts, and it is transforming the ways we live our personal and professional lives. Despite the centrality of computer hardware and software development in today's world, only a narrow and exclusive band of our population is learning the skills and techniques imparted by computer science. Why is this the case?

Starting in 2000, we were funded by the National Science Foundation (NSF) to investigate why so few African American and Latino/a high school students were studying computer science.[3] The NSF was concerned about the underrepresentation of minority students in the field, and the overall drop in the interest and numbers of students studying the subject.[4] We are not computer scientists but rather a team of social scientists, long committed to understanding the factors that undermine equity in education. We were drawn to identifying the sources of these particular instructional disparities at a time when educational and economic opportunities are increasingly intertwined with computer science, and in an era when the youths of all races and genders are virtually dependent on the use of technology for their entertainment and social lives.

The story we tell takes place in three different schools in Los Angeles. The first school is an extremely overcrowded facility in East Los Angeles with an almost entirely Latino/a student population. The second one is an aerospace mathematics science magnet in mid–Los Angeles with a predominantly African American population. In both of these schools with high numbers of students of color, only introductory computing courses covering basic low-level "cut-and-paste" skills are currently available. Our third site is a neighborhood school surrounded by mansions overlooking the Pacific Ocean. Even though it is located in a white and wealthy community, two-thirds of the school population are students of color who travel from all over Los Angeles to attend this well-funded campus. Unlike our first two schools, students here have opportunities to study computer science beyond basic introductory skills; there is a relatively wide array of computing-related courses, including college-preparatory Advanced Placement (AP) classes. Yet we soon notice that even though advanced computing courses are available, few students of color at the school are enrolled in them.

Computing is the kind of high-status knowledge that taps a student into the grid of twenty-first-century opportunities. It is tempting to think that because it is a technical activity, it should be free of the biases that affect more obviously culturally situated fields like business or law. Nevertheless, few students of color are "choosing" to learn computer science at all three of these schools, even those students who are in a setting where the courses are offered. What is going on here?

Our research took place as politicians and policymakers were increasingly worried about the overall decline in interest as well as expertise in mathematics and science in the United States, fearful that America was losing its innovative edge.[5] We approached this question a bit differently, following the perspective of mathematics educator Robert Moses that the knowledge gap in math, science, and technology could turn students of color into the "designated serfs of the information age" (Moses and Cobb 2002, 11), and that this is a civil rights issue for the twenty-first century.[6] We believe that opportunities to learn computer science, independent of its value as a stepping-stone to proficiency in an age of technology, are indicative of opportunity more broadly defined.

This recognition of the importance of computer science was a central motivator for us as we undertook this project, especially at the outset. Then, as often happens in research projects such as this, as we went deeper into our subject, issues began to emerge that suggested a much larger story than we had originally intended. We soon realized that our study of the "computer science pipeline" was a lens into what Jonathan Kozol (1992) more broadly refers to as the "savage inequalities" in our schools. Specifically, our research was revealing how students of color in low-resourced schools are much more generally being denied the learning opportunities and preparation they need and deserve for the changing economic reality of the twenty-first century. Our research also was revealing how inequality gets produced in our society.

As we observed the daily details of inequality unfolding, we realized the broader implications of what we were witnessing as well. The mechanisms and beliefs that channel students of color away from computer science do the same thing in other areas of high-status knowledge.[7] The end result is that students of color by and large are being denied a wide range of occupational or educational futures. And so we ultimately came at our research question with another motivation: to reveal the much broader implications of these computer science inequities. To the extent that there is a race gap in this field, and to the extent that there are disparities in access to and the quality of educational opportunities, our inquiry tells us much about the state of our educational institutions, and how schools are limiting the reach and achievement of their students. Therefore, in the end, it can be fairly stated that our book is not really about computer science. Or better said, it is about computer science, but it is also about a lot more.

Before we can move into these broader issues, we must first establish the current state of computer science, and the statistics reveal the depth of the racial and ethnic divide in the field. A recent survey showed that at the nation's PhD-granting departments of computer science and engineering, just 8 percent of the bachelor's degrees and 4 percent of the master's degrees in computer science are awarded to African Americans and Latino/as (Zweben 2006). In California, where underrepresented students of color make up a combined 49 percent of the high school student population, they account for only 9 percent of the AP computer science test takers (California Department of Education 2005; College Entrance Examination Board 2005). These statistics are especially disturbing in a minority-majority state that gave rise to and nurtures Silicon Valley and houses several of the nation's top computer science programs. Given these statistics, the question we ask is obvious: How does this field remain segregated in the midst of so much professed concern about the problem? Before we can answer that question, we must first more clearly explain what we mean by computer science.

What Is Computer Science, Anyway?

Often when people hear about our research, they assume that we are investigating students' learning of computer *literacy* skills such as word processing or Internet and Web searching. These literacy skills are without a doubt a twenty-first-century necessity, and all endeavors in schools and communities to assure all citizens access to these skills are critically important. But we are looking beyond computer literacy skills, and instead examining who is and is not learning computer *science*. So what is computer science, anyway? Succinctly—albeit broadly—defined, "computer science (CS) is the study of computers and algorithmic processes, including their principles, their hardware and software designs, their applications, and their impact on society" (ACM K–12 Task Force Curriculum Committee 2003, 6).

An algorithm, in simple terms, can be understood as a list of well-defined instructions for accomplishing a task. Within the context of computer science, algorithms take the form of computer programs, and are essentially the language with which we tell computers what we want them to do and how they should do it. Therefore, in lay language, one could say that there is a problem-solving process at the foundation of computer science. The complexity and analytic thinking involved in this process is valuable to know within as well as across an increasing number of professions.

A "users' guide" for Stanford University computer science majors describes how computer science is a remarkably young field, yet a revolutionary one:

> It was just over fifty years ago that the first electronic computers were developed, and there was no recognition at the time of computer science as a field of study separate from electrical engineering or mathematics. Over time, as computers became increasingly powerful and were applied to more and more tasks, people began to realize that the task of programming those computers to solve problems was an extremely difficult problem requiring theories and practice unlike those used in existing fields. Computer science—the science of solving problems with the aid of a computer—became a new discipline in its own right.[8]

This new discipline is now having a seismic impact across disciplines and professions. In an article titled "All Science Is Computer Science," author George Johnson (2001) writes about computer science in the twenty-first century: "As research on so many fronts is becoming increasingly dependent on computation, all science, it seems, is becoming computer science." While we are not prepared to argue that all science is becoming computer science, there is no doubt that computer science is having a transformative impact across all walks of life, and that it is key to innovation across the world. Occupations, industries, and undertakings as diverse as HIV and influenza research, air safety, psychological inquiry, the elimination of world hunger, studies of the world's climate, and the Human Genome Project, just to name a few, would all be crippled without the benefit of computer science. On a grand scale, computer science is transforming knowledge and the scientific questions that can be investigated.[9]

It is not just science that is being transformed. In the creative arts, the changes brought on by computation are also sweeping. Motion pictures today are a "window into an ungodly amount of computation and engineering innovation and talent" (Taub 2003). With each new round of film releases, the use of technology ratchets up even more. The same transformations are happening in music and theater, where advanced technologies are used in set design, lighting, and many aspects of staging for large-scale productions. Similarly, graphic designers, whose tool kits once consisted of paper and pencils, must now have significant technological expertise to make a living at their art.

In her widely circulated thought piece called “Computational Thinking” (2006), Jeannette Wing, the director of the NSF’s Computer and Information Sciences and Engineering Division, has coined a phrase in an attempt to further define computer science. As described on the Carnegie Mellon School of Computer Science Web site, “Computational thinking is a way of solving problems, designing systems, and understanding human behavior that draws on concepts fundamental to computer science. Computational thinking is thinking in terms of abstractions, invariably multiple layers of abstraction at once. Computational thinking is about the automation of these abstractions.”[10] In her role at the NSF, Wing aspires to change the image of computing for the general public and increase the understanding that often without us even realizing it, computing touches our daily lives. She wants to inspire everyone to learn computational thinking, to have the tools that computer science offers, because computer science is now integral to and enhances many professions, whether in computer science or elsewhere.[11]

Not only is overwhelming job growth in information technology and engineering projected over the next decade; computer science is one of the keys to innovation in general.[12] Thomas Friedman (2005), in his best-selling book *The World Is Flat*, argues, for example, that our economy most needs “versatilists,” people who have expertise in some domain *and* technology.[13] And in a much-cited book, *The New Division of Labor: How Computers Are Creating the New Job Market*, Frank Levy and Richard Murname (2004), an economist and educator coauthor team, analyze how computers are now carrying out the “rules-based part of jobs” so that skilled people can focus on the nonroutine parts. This means that well-paid, interesting, and nonroutine jobs will require a new type of expert thinking—that is, “the ability to bring facts and relationships to bear in problem-solving, the ability to judge when one problem-solving strategy is not working and another should be tried, and the ability to engage in complex communication with others” (6).

For an increasing number of jobs in the new economy, then, the cognitive bar has been raised, requiring a firm understanding of the problem-solving processes. And as Levy and Murname note, the line that marks the “digital divide” keeps shifting. In the 1980s when people spoke about the digital “haves” and “have-nots,” it was about who knew how to use a keyboard and a mouse. By the 1990s, it was who knew how to use the Internet. Now, the economic and career landscape is completely transformed, and intellectual capabilities including "engaging in sustained reasoning, managing complexity, testing a solution" are all key (43).

But it is not just the economic landscape that is changing. The technological world is reshaping culture and political participation (Chadwick 2006). Issues and events that have profound consequences for the way we live our lives (from the creation of jobs, to scientific discovery, to fair voting procedures, to communication networks) are all being reshaped by technological knowledge. Who has this knowledge and who does not is consequential for democracy. What John Dewey (1916) said almost a century ago is still true today: education will only prepare people for life in a democracy when the educational experience is also democratic.[14] Unfortunately, *Stuck in the Shallow End* reveals how undemocratic our educational system still is in this technology age.

Our Study

Our study was sparked in 1999 when Jane Margolis, along with Allan Fisher, then Carnegie Mellon's associate dean of computer science undergraduate education, was conducting research at Carnegie Mellon on the gender gap in computer science. The research findings and resulting interventions, described in *Unlocking the Clubhouse: Women in Computing* (Margolis and Fisher 2002), had significant impact on increasing the numbers of females enrolled in Carnegie Mellon University's computer science program. Yet during the years of this study (1994–1999), the numbers of African Americans and Latino/as majoring in computer science (at Carnegie Mellon University and nationwide) remained extremely low (Margolis and Fisher 2002). Margolis committed her next research project to understanding what was happening at the high school level for students of color. It is during high school when students make academic decisions that have the most serious implications for their college and/or career opportunities.

In 2000, Margolis was awarded an NSF grant, and our project, titled "Out of the Loop: Why Are So Few Underrepresented Minority High School Students Learning Computer Science?" began. Our team was built, and over a three-year period we immersed ourselves in three Los Angeles high schools. We made regular schools visits, conducted formal and informal observations, and interviewed educators and 185 students in