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Computer Science Education in California

From Kindergarten to the Workforce: Findings and Policy Recommendations

Overview and Summary

As new technology grows, the demand for computer scientists[1] continues to increase. Between 2012 and 2022, the Bureau of Labor Statistics estimates that the number of computer scientists will increase by 15%.[2] Such an increase in demand is hardly surprising given the increasingly prominent role of technology in everyday life. What is more surprising is how slow California's education system has adapted to this increased demand. The outcry from executives in the technology industry has been nearly unanimous. There simply are not enough well-trained computer scientists coming out of U.S. universities to meet their demand for top computing talent.

This discrepancy raises many questions that framed the analysis of this report. First, what is the pipeline for students who are interested in computer science? Are California's schools providing computer science education to expose students to the field before they finish high school? Second, once students enter college, who decides to pursue a computer science degree and how successful are they in obtaining it? Finally, how does the production of computer science degrees relate to the continued demand for computer scientists in the foreseeable future? **This report intends to answer each of these questions, but also tie these distinct stages of the computer science pipeline together.**

The outcry from executives in the technology industry has been nearly unanimous. There **SIMPLY ARE NOT ENOUGH WELL-TRAINED COMPUTER SCIENTISTS COMING OUT OF U.S. UNIVERSITIES** to meet their demand for top computing talent.

The central findings that emerge from this report are:

- Current computer science course offerings, particularly in public schools, are not sufficient to prepare students for the demands of computer science degree programs regardless of student interest.
- The production of computer scientists in California colleges and universities is low considering the central role that the computer industry plays in the state's overall economy; further, there are few women and minority students represented among the degrees awarded and their numbers have either decreased or not improved significantly over the last quarter-century.
- The available computer science workforce projections all point to significant increases in the demand for computer science jobs through 2022. Based on this data, the current production of computer scientists in the California education system is not expected to fulfill the needs of this field in the twenty-first century.

PREPARED BY California STEM Learning Network

While there are a number of options to consider when it comes to strengthening the pipeline of computer science from kindergarten to college, it is important to note the small likelihood that any one change at any particular stage will help the supply of computer scientists meet demand. **California needs a comprehensive policy agenda for computer science, developed collaboratively by K–12, higher education, business and community partners, to overcome the present deficits and create a system that greatly expands access for all students**.

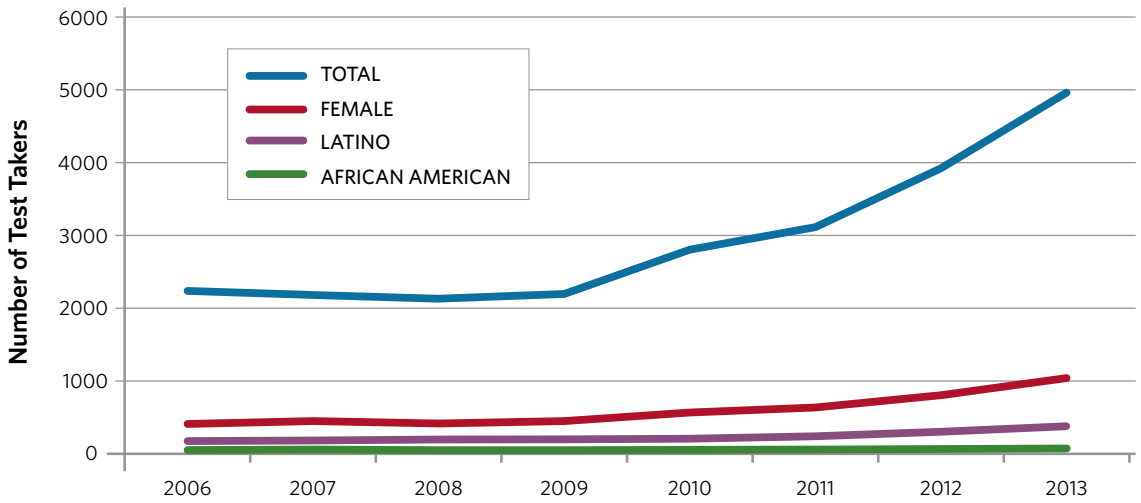
K–12 students have limited access to computer science courses

The Alliance for California Computing Education for Students and Schools (ACCESS) estimates that only 10% of students in grades 7–12 have taken a computer science course.[3] This means that as many as nine out of ten students will leave public school without having taken coursework in one of the fastest growing sectors of the economy.

AP Computer Science is one of the most frequently offered computer science courses across the state. AP Computer Science test takers' demographic information can indicate strengths and deficiencies in access to computer science in high schools.

NINE OUT OF TEN STUDENTS will leave public school **WITHOUT HAVING TAKEN COURSEWORK** in **ONE OF THE FASTEST GROWING SECTORS** of the economy.

AP Computer Science Test Takers by Group



Courses in computer science **DO NOT HAVE THE GROSS ENROLLMENT OR THE DIVERSITY** of enrollment to encourage students' interest in computer science and **PREPARE THEM FOR COLLEGE** level work.

- The number of AP Computer Science test takers increased from 2,224 students in 2006 to 4,964 in 2013. Those 4,964 test takers in California represent 16.8% of the nation's 29,555 test takers in 2013.[4]
- Female test takers grew from 452 in 2006 to 1,074 in 2013, but their share of overall test takers remained below 22%.
- The number of African-American test takers reached its peak of 74 test takers in 2013, a total of 1.5% of the state's test takers.
- The number of Latino students taking the test increased from 168 in 2006 to 392 in 2013.

The principal courses in computer science do not have the gross enrollment or the diversity of enrollment they need to encourage students' interest in computer science and prepare them for college level work in the field.

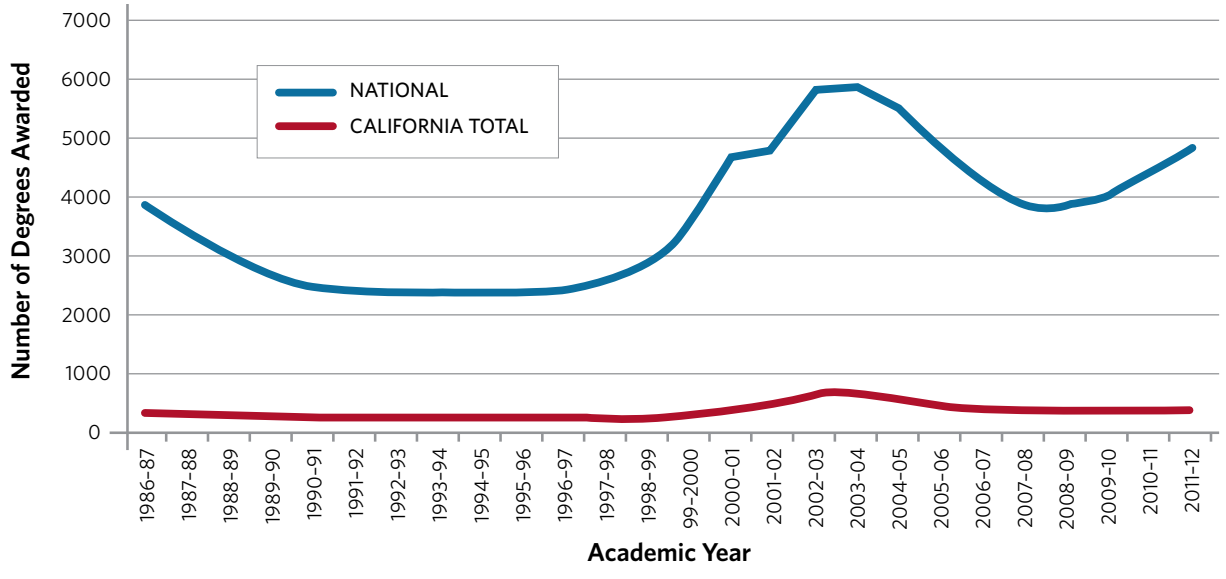
California's production of degrees has been flat while its share of the nation's computer science degrees has shrunk

More than 40,000 computer science bachelor's degrees were conferred in 1986 nationwide,[5] a number that would not be reached again until the second wave of computer innovation ended in 2003–04, when the "dot-com bubble" burst. In 2007–08, national degree production dipped below 40,000 for the first time since 1999–00. While a recent upswing in national degree production has brought that number close to 50,000, California's degree production tells a slightly different story.

Production of computer science degrees reached its peak in California in 2003–04 with 6,746 degrees conferred then rapidly hit its low just four years later in the post "dot-com" era with 3,484 degrees conferred. These numbers have been slowly increasing since 2009–10.

In terms of outcomes for underrepresented groups, the data show disappointing results. For example, in the 1986–87 academic year, 731 of the 2,295 degrees awarded in computer science were awarded to women, or 31.9% of degrees. However, in 2008–09 women only represented 11.4% of degrees awarded, with the number climbing back up to 13.7% in 2011–12. While the share of Latino students earning degrees in the field grew to 10.9% in 2011–12, they are still significantly underrepresented compared to their overall numbers enrolled in higher education. Meanwhile,

Computer Science Degrees Awarded



the share of computer science degrees awarded to African-American students has never surpassed 2.7% of degrees awarded at UC/CSU.

California's national share of Computer Science degree production reached a peak in the "dot-com" era, awarding 11.4% of the nation's computer science degrees in 2003–04, but has shrunk since. Two of the three lowest years in terms of California's share of the nation's computer science degrees came in the last two years in which data was available (2010–11 and 2011–12) at 8.2% for both years.

Getting students into computer science degree programs is only part of the story. The other half is told during those students' college careers. In a national sample of college students, 6% of students declared their intention to major in computer/information sciences. Of that 6%, 59% of students left their respective programs including 28% who changed to a non-STEM major and 31% who left postsecondary education without a degree.[6]

Due to the fact that computer science relies on the mastery of technical skills, Associates' and certificate programs are useful pathways to get people up to a level of knowledge needed for employment. Associates' degree programs rose steadily from the early 1990s to the 2002–03 academic year. After peaking at 1,708 degrees awarded in 2002–03, the number of degrees awarded declined steadily to 758 in 2007–08 with a slow increase in degrees awarded during the past few years. Certificate programs have proved to be more volatile, however. After a steady increase to 2,346 in 2002–03, the number of certificates awarded declined to 1,707 degrees in 2010–11.

Computer science jobs will continue to increase for the foreseeable future

Nationally, there were 5.7 million STEM job postings in 2013, of which 76% required a Bachelor's degree at a minimum. Currently, there are 2.5 entry-level job postings for every STEM graduate.[7] With respect to STEM job openings, the top five occupations in terms of number of job openings are all fields which are likely to be dominated by people with some computer science training: computer support specialist, software developer/engineer, systems analyst, network/systems administrator, and database administrator. This demand for STEM skills, particularly computer science, illustrates the influence that STEM and computer science have on the overall economy. It is important to note that not every computer scientist will look for a computer science job, but will have some level of preparation for the technical demands of other STEM professions.

CALIFORNIA'S NATIONAL SHARE of Computer Science degree production **REACHED A PEAK** in the "dot-com" era, awarding 11.4% of the nation's computer science degrees in 2003–04, **BUT HAS SHRUNK SINCE.**

California is a prominent player in the STEM jobs market with 39% (757,996) of its current job postings in STEM fields, 44% (332,564) of which were specifically in information technology.[8] Looking ahead, California will demand 1.065 million STEM jobs in 2018, compared with 894,860 in 2008.[9] More specifically, 49% of those jobs will be in computer occupations.

Many barriers exist for Computer Science education in K–12 and higher education

There exists a number of differing barriers to increased access and degree production in computer science in K–12 and higher education.

K–12 BARRIERS:

- In California, computer science counts as a general college-preparatory elective, instead of a math or science elective, meaning it is competing with a wide array of other elective courses in district budgets.
- Limited access to trained personnel because of: a) credentialing limitations, b) private sector competition, c) district schedules/budgeting.

HIGHER EDUCATION BARRIERS:

- Colleges and universities do not have unlimited flexibility in supplying computer science education due to staffing, space, and other limitations.
- The vast array of technologies available and rapid pace of technological advancement surpasses the ability of universities to provide expertise in every computer language, technological skill, etc.

California needs a comprehensive agenda for Computer Science education

As this report indicates, no one part of the education system can fully explain the shortage of computer scientists available. It is not as simple as pouring resources into teaching computer science in elementary schools and expecting colleges to produce more computer scientists several years later. Only a comprehensive agenda for computer science education will produce the desired result of improving access to create more highly trained computer scientists.

A comprehensive plan for computer science education in California should include:

1. **Establish standards for computer science education** that are aligned and integrated with state's new Common Core Math & Language Arts standards and the Next Generation Science Standards. The Computer Science Teachers Association (CSTA) has already developed a set of standards for K–12 that can serve as a starting point.

2. **Develop strategies to ensure that all K–12 schools have access** to the technology, curriculum, and resources they need to provide high quality computer science education.

3. **Identify opportunities to build capacity of teacher preparation and professional learning systems** to address the shortage of qualified computer science teachers and teachers with sufficient training to incorporate computer science into their lessons.

4. **Create new programs and incentives to ensure students from underrepresented groups** and female students have access to high quality computer science education.

5. **Strengthen partnerships between K–12 and higher education institutions** to better align K–12 computer science education with computer-related degree programs.

It is **NOT AS SIMPLE AS POURING RESOURCES INTO TEACHING COMPUTER SCIENCE** in elementary schools and expecting colleges to produce more computer scientists several years later.

While there are many different potential avenues for strengthening the field of computer science to bridge the gap between the education system and the needs of the state and national economies, the gap will not solve itself. Computer science stakeholders, including schools, universities, businesses, parents and students will all need to be involved to strengthen the pipeline of computer science education and ensure the vitality of the state's high-tech economy.

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Endnotes

1 Just as computers have evolved, so has the field of computer science. This report will use the Computer Science Teachers Association definition of computer science as "the study of computers and algorithmic processes, including hardware, software, and programming." While some of the recent debate around computer science has been focused on coding, it is important to note that computer science is not a homogenous field, but has many branches that go well beyond programming and delve into engineering and other disciplines.

2 Employment Projections

3 Bernier (2012), 1.

4 Data pulled from California Fingertip Facts on Education: http://www.cde.ca.gov/ds/sd/cb/ceffingertipfacts.asp

5 Soper, (2014).

6 Chen and Soldner (2013), 15.

7 Real-Time Insight into the Market for Entry-Level STEM Jobs (2014).

8 Real-Time Insight into the Market for Entry-Level STEM Jobs (2014).

9 Carnevale (2010).

Acknowledgements

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About CSLNet

California STEM Learning Network's (CSLNet) mission is to prepare the nation's most STEM capable graduates by coordinating and activating a multi-sector statewide network representing all STEM stakeholders. Through this cross-sector collaboration, CSLNet fosters innovation and helps to scale and sustain high-quality STEM teaching and learning for all students. Learn more at our website www.cslnet.org.