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White Paper

Education & Careers in the U.S.: The Future of Computer Science

Executive Round Table

About the Authors

Balaji Ganapathy
Head - Workforce Effectiveness, North America, Tata Consultancy Services

As the Head of Workforce Effectiveness, Balaji oversees the functions of Talent Management, HR Business Consulting, Corporate Social Responsibility, Employee Retention, and Diversity & Inclusion for over 22,000 employees of Tata Consultancy Services in North America. His primary responsibilities include coaching sales & business teams for new business acquisition, driving talent management & employee retention initiatives, leading the corporate sustainability initiatives & chairing the Diversity & Inclusion Council for TCS North America. Prior to this stint, as the Head of HR, CTO/R&D, Balaji was part of TCS Corporate Technology Board & spearheaded the mandate for institutionalizing a culture of innovation across TCS. Ganapathy has been a speaker at numerous venues, presenting a range of topics relating to business, human resources & the information technology industry. He is an active advocate of deriving social good through the confluence of public, private & non-profit partnerships. He holds a Post Graduation in Human Resources Management from Xavier Labor Relations Institute (XLRI), Jamshedpur and a Bachelor of Technology from College of Engineering, Trivandrum

Caitlin Olson
CSR Program Manager, STEM Initiatives, Tata Consultancy Services

Caitlin is a results-driven non-profit management professional with entrepreneurial passion. She has over 19 years experience in creating social outcomes through program development, management, fundraising, communications and marketing. Over the past decade, she has served as the Executive Director of Project Rebirth, the Director of Program Partnership Initiatives at The National September 11 Memorial & Museum, and the Executive Director of Families of September 11. At TCS our Corporate Social Responsibility efforts in the geography have matured over the past few years, as we scaled up our community engagement efforts, partnerships with national-level nonprofits, and expanded the grassroots-level employee volunteering efforts across regions. TCS is committed to help address national issue of STEM Education & Technology Inclusion, in both the US and Canada. Caitlin will be responsible for leading the scaling up of the TCS goIT Student Technology Program to over 10 cities in the US and Toronto, Canada; and drive our STEM partnerships with nonprofits such as NPower, STEMconnector®, US2020, and Million Women Mentors.

Ted Wells
Director, Strategic Partnerships, STEMconnector®

Ted Wells is the Director of Strategic Partnerships for STEMconnector® - an organization committed to improving the flow of information to stakeholders in STEM education. In his role at STEMconnector®, Ted manages a portfolio of projects relating to STEM K-12 education and workforce development. Clients include non-profit organizations, government entities and corporations. Projects include developing communications strategies, convening stakeholders and facilitating strategic planning. As the son of an engineer and an educator, this field is not far from his roots. He began his career as a French and Spanish teacher after attending Washington and Lee University. After teaching for 6 years, Ted attended graduate school in International Affairs at the Elliott School at The George Washington University focusing on International Economic Affairs and International Development. During his graduate studies, he completed internships at the Treasury Department, the Inter-American Dialogue, The Organization for International Investment, Tata and Wells Fargo. Prior to working at STEMconnector®, Ted operated a small business in the District while helping found a non-profit organization working in Haiti. He lives in the Columbia Heights neighborhood in Washington DC.

Cameron Wilson
COO and VP of Government Affairs at Code.org

Cameron is on assignment as Director of Public Policy for the Association for Computing Machinery. In 2010, he launched the coalition Computing in the Core with corporate and non-profit partners to bring attention to K-12 CS education.

Della Cronin
Computing in the Core

As vice president for legislative and public affairs at Washington Partners, LLC, a Washington, DC government and public affairs firm that specializes in education policy, Della Cronin brings a broad range of education, legislative and public affairs experience to the firm's team. Before coming to Washington Partners in 2005, Della worked for a broad array of education companies and interests—a corporate foundation, a Department of Education contractor and an advocacy group among them. She has managed corporate and national partnerships, as well as outreach and public awareness efforts. At Washington Partners, Della manages the firm's STEM education portfolio, and has been working with the Computing in the Core (CinC) and its members on concerns around K-12 computer science education since before the launch of the Coalition in 2010. She and her colleagues at Washington Partners have been helping CinC members develop and execute their advocacy strategy on Capitol Hill and communicate their concerns with the STEM education and business communities, among others. Della Cronin holds a B.A. in economics, with a minor in political science from Virginia Tech.

Jan Cuny
Program Officer of the National Science Foundation

Since 2004, Jan Cuny has been the Program Officer for the CISE Broadening Participation in Computing (BPC) program at the National Science Foundation. Before coming to NSF, Jan was a faculty member in the Computer Science departments at Purdue University, the University of Massachusetts, and the University of Oregon. Her research centered on programming environments for computational science. At NSF, Dr. Cuny founded the BPC program. It aims to significantly increase the number of students getting postsecondary degrees in computing, with an initial emphasis on those groups – women, minorities, and persons with disabilities – who have traditionally been underrepresented in computing. Dr. Cuny has been involved in efforts to increase the participation of women in computing research for many years. She was a long time member of the Computing Research Association's Committee on the Status of Women (CRA-W), serving among other activities as a CRA-W co-chair, a mentor in their Distributed Mentoring Program, and a lead on their Academic Career Mentoring Workshop, Grad Cohort, and Cohort for Associated Professors projects. Jan was also a member of the Advisory Board for Anita Borg Institute for Woman and Technology, the

Leadership team of the National Center for Women in Technology, the Executive Committee of the Coalition to Diversify Computing, and the Board of Directors of the Computing Research Association. She was Program Chair of the 2004 Grace Hopper Conference and the General Chair of the 2006 conference. For her efforts with underserved populations, she is a recipient of one of the 2006 ACM President's Awards and the 2007 CRA A. Nico Habermann Award.

Melissa Moritz
Vice President, Education Initiatives, Teach for America

Melissa Moritz is Vice President of Education Initiatives at Teach For America, where she works with the organization's 46 regions and national teams on recruiting, training and supporting excellent STEM teachers who go on to become lifelong leaders in STEM education. After graduating from MIT with a B.S. in Biology in 2006, Melissa joined the Teach For America corps as a middle school science teacher in New York City. In 2008, she joined Teach For America's staff as the Recruitment Director for MIT and other Boston-area schools. Melissa was recently honored as one of the 100 Women Leaders in STEM, a publication of STEMConnector. She believes passionately that all children should have the opportunity to experience the wonder of math and science. She resides with her husband in Washington, DC.

Claus Von Zastrow
COO of Change the Equation

Claus von Zastrow is the Chief Operating Officer and director of research for Change the Equation. Most recently, Dr. von Zastrow was executive director of the Learning First Alliance, a partnership of 16 major education associations that represent over ten million parents, educators and policymakers. At the Alliance, he worked with the executive directors and elected leaders of Alliance member organizations to facilitate collaboration at every level of the education system and promote the continual and long-term improvement at public education. Prior to joining the Alliance, Dr. von Zastrow was at the Council for Basic Education where he published research on the impact of state and federal policy on school practice. He also served as a policy director at the National Alliance of Business, where he developed or managed policy initiatives to improve student achievement at all levels, promote universal access to higher education, and formulate sound workforce development strategies focused on lifelong learning.

The rapidly growing need for a work force with skills in science, technology, engineering, and mathematics (STEM) poses a considerable challenge for U.S. companies. By 2018, it is expected that there will be a shortage of 230,000 STEM employees. More than 70 percent of the STEM jobs will be in computer science (CS).

To address the challenge, Tata Consultancy Services (TCS), an IT services, consulting, and business solutions organization, joined with STEMconnector®, an advocacy organization for STEM education and careers to host an executive round table.

Computer Science Executive Round Table on Education & Careers in the U.S., an event held on September 6, 2013, at the National Press Club in Washington, D.C., brought together more than 30 executives, government officials, and thought leaders. The round table discussions focused on the convergence of policy, advocacy, and outreach to assess progress at the federal and state level, and recommend next steps for cross-sector collaboration. The analysis and deliberation resulted in a blueprint for addressing the key CS issues. This white paper shares the insights from the round table discussions.

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Introduction

On September 6, 2013, TCS, an IT services, consulting and business solutions organization, joined forces with STEMconnector®, an advocacy organization for STEM education and careers, to host an executive round table to bring much needed attention to CS—from the perspectives of education, policy, workforce, and career.

Computer Science Executive Round Table on Education & Careers in the U.S., an event held at the National Press Club in Washington, D.C., brought together more than 30 executives, government officials and thought leaders, who share a common cause- increasing students' interest and participation in computer science, advocating for a stronger educational policy, and implementing programs that will effectively excite and prepare students for careers in CS.

The participants included representatives from the following organizations: Information Technology & Innovation Foundation; Dassault Systèmes Americas; Code.org; White House Office of Science and Technology Policy (OSTP); U.S. News & World Report; U.S. Chamber of Commerce Foundation; Smithsonian Science Education Center; Georgetown University Center on Education and the Workforce; American Institutes for Research; My College Options; Million Women Mentors (MWM); NCWIT; NSF; Teach for America; National Math & Science Initiative; National Girls Collaborative Project; National 4-H Council; Digital Harbor Foundation; Project Lead the Way; KPMG; and Cisco.

The event was designed to assess the current status of CS education and careers at a national and state level, and then create a blueprint for addressing the key issues through cross-sector collaboration.

Participants at the round table hit upon a variety of CS gap issues, including:

- Public policy landscape and advocacy strategies for CS education at a federal and state level.
- Initiatives of the Obama administration, industry groups, and formal education institutions to influence public policy and education reform.
- Nationwide data presentations on student interest in CS education and current and future trends in CS jobs.
- Implementation strategies, successful national programs (in-school and out of school) and CS mentoring.
- Corporate engagement, including funding strategies, advocacy, and employee volunteerism, as tool to address the CS education issue.

This white paper shares the findings of the day-long round table discussions. Excerpts from participant presentations are included in this paper to provide various points of view related to the future of CS education in the U.S. They also provide insights into how CS education directly impacts careers in the field of IT and the measures that need to be taken immediately.

Computer Science: The Present and the Future of STEM

At STEMconnector®, we enjoy the fortunate position of being at the confluence of education, industry and public policy-making. These perspectives are often very different and we often find ourselves facilitating dialogue between these groups on challenging topics like CS.

When we partnered with TCS to host this roundtable, we had no doubt that the topic would generate a great deal of feedback and enthusiasm. This roundtable and the proceeding white paper are just the first steps in engaging the nation on this critical issue. We will be continuing this work into 2014 and beyond as a major priority for both organizations.

As you will see by the contents of this report, this is a very complicated issue. It also is one that will determine global competitiveness, our future prosperity, and our ability to meet some of society's greatest challenges in the current century and beyond.

The fact is that the jobs of today and tomorrow require computer skills. A U.S. Census Bureau report found that 50 percent of all STEM workers are classified as "computer workers".[1] Moreover, the number CS jobs will grow faster than all others after healthcare by 2020[2]. Clearly, this is a critical sector for our economy and a huge opportunity for our next generation for employment.

Computer Science is often equated with the 'T' in 'STEM' for technology. While certainly computers represent the embodiment of technology, they are also highly sophisticated tools that help solve complicated problems across disciplines. It's not an exaggeration to say today's geologist, biologist or chemist spends as much time utilizing information technology as he or she does in a laboratory with beakers, centrifuges and microscopes. Similarly, engineers use computers to solve complicated problems, such as building bridges, designing automobiles and airplanes. We also need specialized computer scientists with the skills to harness the full potential of computers.

We believe that a foundational understanding of CS is an indispensible skill for the workforce. We believe that we must develop expertise beyond foundational knowledge in much greater numbers to meet employer demand. Finally, we believe that we will only accomplish our goals through collaboration.

Our partners in this roundtable represent a sample of the entire educational and workforce ecosystem with the combined reach to 'move the needle' on this issue. We think you will find their contributions to be compelling and cut to the heart of the issue. We encourage you to join us in making increased access to and outcomes in Computer Science Education a national priority.

Edie Fraser and Ted Wells
STEMconnector®

[1] http://www.census.gov/prod/2013pubs/acs-23.pdf
[2] http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stem-complete.pdf

Forewords

Robert Atkinson
President, The Information Technology & Innovation Foundation

If the last half of the 20th century was all about atoms, the first half of the 21st century will be all about bits—embedding digital IT capabilities into all parts of our economy and society.

Indeed, IT is at the heart of the global innovation revolution, creating entire new industries, transforming existing industries into productive powerhouses, and changing the face of culture and society across the globe.

When we look to the future, we can expect more IT, because the global economy is growing ever more dependent on IT for innovation, productivity, and quality of life improvements. And new IT innovations are occurring regularly, including cloud computing, social networking, new kinds of mobile devices and apps, the 'Internet of Things' and Big Data analytics.

IT is not just the source of innovations, but also of companies and good jobs. In Deloitte's 2011 Technology Fast 500 Ranking, a ranking of the fastest growing high-technology firms in the U.S., two-thirds of the fastest growing companies were in the IT industry. And virtually all of the other companies employ IT workers. This is why between 2001 and 2011, employment in IT occupations grew more than 95 times faster than all jobs—and will continue to grow faster between 2010 and 2020. Moreover, these are good jobs, paying 74 percent more than average U.S. jobs.

Underlying this revolution is the discipline of CS. If the U.S. is to realize these benefits from IT, it will need to produce workers skilled in CS. Code does not write itself.

Unfortunately, we have a lot of work to do. From 1997 to 2009, the number of U.S. high school students taking Advanced Placement (AP) tests doubled, but those taking the Computer Science (AP) version of the test increased by just 1 percent. The result is that in 2009, more than three times as many high school students took the Art History AP test compared to those who took the Computer Science test. At the undergraduate level, it is not much better. From 2000 to 2009, bachelor's degrees increased by 29 percent, but increased just 3 percent for CS.

The effort to increase the understanding of the importance of CS education among the public, industry, and policymakers is critical. To that end, we praise TCS and STEMconnector® for leading The Future of Computer Science Executive Round Table, for promoting awareness of the CS challenges and for helping all of us identify a path to effectively address the challenges.

Gary J. Beach
Author, The U.S. Technology Skills Gap
Publisher Emeritus, CIO Magazine

So just what is a CS degree?

According to the Association for Computing Machinery, the world's largest educational and scientific computing society, CS is a degree program with many and varied fields that "offers a foundation for individuals to adapt to new technologies and new ideas by learning to design and build software; develop effective ways to solve computing problems, such as storing information and sending information over networks securely; and devise new ways of using computers to address areas, such as robotics or digital forensics."

That sounds like a fun field. And it is. But here are the four words that have young people running the other way when it comes to CS: "requires some mathematical background."

As I learned in researching and writing my book, The U.S. Technology Skills Gap, Americans have never embraced math or science. Never. And as Glen Whitney, the founder of the Museum of Mathematics said in a recent Reuters interview, "When it comes to math and science, Americans think those subjects were done by dead Greek guys 1,000 years ago."

And that's a huge mistake in a country where 12 million people are unemployed and another 10 million are underemployed.

Computer science, as a major, was first introduced in the mid-1960s, just as America's tech industry was moving into high gear. That was when the U.S. focused on efforts to land a man on the moon by the end of the decade. As a percentage of all bachelor's degrees awarded in the U.S., CS majors peaked in 1985—right smack in the middle of the PC revolution—at 4.3 percent of all bachelor's degrees awarded.

Nearly 30 years later, that percentage has dropped by 44 percent to 2.4 percent of all bachelor's degrees earned by U.S. students.

Why is that so?

Horrible marketing by the technology industry is one reason. Technology professionals have largely done nothing to counter the popular perception among young people that CS degrees are irrelevant to their lives, are intimidating and require work that is best done by geeks!

Go back to the three-pronged description of work done by computer scientists mentioned at the beginning of this column. "Design and build,""develop new ways to solve problems" and work in the fields of "robotics" and "digital forensics." That sure sounds like interesting work to me.

I happen to also like the definition of CS work offered by Code.org's affiliate, Computing in the Core: "Computer science enables innovation and economic growth and is an integral element of culture. It shapes how people interact with each other and the world around them, and it impacts jobs, health care, energy, national defense and security."

In order to reach tomorrow's professionals, the industry has to do a better job being role models and selling that image to young people.

According to the U.S. Bureau of Labor Statistics (BLS), between 2013 and 2023, there will be two jobs available for every graduate with a CS degree. And those jobs will pay well. Payscale, a global firm that follows hiring trends, recently ranked 129 different college majors based on earnings potential. A degree in CS ranked eighth overall with a starting salary of $59,800 and a mid-career median salary of $102,000.

Moreover, those dollar ranges are likely to rise even higher because, according to BLS, there will be a shortage of talent. Over that 10-year period, 1,223,000 jobs that require a degree in CS will become available, but only 514,740 CS degrees will be conferred. Talk about a long-term ticket to job security!

Another marketing job where the industry must do better is sharing with young women that careers in CS are not just filled by geeky guys with huge rimmed glasses. Here's a sobering number to consider: According to the College Board, the firm that administers the SAT, 21,139 high school students in America took the AP Computer Science test in 2011. Only 4,000 of them (19 percent) were young women. Unfortunately, the basic 80 percent male/20 percent female demographic holds throughout the industry.

So what should we do? What can we do?

We need to start much earlier than middle school. Instead, we should introduce the basic disciplines of science, technology, engineering, and math to children as early as pre-K. The longer a society waits, the more difficult it is to get people to embrace STEM.

As I was researching my book, I came across a fascinating report from the Stevens Institute of Technology in Hoboken, N.J., which gathered data on the perceptions of careers in IT among guidance counselors in New Jersey. Most had no idea what technology workers do for a living. Your next assignment? Call your local school and offer to mentor interested middle school and high school students in what you do for a living.

Do you have a degree in science, technology, engineering, or math? Have you ever thought about becoming a teacher? One of the biggest STEM challenges in America is that nearly 50 percent of middle school math and science teachers are "out of field", meaning they have no degree in science or math.

Finally, we need to follow the advice of the Chinese philosopher Confucius, who once said, "I see and I forget. I read and I remember. I do and I understand."America must bring the "doing" back into CS education. A career in CS is so much more than learning computer algorithms and writing computer code.

And speaking of "doing", thank you TCS and STEMconnector® for your passion and focus on getting more young Americans interested in a fulfilling career built on skills in CS.

Nicole Smith
Senior Economist
Georgetown University Center on Education and the Workforce

The generative economic power and social influence of STEM opportunities has made the production of a capable science and engineering workforce a priority among business and policy leaders. Computer science occupations are at the fore of this debate mainly because computer jobs account for over half of all STEM workers today.

A recent survey conducted by Bayer shows that more than two-thirds of survey respondents from both STEM and non-STEM companies believe that more STEM jobs were being created than non-STEM jobs. Among other things, the Bayer report highlights the growing influence of STEM competencies outside of traditional STEM occupations.

The Georgetown University Center on Education and the Workforce estimates that close to 40 percent of jobs today require STEM competencies—making STEM knowledge, skills, and abilities highly sought-after capabilities that are rewarded in the marketplace. Computer science occupations are no exception to this general rule. Just about half of CS majors end up working in CS occupations, for wages that are higher than other workers with similar credentials. This means that the other half work in a myriad of other occupations that use their skills intensely—including managerial, sales, and production occupations.

The Georgetown Center also shows that 33 percent of all STEM jobs require sub-baccalaureate credentials. These credentials include post-secondary vocational certificates, industry-based licenses, test-based certifications, and associate degrees that form the cornerstone of many computer occupations. Using nationally representative data, the Center shows that a post-secondary vocational certificate in engineering, on average, pays more than many associate's degrees and even some bachelor's degrees. Furthermore, certifications are a better guarantor of the ability to do one's job than traditional credentials. Having them is a great asset to the jobseeker interested in earning good wages with middle-skills and sub-baccalaureate credentials.

Now, more than ever, technology is disruptive to job requirements and job growth. New college graduates need to be flexible and adaptable to the jobs of tomorrow, whatever they may be. STEM and CS credentials are a step in the right direction.

Surya Kant
President, North America, U.K. & Europe, TCS

Why Computer Science?

The world is becoming increasingly digital, and our competitiveness as a nation will depend upon our ability to educate our children on basic programming skills and the fundamentals of CS.

The U.S faces an acute need for skilled programmers, which is a national problem that requires local solutions, as CS jobs account for more than half of all STEM jobs. We believe that cross-sector collaboration is a key to identifying what works, showcasing it to the nation, and building upon momentum.

On September 6, 2013, TCS, in partnership with STEMconnector®, convened experts from many sectors, including the federal government, state administration, education institutions, community organizations, and more. All are advocates for increased focus on STEM education—in particular, CS education.

Why now?

At TCS and within other businesses worldwide, the demand for a technically skilled workforce is increasing dramatically. Jobs that once required fewer technical skills now require working knowledge of programming and information technology.

Unfortunately, the trend in K-12 education is not supporting this increased demand from the workforce. High school seniors are graduating with less proficiency in math and science, and CS is not a requirement or a focus for students in most states.

Following this pathway, interest in higher education, technology, and engineering degrees is already limited before graduation from high school. Coupled with a close to 50 percent dropout rate in college in these disciplines, the problem is lack of interest, proficiency, and persistence.

What do we need?

The demand for skilled technology talent in the U.S. will continue to increase in the foreseeable future, and these jobs will include all sectors-banking, financial services, manufacturing, retail, insurance, energy, food, agriculture, high-tech, and more. We need to do the following to meet the demand for skilled technology talent:

1. Encourage our young people to make use of these opportunities, show them that these new jobs are exciting, and inspire them to learn the technology that powers our daily lives.
2. Enable our students to be life-long learners and innovators because the pace of growth of these new technologies and skills will continue to increase with disruptive innovation.
3. Train teachers with new skills and support these new curricula in the classrooms. We must ensure that all children, especially from minorities or underrepresented groups, in every neighborhood have access to competitive programs and new opportunities.

The demand for these new jobs will be great, and we must ensure that our entire potential talent workforce is able to engage.

How do we implement this?

Through round table discussions, we explored these issues from a policy perspective at the federal and state level, on through to implementation in schools, and at a grassroots level of community involvement.

A steady theme that emerged is one of cross-sector collaboration, corporate engagement, and employee volunteering. To solve this national problem, all of us must work together.

At TCS, I am proud of our long and rich heritage of philanthropy, starting with our founder and continuing with the present majority ownership of the company through our charitable trust. We are committed to giving back to the communities where we conduct business. It is our responsibility as a community partner and we are honored to be able to build sustainable programs to support STEM education across the country.

I invite you to engage in this work with us and learn from the experts about how you can make a difference—perhaps in your schools, for yourself or for your family. The future is bright. Let us work together for prosperity, for our students, our future workforce, and for tomorrow.

Opening Session: Computer Science Trends and Challenges

The kick-off session was led by Edie Fraser, CEO of STEMconnector®, and Balaji Ganapathy, Head of Workforce Effectiveness at TCS. They discussed computer science trends and challenges the U.S. is facing.

The U.S. has long been regarded as the leader in global technology innovation. Approximately 80 percent of the top 10 global Internet properties were 'Made in U.S.A', including Google, Microsoft, Facebook, and Yahoo.

But as skilled baby boomers retire, the U.S. faces a dearth of future employees who have the STEM skills needed to remain on top. A lack of STEM skills has the potential to derail America's technology leadership position, which could have a negative effect on the U.S. economy.

The U.S. technology industry is on a collision course. By 2018, STEM jobs are expected to grow 17 percent, opening up high-paying career paths to employees with STEM skills. The challenge is that more than 71 percent of these STEM jobs will be in CS: cloud computing, Big Data, cyber security, and applications development- skills that are not being developed.

> "We know that 71 percent of jobs are in computer fields and require strong IT skills. However, if the entire career pathway support system is not able to develop these needed skills, we lose out as a competitive nation. Teachers must have the skill set, kids must be encouraged, and organizations and educational systems must embrace computer science."
>
> **Edie Fraser**
> CEO, STEMconnector®

The U.S. faces a host of challenges developing CS skills:

- Student enrollment and student achievement have been on the decline in the U.S.A mere 17 percent of 12th graders are both proficient and interested in STEM careers.
- Computer science is not encouraged in schools in 36 of 50 states.
- Schools in 36 states do not give graduation credit for CS courses.
- 30 percent of STEM teachers did not major in the field that they teach.
- 50 percent of schools do not have a focused STEM program.
- Computer science is not recognized as an AP course under science or mathematics.
- 50 percent of the nation's schools do not offer calculus and 37 percent do not offer physics.

Dr. Rob Atkinson, cited the importance of CS education tied to future workforce needs as IT-related jobs grew 92 percent faster than any other sector from 2001 through 2011.

Dr. Nicole Smith highlighted the overall workforce gender gap, where females earn 77 cents for every dollar male counterparts earn. However, women earn 92 cents on the dollar in STEM fields, a sector projected to grow by 17 percent by 2018 (with 71 percent of those new jobs in CS).

The good news is that careers in CS are everywhere, not just within technology companies. They exist in every sector and at every level.

To meet the demand for CS skills, Fraser and Ganapathy say that there must be a career pathway support system to develop the needed skills. Private and public organizations must train the future talent pool to meet the growing demands. Community engagement, teachers, parents, and the private sector must all work together.

"Computer science has the power to transform businesses, and unlock amazing career and earning opportunities for our country's youth," said Ganapathy. "But to develop the needed skills, we require cross-sector collaboration. We need to pool our efforts, sharpen our focus, maximize our results, and build STEM pathways from education to careers for our students."

Fireside Chat: Workforce Needs and Action for the Future

During the Fireside Chat session, Surya Kant, and Brian Kelly, Chief Content Officer, U.S. News and World Report, further defined the CS challenge facing the U.S.

Kant said that since 2005, TCS has been unable to hire enough CS professionals in the U.S. to meet the needs of its clients. To help address this challenge, TCS created the goIT program in Cincinnati, Ohio.

"We established goIT to provide students with in-school IT career workshops, in-school technology awareness workshops and a 3-day hands-on technical summer camp aimed at getting students interested in IT careers," said Kant.

To nurture goIT's success, TCS has engaged top clients and companies within North America that support STEM efforts. TCS has also partnered and supported leading STEM advocacy organizations, including STEMconnector®, NPower and other STEM initiatives.

For instance, TCS has become a Founding Leadership Partner of US2020, a national STEM education initiative that aims to engage one million STEM professionals in mentorship opportunities by 2020.

"At TCS, we believe we are a part of the community," said Kant. "We get our business from the community and part of our motivation for supporting STEM development is to repay that favor over and over."

> "To succeed on tomorrow's world stage, students must have a solid foundation in STEM and be fluent in the technologies that will power the global economy of the 21st century. TCS is proud to bring not only our technological expertise to this national effort, but also the passion and commitment that our employees have in lending their talents to positively impact their communities, across the country and around the world."
>
> **Surya Kant**
> President,
> North America, U.K. & Europe,
> TCS

TCS measures its STEM success by the number of students they encourage to pursue CS after they graduate from high school.

"Our goal for these programs is to create a tiny spark in students and get them interested and involved in computer science," said Kant. "We must inform parents, as well, so they can help guide their children to the right choices. We all must take responsibility for getting kids involved in STEM."

Executive Panel Discussion: Top Eight Recommendations

The Executive Panel Discussion was moderated by Brian Kelly. The panel included Surya Kant, Robert Atkinson, and Al Bunshaft, President and CEO of Dassault Systèmes Americas.

The panel identified eight specific actions that must be taken by the U.S. to develop the CS talent needed to support future demands.

The recommended actions are as follows:

1. **Inject real-world problems into STEM school curriculum to inspire students toward STEM careers.**

   That STEM jobs are exciting and relevant is the message you must clearly convey to high school and college students.

   "STEM professionals made it possible for man to walk on the moon and explore space,", said Al Bunshaft. "It is by using such examples that we must bring the excitement and relevance of STEM careers to life."

   Bunshaft said that inspiration is the first of three steps to engage and develop CS skills.

   "The three steps include inspiration, education and retention," he said. "We must create an inspiration pipeline that encourages enthusiasm around STEM."

   Once an inspiration pipeline is established, all potential leaks must be closed, said Robert Atkinson.

   "Many students are switching out of computer science when they get to college," he said. "In fact, computer science has a higher dropout rate than any major in college, because students do not have any idea of what they will be doing with their degree."

   "Another is to begin in high school with project-based learning that keeps the subject lively and relevant and keeps students engaged" he said.

2. **Expose teachers to careers in computer science training.**

   "Many of our teachers have limited exposure to computer science and are simply not ready to implement technology into their curriculum," said Bunshaft. "At our company, we established a teacher internship program called TADS (Teachers at Dassault Systèmes), in which we compensate teachers to learn about careers in technology companies, such as ours, while they develop STEM curricula for their classrooms."

3. **Help educators deliver work-ready students at the high school and collegiate level.**

   Another solution to assist educators is to reach students in the after-school and community college space and provide skills development to them there.

> "The fact is IT jobs are pervasive. Every organization has IT people. IT is embedded in all systems and production. Computer science jobs are growing 92 percent faster than all jobs. So the message must go out to all to jump on the computer science bandwagon to get computer science jobs in any sector you choose."
>
> **Robert Atkinson**
> President,
> The Information Technology & Innovation Foundation

"We need to support and examine the critical role of community colleges as feeder-schools to industry and university," said Atkinson.

4. **Engage minority populations.**

   In 5 years, 51 percent of U.S. youth 18 and under will hold minority status. Minorities and young women offer tremendous opportunities to develop the needed STEM skills of the future. All four executives agreed that the tent must be opened to accommodate new demographics. One way to do that is to establish hands-on partnerships to inspire and develop these large talent pools.

5. **Computer science courses should qualify as math credits in high school; caps should be lifted in college.**

   Atkinson said that at the high school level, only 14 U.S. states allow students to count CS courses as "math credits" toward graduation. By removing these restrictions, many more students will be encouraged to sign up for CS courses.

   "At the college level, many universities cap the number of students who currently major in computer science," he said. "Colleges need to be encouraged to either expand or eliminate caps."

6. **A basic knowledge of coding should be required for even the simplest of jobs.**

   Surya Kant of TCS said that in China and India, unlike in the U.S., there is a ready supply of CS talent and professionals.

   "In the U.S., this basic knowledge of coding and how things work should be required of all workers," he said. "To help educators deliver these skills, we need a broader and more balanced ecosystem for STEM education in the U.S."

7. **Take action in every community and scale up winning CS programs.**

   Bunshaft said companies must collaborate more closely with each other, local governments, and the academic community to bridge skills, education, and career readiness gaps.

   "Our efforts have been too fragmented," he said. "We must consolidate and scale up programs that are successful."

   He shared a success story in which Dassault Systèmes collaborated with DIGITS, a STEM awareness and education program that pairs STEM professionals with sixth-grade classes throughout Massachusetts. DIGITS is one of seven programs in Massachusetts that have been awarded the @Scale distinction from the governor's STEM Advisory Council. This @Scale designation is awarded to programs that effectively make a measurable impact, consistent with the Commonwealth of Massachusetts' STEM plan.

   Bunshaft co-chairs the Massachusetts High Technology Council's Talent and Education Committee.

   "This committee is composed of leaders from industry, academia and government. We are working together in support of computer science needs across our community," said Bunshaft. "This collaborative effort will raise education standards in STEM and help us establish a foundation for an inspired pipeline."

8. **Universities must be incentivized to support STEM and computer science.**

   Compared to other university academic programs, the cost of educating CS students is considerably more.

   To address this challenge, the executives agreed that universities must be incentivized to provide and even expand their STEM and CS offerings.

   One solution is to encourage state government to reallocate funding with a priority on STEM and CS education to incentivize universities to support STEM programs and students.

State Policy Panel Discussion: Top Ten Recommendations

During the State Policy Panel Discussion, leading executives from state and federal governments recommended ten ways to advance CS at the state level.

Cameron Wilson, COO and VP of Government Affairs at Code.org, moderated the discussion. Participants included Lucy Sanders, Founder and CEO of NCWIT; Allie Kimmel, Legislative Assistant to U.S. Rep. Jared Polis; Emily Bouck, Legislative Aide to Florida Senator Marco Rubio; and Della Cronin, Computing in the Core. They recommended the following actions:

1. **Make CS a part of the math or science graduation requirement for all students in all high schools.**

   As stated earlier in this white paper, only 14 of 50 U.S. states allow students to receive math or science credits when they take CS courses. If every school in the U.S. were to provide graduation credits for CS courses, many more students would be likely to sign up for them. Stakeholders at all levels are urged to encourage this change.

2. **Support grassroots campaigns, such as Washington State's 'Make it Count' Campaign.**

   Washington became the 14th state in the U.S. to sign a bill into law requiring that CS courses count toward high school graduation credits. The law was the result of a grassroots effort across the state.

   Starting in 2014, students will no longer have to forgo taking a CS class because it does not count toward graduation. Also, Washington state schools that don't already provide Advanced Placement CS classes are now encouraged to do so.

   Such grassroots efforts are encouraged across the remaining 36 U.S. states that still do not provide graduation credits for CSs courses.

> "Few elementary and public schools teach computer science. Those that do, teach how to use technology rather than how to create it. There is also the issue of recruiting teachers. The median job for people with a computer science degree pays around $80,000 to $100,000; the typical teaching salary is closer to $45,000 or $55,000. At the state level, we must create rational pathways to educate and certify teachers in computer science."
>
> **Cameron Wilson**
> COO and VP,
> Government Affairs at Code.org

3. **Close the computer science diversity gap.**

   Today, women and minorities present a significant opportunity for CEOs and their organizations to source the needed STEM skills.

   According to the U.S. Commerce Department, for instance, women fill close to half of all jobs in the U.S. economy, but hold less than 25 percent of STEM jobs.

   Panelists agreed that the U.S. must increase the number of women and minorities in STEM fields; without their contribution the U.S.'s economic and societal potential will not be realized. The country cannot afford to not educate half of its population in CS. The jobs will not be filled by only reaching out to half of the population.

   "Girls are avid users of new technology, but girls and women continue to be underrepresented in technical occupations" said Lucy Sanders. "Increasing their participation through improving access to rigorous computer science education is critical now more than ever. NCWIT provides research-based practices that teachers can use to improve computer science education."

4. **Build support at the local and state level for bipartisan, bicameral federal legislation to strengthen K-12 computer science education.**

   Though education is primarily a state and local issue the federal government can play a role in making CS education part of core curriculums at the state level.

   Currently, there are proposed federal bills, such as the Computer Science Education Act (CSEA) in the U.S. House (HR 2536) and the Computer Science Education and Jobs Act in the U.S. Senate (S 1407) that are designed to remove barriers to CS in K-12 classrooms nationwide.

   Building local, bipartisan coalitions will support bicameral federal legislation that will strengthen K-12 CS education.

   "Experts and policymakers acknowledge our existing skills gap, and we know there will be millions of openings in high-skilled jobs in the future, where knowledge of computer science will be valuable" said Emily Bouck. "Expanding access to computer science education is a smart approach to ensure our young Americans in school today become the global leaders of tomorrow."

5. **Support Computing in the Core, a computer sciences advocacy organization that is advancing changes to federal and state policies.**

   Computing in the Core[3] and its members are working in Washington, D.C., to change K-12 education policies that marginalize the teaching and learning of CS in the country's classrooms. This advocacy organization provides useful resources, such as talking points and letters, to help individuals and other organizations make their state legislators aware of the CS challenge.

6. **Participate in Computer Science Education Week.**

   Apple founder Steve Jobs once said that "I think everyone in this country should learn to program a computer. Everyone should learn a computer language because it teaches you how to think."

   To recognize the critical role that computers play in our lives, we celebrate Computer Science Education Week[4]. This celebration is observed on the week within which December 9 falls-coinciding with the birthday of computing pioneer Admiral Grace Murray Hopper (December 9, 1906).

[3] Computing in the Core, www.computinginthecore.org
[4] Computer Science Education Week, www.csedweek.org

The 2013 event, Hour of the Code, aims to get 10 million students to engage in learning coding and CS for one hour during the week.

7. **Create rational pathways to educate teachers.**

   State leaders agree that a rational pathway must be created to educate and certify teachers in CS. Currently, there are inconsistent requirements, resulting in inconsistent skill levels.

   "Computer science teachers need to work together with advocates in industry and academia to advocate for robust integration of computing education for all students into the core curriculum, particularly at the high school level," said Darren Cambridge of the American Institutes for Research. "We also need to rapidly expand the number of teachers who are well qualified to teach computer science in a way that significantly broadens participation."

   Cambridge said that online communities and social networks provide a powerful means for teachers to learn what they need to know and to build the coalitions essential to ensuring that policies and funding are aligned with these goals.

   "The American Institutes for Research's work with the National Science Foundation on the CS10K Community is a first step toward realizing this potential," he said. "The CS10K Community is where teachers can connect with each other and master computer science skills and knowledge."

8. **Expand enrollment caps.**

   University enrollment caps limit the number of students who can major in CS or enroll for CS courses. Computer science degrees and course offerings need to be expanded and integrated into other fields. Schools should also be incentivized to include more women and minorities within their CS programs.

9. **Share best practices among states.**

   States need to collaborate more closely to identify and share successful initiatives programs. One solution is to identify metrics and grading systems to track programs and measure their effectiveness.

10. **Create an annual 'Leaders and Laggards' report card.**

    One way to increase awareness of CS issues is to establish an annual report card that showcases organizations that are leaders in successfully advancing CS education — but also showcase those organizations that are not advancing this important cause. Highlighting both leaders and laggards is a powerful way to motivate change.

Federal Policy Panel Discussion: Top Eight Recommendations

During the Federal Policy Panel Discussion, key experts from industry and Washington, D.C.-based organizations explored steps that can be taken at the federal level to advance CS education and skills.

The discussion was moderated by Balaji Ganapathy. It included Kumar Garg, Assistant Director of Learning and Innovation, White House Office of Science and Technology Policy (OSTP); Cheryl Oldham, Vice President of the U.S. Chamber of Commerce Foundation, Education and Workforce; and Dr. Thomas Emrick, Executive Director at the Smithsonian Education Center.

The panel identified eight key recommendations.

1. **Collaboration is essential.**

   No major initiative in the country is accomplished in the absence of collaboration. Bridging the CS skills gap is no exception. Corporations, government agencies, education institutions and community organizations must work together to resolve the CS challenge.

   Cheryl Oldham explained that this is a key area of focus for her organization.

   "The U.S. Chamber Foundation can bridge the workforce gap in a number of ways," she said. "We can help prioritize workforce issues in Washington and engage in policy and advocacy. Our role is to encourage collaboration in every community and a skills-investment approach across America. The lines of communication between business and education are important. We will do everything we can to foster collaboration, so that industry and academia can join forces to develop the computer science skills of the future."

2. **Industry cannot afford for the U.S. to neglect half of its children.**

   Computer science is a bipartisan issue, and the time for action is now. There are far too many CS jobs to fill and far too few American students being groomed to develop the needed CS skills.

   "Computer science has the largest diversity gap of almost any profession," said Tom Emrick. "As we work to expand computer science literacy across the country, we must be sure to reach out to underprivileged communities and young women."

   In doing so, we solve a host of other societal problems. By helping underprivileged students achieve CS skills, we not only provide the needed skills for industry, but we improve the well-being of many young people who go on to become productive taxpayers—helping the U.S. address its deficit challenges and generate needed revenue to fund government programs.

3. **The business community can impact secondary education by not relying solely on four-year college graduate programs.**

   One of the upsides to developing CS skills is that students do not necessarily need to acquire a four-year college diploma to become valuable to employers.

   A range of programs from certifications, to two-year degrees at community colleges are helping students acquire useful skills in cloud computing, Big Data, cyber security and applications development.

> "The shortage of STEM and computer science skills is a national problem that begins with grassroots solutions at the local level. But it is just as important that initiatives at the federal level, driven by the White House and Congress, motivate public and private organizations to embrace and promote STEM education and ensure that underprivileged communities receive their share of STEM funding."
>
> **Balaji Ganapathy**
> Head,
> Workforce Effectiveness at TCS

The business community needs to embrace and further develop students with specific computer skills now, rather than waiting for them to complete traditional four-year degrees.

Such programs will not only inspire more students to pursue CS education after high school, but will also give the business community another avenue to source and develop the CS skills of the future.

4. **Students need to be ready for STEM higher education.**

   The purpose of a classical education is to teach students to learn how to learn. To that end, students who pursue STEM and CS degrees in college need to be well-versed in the sciences so that they are ready for the constantly changing world of IT.

   "We can't just teach specific knowledge in IT," said Kumar Garg. "The field of IT is continually evolving and changing. The half-life of new IT skills keeps dropping. That is why it is important that we create life-long learners who have learned how to learn. Working in science and technology is about continually learning and growing, so you can determine how to make the latest IT innovations advance strategic goals and generate strong results."

5. **State funding should be allocated to create STEM pathways—'K to J (jobs)'.**

   U.S. states need to do more to fund innovative STEM education initiatives that support STEM career readiness for all students, beginning as early as Kindergarten. Partnerships through education and economic development agencies can support local programs that empower students to explore a variety of STEM career pathways— and guide students all the way through their successful entry into a STEM career.

6. **States should be graded on their STEM education performance and consistent standards for comparison should be established.**

   At the federal level, programs can be established to foster increased collaboration among states to improve STEM education performance across the country.

7. **We must create convenient website platforms to 'match' computer science advocates.**

   The panel suggested that a match.com style online platform be created to encourage collaboration among CS stakeholders. The online site could include internal badging systems, provide resources campaigns and encourage volunteerism.

8. **We must address the digital divide and support under-resourced communities.**

   Some communities in the U.S. have every advantage to pursue CS skills and degrees, such as CS courses, computers, ready Internet access, and mentoring whereas many other communities lack access to these resources.

   Federal, state, and local programs need to address the digital divide and ensure that resources are established and shared. It is in everyone's best interest that students in under-resourced communities be given every opportunity to develop STEM and CS skills that will benefit them and the entire country.

Lunch Presentations: State of Computer Science Education and Jobs

During the lunch break, Ryan Munce, Vice President of My College Options, gave a presentation about the lack of CS students. Nicole Smith gave a presentation about the state of CS jobs in America.

"Students just don't understand the breadth and depth of computer science careers," said Munce. "There currently is no next step. There are not enough course opportunities related to STEM, and courses that do currently exist have limited availability."

While the student interest metrics showed a steady and alarming decline in the CS disciplines, the jobs metrics showed how CS jobs have the highest pay amongst all STEM jobs.

"The challenge is that 65 percent of all jobs will require post-secondary education and that STEM occupations will grow from 6 million to 7.6 million by 2020," said Smith. "STEM careers represent the best equal employment opportunities for women and minorities," she said.

Education Panel Discussion: Top Seven Recommendations

During the Education Panel Discussion, leading education implementers identified their top seven recommendations to address the CS challenge.

The discussion was moderated by Jan Cuny, Program Officer of the National Science Foundation. Participants included Andrew Coy of the Digital Harbor Foundation; Bill Regehr of the National 4-H Council; Lucy Sanders, Founder and CEO of NCWIT; Talmesha Richards of the National Girls Collaborative Project; Dave Saba of NMSI; Stephanie Cuskley of NPower; Anne Jones of Project Lead the Way (PLTW); and Melissa Moritz of Teach for America.

> "We must show students that computer science is the lever they can use to change the world. Computer science underlies every industry and government operation, every innovation, and every charitable endeavor. STEM and computer science skills are now relevant and useful in every career choice, including marketing, sales, medicine and farming."
>
> **Jay Cuny**
> Program Officer,
> National Science Foundation

1. **Computer science must be a core requirement in high school education.**

   In the modern world, everything we touch involves some level of technology and requires some level of STEM and CS support. At the very least, every high school student should acquire some level of technological fluency through hands-on experience. This includes understanding how computers are able to help us solve complex problems.

   The panel agreed that CS improves problem solving abilities and learning. Learning CS skills develops critical thinking, which is the key to solving problems for all businesses.

"NMSI believes that all students in all schools should have equal access to rigorous computer science courses and support from their teachers, especially in the STEM subjects," said Gregg Fleisher, Chief Academic Officer of NMSI. "We believe STEM is the best way to expand opportunities, increase skills, and promote innovation and growth in this country."

Melissa Moritz said we must ensure that students in under-resourced schools have access to CS education.

"This empowering skill set gives students the opportunity to innovate and create solutions to our nation's most pressing challenges," she said. "All kids deserve the opportunity to explore CS and it is our collective responsibility to ensure that equity is at the heart of CS education."

2. **There is a critical need to train teachers in STEM and computer science.**

   "We need all educators and schools to come to terms with the reality that rigorous computer science coursework is necessary," said Anne Jones. "We need to create 'K to career' solutions, and that means we need to train teachers who can support this coursework."

   Jones suggested that one way to accomplish this would be to require schools to outline a '3 consecutive year' CS education program, which would highlight the seriousness and importance of effective CS training and education.

3. **Formal support for informal STEM and computer science learning is essential.**

   Panel participants agreed that there is a negative image associated with STEM careers that must be addressed. Many students may view STEM and CS professionals as "computer geeks" or "nerds." If students are unable to identify with STEM and CS role models, they will be much less motivated to pursue STEM careers.

   In order to develop a robust pipeline of CS talent, young people must be connected with CS mentors in industry—mentors who are from similar backgrounds, to whom students can relate.

   It is also important to establish fun and flexible environments in which students can think, explore and learn—and discover how interesting and compelling CS careers can be.

4. **Out-of-school and after-school opportunities to learn and grow should be encouraged.**

   Extracurricular programs that complement formal classroom learning can create excitement around STEM and CS.

   Schools can be risk-averse to experimenting with informal learning programs. Out-of-school and after-school activities, however, can be free to innovate. Such programs give students hands-on opportunities to invent, explore and discover. They appeal, in particular, to students who may not be as motivated in formal classroom settings.

   "Unless we develop innovative approaches to technology skill development among young people, we will see ever-increasing failure across the board," said Andrew Coy. "Unlike failing on high-stakes tests, however, failing to prepare our youth for the careers of tomorrow has real and permanent consequences."

   Bill Regehr said that after-school programs are critical to helping today's youth acquire a firm grasp of the CS skills they will need to be the next generation of innovators.

   "For more than a century, 4-H has been reaching young people with after-school STEM programs and it has been proven to work," he said. "We have found that 4-H youth are two times more likely to plan to pursue future courses or a career in science. High-quality after-school programs are a vital complement to the formal education that young people receive in the classroom and have proven to spark an early interest and passion for science."

5. **Schools should be proactive in recruiting and encouraging students to pursue STEM.**

   Local educators can greatly benefit students by encouraging them to explore careers in STEM fields, such as CS, since STEM jobs offer a clear pathway to economic prosperity. In addition to improving STEM education opportunities, schools need to establish STEM recruiting programs. Guidance counselors need to become familiar with STEM careers and the skills needed to pursue them. Schools without career or college guidance and ancillary support for students should make funding these services a priority.

   Effective recruiting could help educators encourage students to go onto successful STEM careers—a path that, without effective recruiting and encouragement, they might not otherwise have chosen.

6. **Recognition is important.**

   With every success in addressing the STEM and CS challenge, a little recognition can go a long way. Be sure to take the time to call out students, teachers and corporate volunteers who are doing their part to advance the STEM cause.

7. **Collaboration among educators is key.**

   Educators offer tremendous value by addressing STEM and CS challenges at the local level— and many are establishing collaborative approaches to solve the challenges within their own schools and communities.

   "Everyone, most importantly the tech community itself, must work together to encourage and enable young people to gain the tech skills needed to succeed in the future," said Stephanie Cuskley. "This is not just for themselves. This is a national imperative for us all."

   The panel recommended establishing an open-source playbook that is made available to everyone. It will allow educators and community leaders at the local level to collaborate with other local organizations to identify creative ideas to address CS challenges in their own schools and communities.

Corporate Engagement Panel Discussion: Top Eight Recommendations

During the Corporate Engagement Panel Discussion, industry thought leaders identified their top eight recommendations to address the CS challenge.

The discussion was moderated by Claus Von Zastrow, COO of Change the Equation. Panelists included: Caitlin Olson, STEM Program Manager at TCS; Brenda Walker, Principal at KPMG; Carroll McGillin, Strategic Business Development Manager for Education at Cisco; Janet Nicholas, Director of Strategic Initiatives at Dassault Systèmes Americas; and Rico Singleton, National Director of Technology at the University of Phoenix, Industry Strategy Group.

"Senior business leadership understands the STEM challenges and their impact on the future of our country. We need to make better connections between education institutions and employers - such as establishing industry-specific computer science curricula. We must be strategic in our collaboration, communication and measurement of our impact."

Claus Von Zastrow
COO, Change the Equation

1. **Corporations must lead the mobilization effort.**

   Corporations have considerable skills and resources to effectively mobilize public relations and organizational initiatives. They must use these skills and resources to organize all stakeholders, share IT competencies and provide financial support. Business leaders must find and collaborate with local organizations that are solving CS problems at the regional level and then scale successful models nationally.

2. **Corporations must expand hiring practices.**

   Too often, corporations set a high bar for entry to CS jobs. They may require advanced degrees or minimum grade point averages.

   Corporations would be better served if they expand their hiring practices to reach a wider range of future CS and STEM employees. Internships offer a terrific way to identify and develop new STEM talent. Corporations need to be more creative in the way they identify, attract and cultivate STEM employees.

3. **Corporations must promote CS diversity.**

   Business leaders agree that CS resources must be made equally available to all students, including those who attend under-resourced schools. Creating and funneling the needed financial resources to under-resourced schools is a top challenge.

   But diversity is also a bottom-line issue for corporations. Women and minorities represent a huge potential talent pool for the STEM employees of the future. Business leaders must lead the effort to engage and motivate women and minorities to pursue CS and STEM career paths—to the benefit of everyone.

4. **Bigger businesses must mentor smaller businesses.**

   All big businesses began as small businesses. Bigger businesses have greater resources to lead by example and build creative collaborations. As they refine and improve their STEM best practices, they are encouraged to collaborate with and mentor smaller businesses to build an overall STEM pipeline of opportunity.

5. **Consistent CS policies must be established.**

   For-profit universities have different policy standards for CS students than do non-profit universities. These differences involve enrollment qualifications, funding and reporting.

   This lack of consistency makes it challenging to measure and track the data that will inform stakeholders who are working to solve the CS challenge. Corporations must lead the effort to standardize the processes and policies for tracking and reporting CS issues.

6. **Corporations must encourage volunteer engagement among employees.**

   To encourage volunteer engagement among employees, corporations must allow employees to charge their volunteered STEM time and expenses back to the organization. It will take employees time and effort to prepare for their volunteer roles at after-school events. Volunteers who are reimbursed by their employers will be incentivized to do the best possible job and deliver the greatest level of value to students and teachers.

7. **Corporations must create a parallel support stream.**

   Corporations have the opportunity to establish a new, innovative business process that motivates students and teachers to pursue CS as it identifies and cultivates needed skills and talents.

This can be accomplished by establishing a parallel stream between charitable giving and support to CS initiatives and the hiring procedures to bring new CS talent into the organization.

Eventually, the two previously unrelated processes will converge into a single innovative business process that supports charitable endeavors as it identifies and cultivates needed CS skills and talents

8. **Recognition programs should be established.**

   Business leaders know that productivity levels soar when employees are recognized for a job well done and that formal recognitions produce a huge return for a relatively minor investment. All agree that recognition programs that showcase and reward volunteers, teachers and students will greatly benefit efforts to address the CS challenge.

Conclusion: Five Key Takeaways

Numerous actions that need to be taken at the local, state and federal levels were identified during the day-long round table discussions. The Computer Science Executive Round Table on Education & Careers in the U.S. concluded with five key takeaways:

1. Leaders across sectors—government officials, corporate executives, educators, policymakers, and non-profit leaders must join forces and align their efforts in supporting successful initiatives to advance CS education at national and regional levels.
2. Computer science must be counted toward high school graduation requirements at the state level.
3. Big and small businesses can, and should, join together to influence public policy and education reform.
4. Non-profit initiatives that provide education, coaching, and mentoring pathways to millions of students and youth, many of whom are minorities, girls, underrepresented groups, and at-risk youth, are critical to addressing the need for skilled programmers.
5. Corporate America must ignite students' interest in CS by collaboratively spreading the word about the opportunities available through volunteer programs.

TCS Commitment to STEM and Computer Science

TCS' workforce development and community engagement strategies in the U.S. are focused on advanced and niche technology skill development and certification.

The Computer Science Executive Round Table was one of TCS' many programs in the U.S. designed to cultivate the talent that will make up the future technology workforce. In June, 2013, TCS became a Founding Leadership Partner of US2020, a national STEM education initiative that aims to engage one million STEM professionals in mentorship opportunities by the year 2020.TCS is developing US2020's web-based matching technology to spearhead placements into top non-profits.

TCS sponsored STEMconnector's 100 CEO Leaders in STEM, an unprecedented publication that presents 100 corporate CEO profiles, including their thought-provoking views on the future of our national competitiveness and need for a STEM workforce. TCS was also the Presenting Sponsor of the U.S. News STEM Solutions Conference, a national gathering of more than 2,000 leaders and visionaries in business, education, and government from across the U.S.

TCS recently completed the latest session of its own STEM education initiative—the TCS goIT Student Technology Program—a multi-tiered outreach program engaging students, parents, universities, and local government with the goal of increasing student excitement and participation in technology-related careers.

Since the launch of goIT in 2009, the program has evolved from a two-school camp to a national, year-long program that has influenced more than 7,000 students across 35 school districts. This year, it will reach schools and students across 10 cities in the United States and Toronto, Canada.

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