Charge to the Commission on Computer Science, Information Technology and Related Career Fields

Jobs in computer science, information technology, cybersecurity and related fields are a large and growing sector of the U.S. economy. By one estimate, by the year 2020, some 3,782,210 jobs in the U.S. will be in the broad area of computer science (see Table 1). While 70 percent of these jobs will require a bachelor's degree or higher, about one-quarter will require some college or an associate degree. Overall, by 2020, out of 9.2 million STEM (Science, Technology, Engineering and Mathematics) job openings, 4.6 million will be computer-related.[1]

Jobs in computer science-related fields pay well and are in high demand. In 2012, the average median salary of jobs in computer science and information technology was more than $78,000.[2] Three computer science and information technology-related occupations were among the top 10 most in-demand jobs advertised online in 2013; software developers were the most highly sought-after, with a mean salary of $92,000.[3] Jobs in cybersecurity, which pay an average salary of $100,000, are on the rise in the wake of numerous highly publicized data breaches involving millions of compromised credit cards and other personal data. [4]

Such jobs are also more stable. Post-Recession, computer science graduates have experienced much lower unemployment rates — just 4.9 percent in 2012 — compared to graduates with other in-demand college degrees like business or engineering.[5]

Table 1: Projected Workforce Needs in Computer Science-Related Occupations by 2020[6]

	Education Level of Occupations					Percent of Total			
Occupation	High School	Some College	AA	BA+	Total	HS	SC	AA	BA+
Computer systems analysts	13,810	99,240	0	484,700	597,800	2	17	0	81
Computer software engineers, applications	17,610	42,990	35,520	496,870	593,000	3	7	6	84
Computer support specialists	82,150	127,580	94,630	233,950	538,310	15	24	18	43
Network system & data communication analysts	36,760	106,930	40,350	270,380	454,420	8	24	9	60
Computer software engineers, system software	13,460	32,870	27,150	379,850	453,330	3	7	6	84
Network & computer systems admin.	29,690	86,360	32,590	218,370	367,000	8	24	9	60
Computer programmers	29,970	32,270	43,200	253,080	358,530	8	9	12	71
Computer specialists, all other	25,290	30,430	25,350	130,700	211,770	12	14	12	62
Database admin.	3,370	8,240	6,810	95,220	113,640	3	7	6	84
Operations research analysts	5,110	3,620	5,670	49,300	63,690	8	6	9	77
Computer & information scientists, research	2,490	7,230	2,730	18,280	30,720	8	24	9	60
Total	**259,710**	**577,760**	**314,000**	**2,630,700**	**3,782,210**	**7**	**15**	**9**	**70**

But computer science-related jobs are becoming much harder to fill. According to a recent analysis of Bureau of Labor Statistics (BLS) data, by 2020, there may be 1 million more jobs in computer science-related fields available than there are students prepared to fill them.[7] And in the area of cybersecurity, there may be a global shortage of over 1 million workers. BLS

data show that there were 75,100 openings in 2012 for information security analysts, and the job market in this area is projected to grow 37 percent from 2012 to 2022. Given this shortage, the U.S. government has invested heavily in training cyber experts to protect the nation's military and civilian computer systems, and Ashton Carter, the U.S. Defense Secretary, has even said that "cyber may one day become the sixth service branch."[8]

Many employers report struggling to find workers with the advanced skills demanded in these career fields. A recent Brookings study of STEM job openings found that key computer skills carry a high wage premium but take the longest for employers to fill — as much as 40 days or more for some high-value programming skills.[9] That could explain why many businesses are seeking highly-skilled workers from overseas. In 2015, U.S. Citizenship and Immigration Services received a record-breaking 233,000 applications for skilled-worker visas (H-1Bs) compared to the previous year's total of 172,500. Only 85,000 such visas are allotted each year, mainly for workers in STEM and computer programming fields.[10]

Troublingly, the college-degreed workforce in computer science-related fields is small and lacks diversity. Code.org, a non-profit organization that advocates for increased access to quality computer science education, cites National Science Foundation (NSF) data showing that only 2.4 percent of college graduates have a degree in computer science, down from a peak of 2.5 percent in 2004.[12] The Association for Computing Machinery uses NSF and other data to show that just 18 percent of bachelor's degrees in computer science are earned by women, 11.5 percent by African American students and 8 percent by Latino students.[13]

Table 2: Computer Science Education in SREB States[11]

SREB State	CS Counts as Math or Science for Graduation	Clear CS Teacher Certification Pathways	Clear CS Curriculum Standards
Alabama	Yes	No	No
Arkansas	Yes	No	No
Delaware	No	No	No
Florida	Yes	No	No
Georgia	Yes	Yes	Yes
Kentucky	Yes	Yes	No
Louisiana	No	Yes	No
Maryland	Yes	Yes	No
Mississippi	No	Yes	No
North Carolina	Yes	No	No
Oklahoma	Yes	No	No
South Carolina	No	No	No
Tennessee	Yes	No	No
Texas	Yes	Yes	Yes
Virginia	Yes	Yes	No
West Virginia	No	No	No

Despite the obvious and overwhelming need to produce more graduates in computer science and information technology-related fields, computer science-related courses remain "marginalized"[14] or non-existent in elementary, middle and high schools nationwide. Without a place in the required curriculum, computer science is simply not a priority for most schools. As Table 2 shows, computer science counts as a math or science credit toward graduation requirements in 11 SREB states and 27 states nationwide. No states require students to take computer science to graduate. Few high schools offer career pathways designed to introduce and prepare students to pursue advanced studies in the computer science field. And of the more than 1 million students who took Advanced Placement (AP) exams in STEM-related subjects in 2012, just 24,782 — under 3 percent — took the AP Computer Science A exam.[15]

Part of the problem lies with persistent confusion at the national, state and district levels over what computer science is, how to teach it and who can teach it. Organizations like the Computer Science Teachers Association (CSTA), for example, are leading efforts to clarify how *computer science* — which encompasses the conceptual, experimental and practical study of computers, algorithms, hardware, software, and their impacts on society — differs from *educational technology* (the use of computers as a learning tool in instruction) and *information technology* (the use of technology to manipulate information, as with software, networks, communication systems and digital media).[16] Common to both computer science and information technology are essential math, literacy, critical thinking and problem-solving skills that allow students to analyze, visualize and apply knowledge from multiple disciplines to address problems in the real world.

> *"Computer science is not about point and click skills. It is a discipline with a core set of scientific principles that can be applied to solve complex, real-world problems and promote higher-order thinking. In short, knowledge of computer science is now as essential to today's educated student as any of the traditional sciences."*
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> — CSTA Curriculum Improvement Task Force (2005), p. 13

As Table 2 shows, most states have much work to do to bring their computer science standards into alignment with nationally recognized standards.[17] Code.org reports that just two SREB states, Georgia and Texas, have clear computer science curricular standards. Further, most states' computer science curricula do not meet the CSTA's standards for K-12 education; even most state college-ready standards and the Next Generation Science Standards do not include elements of computer science.[18]

States also need help sorting out their teacher certification and licensure requirements and processes. As the CSTA reports, many states have no certification programs for computer science teachers, or have programs with "no connection to actual computer science content and pedagogical issues."[19] Many teachers with strong backgrounds in computer science-related fields, including those from industry backgrounds, find themselves unable to teach courses they are imminently qualified to teach because state certification requirements demand the completion of courses their state postsecondary institutions do not offer.[20] As Table 2 shows, less than half of SREB's 16 states have clear computer science teacher certification processes. Such processes need to take into account the many different backgrounds from which talented computer science teachers may come, whether they be new or veteran teachers with a traditional university background, or alternatively certified career and technical education (CTE) teachers.[21]

Focus of the Commission

SREB's Commission on Computer Science and Information Technology is charged with recommending state policies and practices that will increase access to high-quality educational experiences that help more young people explore jobs in computer science, information technology and related areas; complete challenging career pathway course sequences that begin in high school and lead to postsecondary certificates, credentials or degrees at the associate's level and higher; and secure well-paying jobs in these exciting fields.

The Commission will address the following questions:

- What is the projected labor market demand for jobs in the broad fields of computer science, information technology and cybersecurity in the SREB region?
- What are the common academic, technical and soft skills needed in these broad career fields?
- What kinds of educational and work-based learning experiences will best prepare young people for success in postsecondary education and careers in these fields?

- What can educators do to encourage middle and high school students, including underrepresented and nontraditional students, to pursue further studies and careers in computer science, information technology and cybersecurity?
- What should career pathway course sequences[22] that link high school studies to postsecondary programs in these fields look like?
- What promising policies, curricula, programs and practices currently exist that help states, districts, postsecondary institutions and schools enhance student achievement and meet workforce demand for existing and emerging jobs in computer science, information technology, cybersecurity and related career fields?
- What major gaps in policy, curricula, programs and practices at the state, district, postsecondary and school level (e.g., graduation requirements, teacher certification policies and programs, perceptions of computer science, critical resources, etc.) hinder students from pursuing advanced studies and careers in these fields?

The Commission will answer these and related issues as it completes a final report that recommends actions SREB states can take to close gaps in policy and practice, prepare more young adults for success in further education and careers, and meet their current and future workforce needs.

ENDNOTES

[1] Kaczmarczyk, L., & Dopplick, R. (2014). *Rebooting the Pathway to Success: Preparing Students for Computing Workforce Needs in the United States*. Washington, DC: Association for Computing Machinery.
[2] http://www.bls.gov/ooh/computer-and-information-technology/print/home.htm.
[3] Carnevale, A. P., Jayasundera, T., & Repnikov, D. (2014). *The Online College Labor Market: Where the Jobs Are*. Washington, DC: Georgetown University Center on Education and the Workforce.
[4] Robertson, J., & Riley, M. (2015, July 9). Inside the Pentagon's Boot Camp for Cyber Warriors. *Bloomberg Businessweek*. http://www.bloomberg.com/news/articles/2015-07-09/inside-the-pentagon-s-boot-camp-for-cyberwarriors.
[5] Weinberg, C. (2015, July 10). Four Years Out, the Great Recession's College Grads Fared Well—if They Picked the Right Major. *Bloomberg Businessweek*. See http://www.bloomberg.com/bw/articles/2014-07-10/college-graduates-who-majored-in-most-tech-fields-and-health-care-during-the-recession-had-better-outcomes-than-business-students.
[6] Modified from Carnevale, A. P., Smith, N., & Strohl, J. (2013). *Recovery: Job Growth and Education Requirements through 2020*. Washington, DC: Georgetown University Center on Education and the Workforce. The authors used Bureau of Labor Statistics (BLS) data to generate these "middle of the road" (p. 5) estimates of projected workforce demand.
[7] See the source data used by Code.org for its analyses of the skills gap in computer science at https://docs.google.com/document/d/1gySkItxiJn_vwb8HIIKNXqen184mRtzDX12cux0ZgZk/pub.
[8] Robertson, J., & Riley, M. (2015, July 9). Inside the Pentagon's Boot Camp for Cyber Warriors. *Bloomberg Businessweek*. http://www.bloomberg.com/news/articles/2015-07-09/inside-the-pentagon-s-boot-camp-for-cyberwarriors.
[9] Rothwell, J. (2014). *Still Searching: Job Vacancies and STEM Skills*. Washington, DC: Metropolitan Policy Program at Brookings.
[10] Jordan, M. (2015, April 14). Skilled-Worker Visa Applications by U.S. Companies Reach High. *The Wall Street Journal*. See http://www.wsj.com/articles/skilled-worker-visa-applications-by-u-s-companies-reach-high-1429056123.
[11] Source: Code.org, using data from The Conference Board, the National Science Foundation, and the Code.org database.
[12] See http://www.nsf.gov/statistics/seind12/append/c2/at02-18.xls and http://www.nsf.gov/statistics/seind12/appendix.htm.
[13] Kaczmarczyk & Dopplick, 2014.
[14] See Code.org: https://code.org/promote.
[15] Kaczmarczyk & Dopplick, 2014.
[16] See Computer Science Teachers Association Task Force. (2011). *CSTA K-12 Computer Science Standards – Revised 2011*. New York, NY: Computer Science Teachers Association. See also CSTA Curriculum Improvement Task Force. (2005). *The New Educational Imperative: Improving High School Computer Science Education*. New York, NY: Author.
[17] CSTA. (2010). *Running on Empty: The Failure to Teach K-12 Computer Science in the Digital Age*. New York, NY: Author.
[18] CSTA Task Force, 2011 and Kaczmarczyk & Dopplick, 2014.
[19] CSTA, 2010, p. 15. See also CSTA. (2013). *Bugs in the System: Computer Science Teacher Certification in the U.S*. New York, NY: Author.
[20] CSTA, 2013.
[21] CSTA, 2013.
[22] Consisting of four or more related, progressively intensive courses. See SREB. (2015). *Credentials for All: An Imperative for SREB States*. Atlanta, GA: Author. http://www.sreb.org/CTECommission.