TATA CONSULTANCY SERVICES

STEMconnector®

White Paper

Empowering an Industry Responsive Computer Science Education System

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Computational Thinking is a 21st Century Skill to Unlock Careers Across all Sectors

By Surya Kant
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The American dream is based on the principle that everyone should have an equal opportunity to achieve success and prosperity through hard work, determination and initiative. In today's world, technology is disrupting the way we live, eat, shop, work, and play; and there is tremendous potential for tech-enabled innovation. Every individual possessing foundational skills for 21st century careers will have the unique opportunity to include themselves and their families in the pursuit of prosperity and upward mobility.

However, we are faced with a daunting gap between education and opportunity that has resulted in social, economic, gender and ethnic inequities. Most of today's education systems are based on models put in place over a century ago, and needs to be reformed and modernized to address the growing gap between conventional education systems, the demands of modern life and new labor markets. Efforts to address the opportunity gap have to be grounded in providing every young American access to education that is relevant and contextual to the needs of today's society. Research from OECD has consistently shown a positive correlation between education attainment and economic prosperity for individuals and families.

Many young Americans may only be steps away from gaining access to a pathway to prosperity, as they could aspire to be hired for over 500,000 high-paying technology jobs that will be opened by 2024, or the one million more computer science-related jobs in the U.S. than there will be students qualified to fill them. These jobs are in every sector and in every state, yet last year only 42,969 computer science students graduated into the workforce. As a society, we need to recognize that computational thinking is a foundational skill for all 21st century jobs, including the fastest growing jobs of today and jobs of tomorrow that have not yet been invented. Students who gain proficiency in computational thinking can transition from merely being consumers of technology to being creators and innovators who can lead our new moonshots. They will build resilience to disruptions caused by adoption of automation, artificial intelligence, and other technologies in the quest of enhancing productivity and maintaining America's competitiveness as a nation.

National efforts to advocate for policy and legislation to mandate computer science in K-12, provide funding and resources for schools, and preparing educators who can teach computer science is starting to move the needle. In 33 states plus Washington D.C., computer science can count towards high school graduation math or science requirements—up from only 12 states in 2013, but only seven states have created K-12 computer science standards. Based on these efforts, it is estimated that today a tiny minority of our 50 million K-12 students—mostly in high schools—are learning computing skills that can lead to these high-paid, highly rewarding, in-demand jobs.

Implementing innovative, sustainable and scalable solutions would require government, corporations, policy makers, educators and civic organizations to work on new models of preparing young people for the future of work. Corporations have a pivotal role to play to develop and implement solutions to this societal challenge, as this will play into their ability to remain competitive and their long term sustainability. Nonprofit organizations have the unique opportunity to use conventional and innovative models that uplift women and traditionally underrepresented minorities, while at the same time preparing workforce-ready-talent.

Ultimately it is important that we collectively share a vision to empower the education system to provide requisite knowledge in computing disciplines to prepare young people for careers of today and tomorrow.

Chicago Public Schools students Mario Morales and Abisola Olawale (left, center) and teacher Bill Starzyk (right) talked with attendees at the computer science education roundtable hosted by Tata Consultancy Services and STEMconnector®.

Foreword

By Edie Fraser
CEO, STEMconnector and Million Women Mentors

Ted Wells
Vice President & Chief Strategy Office, STEMconnector

Over the last 10 years, we have seen technology transform our lives more rapidly than it did in the last 100 years. As nearly every person—young and old—has found technology not only more accessible but increasingly more essential to our daily lives, it has also become clear that we must ensure that students learn about what enables technology. The jobs of tomorrow, in addition to many current jobs, require computational thinking skills and we must start the change today. We are pleased to partner with Tata Consultancy Services on this white paper and the preceding roundtable in Chicago with a focus on collaboration between employers and education to start the process of sustainable change.

Early on in planning this workshop, we realized that the vision for this work was very much the collaborative framework illustrated by the horizontal "8" or infinity sign. In the long run, not only do all parties contribute to CS education; all parties benefit. We also realize that there is no one-size-fits-all framework for all communities, but there are "pearls of wisdom" that we can glean and implement as we go about our work. We continue to advocate for replication over duplication when it comes to expanding access to computer science.

The need to include employers in this education discussion should be obvious to anyone that has lived through the last decade: technology is changing the nature of work. The demand for technology skills will only increase as time goes by. In a sense, CS education is more like NASCAR and less like NASA. There is no ship that we can engineer and build that will take us to the next planet or galaxy; rather, we must find ways to check the systems in regular intervals or "pit stops." Our workshop served as a kind of inaugural "pit stop" to set this process in motion. We are hopeful that policymakers, educators and employers will adopt this paradigm as they approach this issue. We tend to find that there is no simple solution but there is one common ingredient to nearly all elegant solutions: collaboration.

We hope you enjoy this collaborative work and we salute our partners at Tata Consultancy Services for their leadership on this issue. Additionally, we thank all the contributors from the workshop who made this work possible—especially our corporate partners and the City of Chicago. Let's keep up the hard work and keep working to make sure that computer science is for all.

Empowering an Industry Responsive Computer Science Education System

Executive Summary

This white paper focuses on how industry and education can sustainably collaborate to ensure that students are prepared for the dynamic labor market. This draws upon the conversations and experiences of a diverse group of participants including students, parents, teachers, administrators, non-profits, government, and industry at a computer science education roundtable in Fall 2016 held at Chicago's UI Labs and hosted by Tata Consultancy Services (TCS) and STEMconnector®.

The state of computer science (CS) education in the U.S. has changed dramatically in the past few years, quickly moving from grassroots-level advocacy to demonstrate that CS education is important to determining scalable models that support local innovation. In concert with President Barack Obama's landmark CS education initiative (CS For All) that aims to bring computer science to *all* children in the United States, Tata Consultancy Services and STEMconnector® are pleased to see that many cities and states are recognizing the importance of CS education and are beginning to mandate the inclusion of CS and computational thinking into their PK-12 educational pathways for *all* students. Additionally, industries from energy and healthcare to finance and consulting have evolved and require their future workforce to be digitally fluent and versed in computer science.

As computer science education becomes more integrated into the PK-12 landscape, the challenge turns to developing educational models alongside local industries that will not only adapt to the future but also be equitable and accessible for all students, not just the elite few.

How can industry get involved in making computer science education agile and responsive? How do educators, employers and parents prepare students for the jobs of today, but more importantly, the jobs of tomorrow? The need for answers is urgent: The World Economic Forum estimates that

the world needs to create 470 million jobs by the year 2030. *The jobs that fill that void will take the form of roles that don't currently exist, requiring skillsets that have not yet been defined.*

Building the CS education "plane" and flying it. The incredible efforts of the past few years to promote computer science education have helped to put the plane in the air, but "we're still building it while we're flying it," said Brenda Wilkerson, program manager of Chicago Public Schools' "CS4All" initiative, where each student, starting with the class of 2020, must now take one credit of computer science in order to graduate.

In Chicago, students' appetite for CS education far outpaces the ability of schools to keep up, both in the number of teachers and in their level of subject-matter expertise. Many teachers are eager to expand their expertise, but do not currently have the tools or support to do so. Often, student enthusiasm about CS stems from an excitement about learning programming languages and tinkering with robots, with fewer students excited or even aware of the fundamentals of computer science—computational thinking. Although studying the basics may not be as exciting as learning how to program a robot, Surya Kant, President of TCS North American, UK and Europe operations,

Industry leaders must invest more time and capital into computer science education at every level, according to one of the breakout groups.

noted that "computational thinking and digital fluency are foundational skills to prepare our youth for jobs across all sectors, not just tech." *A holistic computer science education must be integrated vertically (from PK-12) and horizontally (across subject areas) and not overemphasize the technical skills (like coding in specific programming languages) at the expense of broader employability skills, including collaboration, teamwork, delivering presentations, and communicating across lines of difference.*

Ensuring the "all" in CS For All. Parents want to foster an interest in computer science in their children, but they may find they are choosing between a school that offers exposure to computer science but does not offer arts education or has lower overall academic rigor. Other students face challenges in accessing the technology needed to complete homework assignments. Lacking a home computer or home internet access, some students must rely on public computers in libraries, which typically come with 30-minute or 1-hour session limits. On the employer side, students with backgrounds underrepresented in computing—female students, students of color, low-income students, and students with intersections of those identities—continue to face implicit bias with hiring practices or concerns that they will be a good "cultural fit" in a company. Most students do not have access to internships and research experiences, which are often highly competitive and provide valuable connections, experience, and employability skills. And finally, for many talented individuals, the requirement of a 4-year degree to gain an entry-level job in a computer science field is an insurmountable obstacle to pursuing a career in computer science.

Leveraging industry as a partner in CS education. To overcome these systemic challenges and develop an ecosystem of skilled workers, industry must take a more active role in computer science education through direct investment and partnerships in local communities. Many of the barriers articulated above could be removed by either sponsorship of schools and educators who wish to pursue professional development that improves their computer science pedagogy or through an infusion of capital for equipment and infrastructure to support CS education vertically and horizontally. Other challenges require a renewed effort by industry leaders to promote diversity and inclusion in their workforce. "Industry needs to set an example in taking the lead and developing and implementing strategies," said Surya Kant.

Challenges in computer science education aren't exclusive to PK-12 or college. Since many skills including data analytics, coding and cloud computing are already relevant to every industry, many businesses find that members of their current workforce need to upgrade their skills. That challenge will not disappear when the supply of CS educational opportunities catches up to demand; with the rapid pace of innovation, industry must adapt to incorporating continuous education practices to keep its workforce up-to-date.

While the "to-do" list for employers who wish to support the development of their current and future workforce is long (and will evolve as new approaches are tested), they must also realize that investment in the computer science educational ecosystem is one that bears long-term fruits and is worth the inevitable short-term growing pains. **Industry has an unprecedented opportunity to work alongside the PK-12 (and beyond) educational community to ensure that computer science education is current, responsive, and equitable for *all* students.**

Six steps industry must take to support the next generation of digitally fluent employees

Tanner Armstrong is willing to do just about anything to help his students learn computer science, including cutting metal parts while leaning out a window in his classroom. The Chicago Public Schools teacher's can-do approach exemplifies the enthusiasm surrounding computer science education that has been building across the country over the last few years. But his ill-equipped classroom also highlights a growing need for industry to take a more active role in building a future pipeline of digitally fluent workers.

Armstrong was one of dozens of speakers at the Tata Consultancy Services/STEMconnector 2016 computer science roundtable. The six action items that emerged out of the conference center on achieving two audacious goals: Make CS education flexible and responsive, and ensure equitable access that does not leave anyone behind. To build a strong pipeline of future workers in all fields connected to computer science, educators and industry must shift their approach to Pre-Kindergarten through college education, and address the skill gaps in the current labor force through constant training.

1. Industry should increase its direct involvement with students.

Because in-demand skills change so rapidly, employers can no longer take a hands-off approach to education. They need to view the skills pipeline as starting in grade school. By getting involved early, they can heavily influence the subject matter being taught.

Some businesses will have more resources—human and physical—available to invest in creating that pipeline, but there are levels of involvement available that would fit any size business.

> ***"Industry is sitting on the lookout tower,"***
>
> — Balaji Ganapathy, *Head of Workforce Effectiveness, Tata Consultancy Services*

Employers can offer on-site career fairs that expose students to the different opportunities in computer science. They can also host programs such as once-a-year student hacking or robotics competitions, providing students hands-on experience on typical problems solved by companies. If they have the resources, they could start an after-school student-run enterprise that solves real problems for businesses through computer programming or data analysis. These experiences will help students build their resumes and their network of references, both crucial elements to succeeding in the computer science field.

Many companies already offer high school internships, but they should consider ways to make those even more robust. When a student does well, employers should give them an opportunity to up the ante—to continue the internship in future semesters and to take on more critical tasks. Another option would be to make online webinars available to former interns to help them continue their immersion in the field.

> ***"When we have teenagers that have never been in a multi-story office building downtown, and we get them into programs working with volunteers and they see the real world problems they can solve, they think, 'Oh, this is it!' There's excitement and engagement."***
>
> — Steve Betts, *chair of Lumity and senior vice president and chief information officer for Health Care Service Corporation*

"We need industry updates that are very focused on the trends, so computer science educators can focus their skills at the concept level," said Abisola Olawale, a Chicago Public Schools student. "Then we'll know that that skill, once learned on one language, is adaptable to the next language we haven't even seen yet."

Drew Glassford, director of strategic initiatives for the National Foundation of the Boy Scouts of America addressed Chicago Public Schools students from 3rd grade through high school and their teachers before they participated in a roundtable sharing the challenges they face in studying and teaching computer science.

2. Industry must help equip teachers.

From the perspective of some in the computer science education community, the gold standard of industry involvement looks like direct mentorship and training for educators. Ruthe Farmer, former senior policy advisor for the White House Office of Science and Technology Policy, offered an example of a large bank providing summer internships to teachers to help them update their skills and competencies. But for businesses who do not have entire teams devoted to community outreach, there are still ways they can get involved.

> ***"I'm afraid I'm not up to date enough to teach these kids. What do companies want right now and how do I get that training?"***
>
> — Bill Starzyk, *Chicago Public Schools teacher*

"Sixty percent of Kindergarten through 5th grade teachers are female and have a background in humanities," Farmer said. "If we want them to teach computer science and be excited about it, they need some support for that."

Some low-cost ways to get involved include financially supporting the Computer Science Teachers Association, messaging local and national education policy makers, and engaging with teachers through innovative programs like Cup of Code, a program that pairs teachers with computing professionals for a casual coffee meeting.

3. Industry must help equip classrooms.

For businesses who are able to directly support schools, but don't have the time for long-term programming, supplying equipment to classrooms can make a significant impact on computer science education.

> ***"We need industry to help us remake our learning spaces to come into the information age model."***
>
> — Brenda Wilkerson, *program manager of CS4All, Chicago Public Schools*

While most public schools may have computer labs, many do not have dedicated classroom space available for more innovative technologies like robotics, 3D printers, and fabrication labs. These schools must adapt unused storage closets or other spaces that limit the potential opportunities. Other schools must share a handful of computers or tablets among dozens of students. Financial contributions could be as small as buying a handful of Raspberry Pi computing devices to as large as providing a grant to build a robotics lab.

4. Industry must change its hiring practices to promote CS For All.

Diverse teams produce better financial results, as recent studies from McKinsey & Co., and the Harvard Business Review confirm. Employers need only to look to their bottom line to see the case for working toward a more diverse skilled workforce. While women and minorities are catching up with white males in many technical fields, some studies show diversity is regressing in computer science. To ensure progress toward parity in computer science education and employment continues, employers must evaluate their hiring practices from advertisement to the interview.

Employers should invest in advertising that showcases their commitment to diversity, and they should make sure these ads reach nontraditional markets to raise awareness of computer science careers. Automation in human resources functions can also introduce unintentional bias against nontraditional candidates. Having individuals with computer science backgrounds review applicants instead of using automated systems to screen candidates could help fight that bias. However, interviewers must also receive training to recognize their own inherent biases. Currently many firms in the white-male-dominated computer science hub of Silicon Valley look for a "cultural fit" in their hires, which could unintentionally result in exclusion of minorities and women.

Employers might consider numerical goals or quotas related to their diversity hiring and should also evaluate their educational requirements for all positions. Many positions require 4-year degrees for entry-level positions or master's degrees for leadership roles, which can unfairly impact economically disadvantaged candidates.

5. Industry must work to transform the workplace culturally so that everyone succeeds.

For many, especially women and minorities, the road to a career in computer science is long and convoluted.

> ***"Computer science pathways can't be like the Room of Requirement from Harry Potter, where you can only find it on your own. We need to make those pathways easier to find."***
>
> — Ruthe Farmer

If students make it into a firm, only to discover that the environment is toxic to minorities, all the work to build the labor pipeline will be in vain. Employers must directly address instances of bias, cultural insensitivity or discrimination in the workplace. Industry leaders must recognize that change is needed in corporate culture to provide an environment where anyone can contribute and be heard.

6. Industry must also create a culture of continuous learning.

With the unprecedented rate of change in technology in the computer science field, hiring employees with current skills will not be enough. Employers must invest in their talent with internal training and incentives for employees to pursue their own continuing education. Initiatives could include offering robust training for new employees to make sure they understand what resources their employer can provide, and to start out strong on any proprietary technology. Intense new-employee training could also open up careers to more potential candidates who demonstrate aptitude, but don't have specific experience. In the long run, recruiting for passion and adaptability will prove a more successful formula for most companies.

Companies must create a corporate culture that encourages flexibility and curiosity and banishes the mindset that refuses to question processes because "we've always done it like that." Bringing employees together from multiple disciplines can encourage collaboration that leads to innovation. And to further cement a company's culture and reputation for continuous learning, companies should consider offering computer science courses to community members to retrain them and make them more employable in the labor market as a whole.

Michael McGee represented CodeNow, an organization that provides a beginner-friendly program to help high school students learn how to code in New York, Chicago, and the Bay Area at the roundtable.

Building upon CS For All

Building an industry responsive computer science education system takes a concerted effort from all stakeholders. "If computer science is not embraced by the teachers delivering it, the parents in the school and the surrounding community, it won't be sustained," Farmer said. Fortunately, states are embracing their responsibilities regarding computer science education, and parents across the country are calling for schools to expand their curricula to encompass computer science classes. Farmer left her audience with the reminder that the road will be long and hard. "We need to keep the momentum going," she said. "It's sexy to say 'A million kids did X,' but we need standards for schools, for creating a teacher pipeline, and supporting ongoing development. All of the messier, harder stuff, we need to celebrate that. That's what's going to make this more permanent."

Equity Checklist

Industry must evaluate its efforts to provide equitable opportunities in computer science for all students. The following checklist provides a way to evaluate whether that is happening:

- LOCATION: Are the programs accessible regardless of geographic location? Are rural stakeholders at a disadvantage to urban stakeholders? Are efforts made to spur computer science programming in non-tech hub areas?
- GENDER: Are programs presented to students equally regardless of gender? Does content cater to one gender over another? Are equal expectations placed on students, regardless of gender?
- RACE: Are diverse races represented across all levels of programming (participants and facilitators)? Are programs presented to students equally regardless of race? Does content exclude minorities? Are equal expectations placed on students, regardless of race?
- ACCESS: If students do not have access to the internet or a personal computer at home, will they be able to access the programming? Will they be at a disadvantage? Are there ways to equip students with personal technology to access programming?
- PATHWAY: Is there a clear pathway to a career for each student? Do students need to rely on their network to provide a foot in the door to pursue a career in computer science? Are mentors and sponsors available to guide students into careers, regardless of background?

The pipeline starts here: how the education system can develop the future computer science workforce

More, more, more—that's the theme of computer science education in grade school. Students want more classes, teachers and equipment, more students need equal access, and the education needs to go into more depth. What's not lacking in grade school education is enthusiasm. From elementary school through high school, the teachers and students who participated in the Student & Teacher Perspectives panel were excited about the opportunities to get involved with computers and coding, and keynote speakers Ruthe Farmer and Brenda Wilkerson shared how administrators are working to support them.

Harnessing enthusiasm with limited resources

Many schools across the country are stepping up the challenge of training the next generation of tech-focused workers, despite lack of funding and support in many areas.

"We need a lot more technology," said Carlos Villalon, a Chicago Public Schools middle school student involved with goIT, TCS North America's flagship community engagement program, in which its employees teach computer programming and mentor youth to increase STEM education and career awareness. "We've got Chromebooks, but we only have 30 for 200 students. We need more teachers because we only have two or three who can really teach us."

Teachers like Bill Starzyk at Lindblom Math and Science Academy find it difficult to keep current on relevant skills. Although classes are available, finding time to take them is a challenge.

"I want to know what companies want right now, and how do I get that training?" Starzyk said. "Then [the students] aren't wasting their time and in two years say, 'What did our teacher teach us?'"

Until industry increases its commitment to grade school computer science education, the reality is that there won't be enough teachers to bridge the gap of demand. But Mario Morales, a CPS 10th-grade student, said he has found ways to further his education through online resources like Codecademy.

"It's important for kids to know there are so many resources online for kids to teach themselves," he said.

Teachers must often get creative in finding spaces for computer science programming. "We don't have a whole lot of space in our building," said Tanner Armstrong, an instructor with goIT. "Last year we didn't have a workshop at all for constructing robots. We had to do it in my classroom. I had to do all the cutting myself while leaning out of a window to avoid having kids in a hazardous situation."

While students clamor for advanced coding classes, teachers can't neglect the fundamentals. Looking at the speed of change in the tech industry, schools must recognize that they will not be able to keep up with the constant stream of new coding languages being developed every year. To stay relevant, they must focus on the less sexy discipline of computational thinking to lay the foundation for lifelong computer science education, even though students are anxious to begin coding.

Starzyk also brought up another concern about the computer science curriculum: neglecting to teach employability skills.

"It scares me that we have students saying, 'I want to take Web 1!' But they don't have collaboration or presentation skills," Starzyk said. "You need those to work together as a team."

Ensuring equal access for all

Computer science education in grade schools has come far in the last few years, but not all schools have progressed at the same rate. In Chicago, parent Karen Ricketts noted that it's not an even playing field.

"Some schools are exposed to sciences and some are not," said Ricketts, whose 3rd-grade son Josiah participated in the panel. "My daughter went to an elementary school that had a solid computer science program, but I wanted her to be more challenged in the regular subjects. So she went to another school and it was very rigorous, but there was no computer science."

The design of computer science programs can also set some students at a disadvantage. Wilkerson shared an example of a college-level class that required students to create a poker-playing app for their first assignment, which discouraged many of the women from continuing in the class, sensing an implied male-bias. Students of all ages and genders also respond powerfully to the expectations placed on them, Wilkerson said, so educators must be sure to hold equitable aspirations and expectations for all students.

Holding equal expectations also means understanding the challenges a student faces to completing homework.

"Closing the homework gap is critical," said Ruthe Farmer. "Seventy percent of low-income kids access the internet on a mobile device using pay-as-you-go data. All the Khan Academies in the world won't solve the problem of students not being able to get on the Internet."

The education community must recognize the limitations of its student body and adjust teaching models accordingly, Farmer said.

Shifting from introduction to meaningful interaction

As early computer science education is in its infancy, efforts currently focus on providing students an introduction to the career field and the skills required. But to fully prepare students to fill industry's need, that must shift to providing meaningful interaction. This will include guiding students to see the connection between what they are learning and solutions to real-world problems. By tackling projects relevant to their lives, students will see the potential impact computer science can have on their lives, beyond just preparing them for college.

Teaching digital fluency and employability skills helps develop well-rounded talent

Conversations around computer science education often over-emphasize hard skills at the expense of other aspects that make up a well-rounded and creative member of the workforce. To address this, STEMconnector®'s STEM Innovation Task Force—an industry-led consortium of 36 organizations focused on cultivating STEM human capital—developed a STEM 2.0 framework, published in June 2014, that identified four core capabilities that will be necessary to succeed in tomorrow's workforce: employability skills, innovation excellence, digital fluency, and industry-specific hard skills.

Schools are adapting to equip students with hard skills, but stakeholders must be sure to integrate training in the other three skills of general digital fluency, innovation excellence and employability skills.

Employability skills tie all of the other skills together.

"Technology is creating new jobs that have never existed before," said Surya Kant, President of North America, UK and Europe for Tata Consultancy Services. "The ability to adapt, learn, grow and collaborate are key to success." The ability to collaborate with peers is a top concern in the tech industry.

"I'm not looking for pure techies," said Steve Betts, chair of Lumity and senior vice president and chief information officer of Health Care Service Corporation. "A lot of the skills we focus on are solving business problems through tech. Teaming and collaboration skills are required. You don't want to have that egghead mentality."

Collaboration between two people from similar backgrounds is one thing, but Murtaza Sitabkhan, chief information officer for US Fuels Value Chains for BP, said the fuel giant faces the challenge of integrating global teams. "We have skillsets distributed all over the world," he said. "You have to work together and push one another. Working across cultures is extremely difficult."

To cultivate innovation, students must see a variety of options in their careers and in their approach to problem solving. So computer science curricula need to be careful to avoid uniformity, said Ruthe Farmer, former senior policy advisor for the White House Office of Science

and Technology Policy. "I don't want every kid to build an app," Farmer said. "But if all kids can have an understanding of the world of tech, then they can dream of what's next."

Finally, equipping students with a foundation of digital fluency will guide them through a career full of many dramatic changes in technology. "People ask: What programming language should we teach?" Farmer said. "It doesn't matter. They just need to understand computational thinking: Computers and devices are programmed by someone. They have a purpose, and usually a profit motive." Students who understand computational thinking will be more ready to apply their skills to every industry, not just explicitly science, technology, engineering and math fields.

Roundtable attendees divided into breakout groups to discuss the needs and challenges public-private partnerships must address in computer science education from early education through college and beyond.

Chicago Public Schools tackles CS4All

By Brenda Wilkerson

Chicago has come a long way in computer science education since 2013 when Mayor Rahm Emanuel first announced Chicago's K through 12 computer science initiative. That policy made Chicago the first major school district to require computer science classes for graduation. At that time those schools within the CPS-system that did offer computer science typically only saw enrollment from Caucasian students, and the students in those programs faced the social stigma of being a geek.

In pursuit of our vision to provide relevant and compelling computer science and information technology educational experiences for every Chicago student, we have made a real impact in three years.

Now, more than 80 percent of students enrolled in computer science and information technology classes are Latino or African-American, a figure that closely matches the demographic makeup of Chicago Public Schools. More than 40 percent of those students are female, an indication that the gender gap is closing.

To achieve these results, CPS has introduced its CS4All program at every level of education, and has worked to address many perception issues surrounding computer science. For many students, their only exposure to computer science careers is through pop culture, which tends to depict computer scientists as unseemly geeks, and often exclusively male.

CPS is also working to transform the mindset of its students. Many students grow up thinking that their intelligence and abilities are fixed, and that their future is defined by those natural abilities. We are changing that perspective into a growth mindset that believes those abilities can grow through personal effort, which will change students' futures.

Our internal research proves that our efforts are making an impact:

- More than 700 CPS teachers have participated in professional development for our K-12 computer science initiative. Over half are women and around half are Latino or African-American.
- Students who take the Exploring Computer Science class show increased interest in taking another computer science class and in majoring in computer science.
- More than 10,000 students across the district are enrolled in computer science and IT classes.

Our curriculum uses student-centered techniques to encourage inquiry-based learning. Students solve real-world problems and collaborate on projects to become well-rounded future employees.

But we have a long road ahead. Continuing to meet our goals will take ongoing support from every level of the educational ecosystem. We need industry to become a stakeholder, taking on meaningful projects to interact with students and teachers. Only then can we truly accomplish the mission of providing computer science for all.

Industry must bring lifelong learning into the workplace

How do you bring a 75-year-old company into the digital age? Recruiting the top talent with an understanding of the latest technology tools is one step, and industry will play a crucial role in nurturing that pipeline in the next 15 years. But companies cannot afford to wait until today's high school students graduate college to begin tackling their digital challenges. Companies with the good fortune of being located in digital meccas like Silicon Valley have a leg up on other companies when it comes to attracting the limited talent available. Everyone else must be creative to attract talent, and all companies face the constant challenges of upskilling current workers and applying computational thinking and connective technology to diverse disciplines.

Representatives of diverse industries participated in a panel discussion about the immediate challenges facing their companies related to computer science education and application. The panel included Surya Kant, president North America, UK and Europe for Tata Consultancy Services; Danielle DuMerer, chief technology officer for the City of Chicago; Kelley Mavros, Partner with PwC's strategy consulting business Strategy&; Murtaza Sitabkhan, chief information officer for US Fuels Value Chains for BP; and Steve Betts, chair of Lumity and senior vice president and chief information officer for Health Care Service Corporation.

Attracting talent requires creativity

Attracting talent with needed skills in programming or data science feels like a competition that is slanted toward startups, and away from legacy organizations. Danielle DuMerer said recruiting talent with technical skills has been an uphill battle in Chicago.

"There is a dearth of technologists in the marketplace at the moment," she said. "And we cannot compete against new startups or other organizations that can offer higher salaries and perks like free lunch and ping pong tables."

If a company didn't start out as a "tech company," it often faces a perception problem. Recent graduates with technical skills don't know about the opportunities available to work in tech for the city of Chicago, or they may assume that their growth opportunities will be stunted if they don't immediately move to a tech hub like Austin or San Francisco. But Kelley Mavros counsels companies to look for talent that may not have the flexibility to move, and take responsibility for training its own hires.

"Because it's so accessible, we can access an untapped talent pool that's here," Mavros said. "We can create a whole new talent pool."

All workers will need training throughout their careers

New hires are not the only employees in need of training. Current workers in any company trying to embrace digital tools to streamline its processes need constant training to take advantage of these tools. This could be as simple as holding a lunch-and-learn to demonstrate how to use the Google Suite of cloud-based communication tools, which is a tactic Mavros' organization tried.

"That did a couple things: For the more senior individuals, we learned," Mavros said. "It increased our network, and it gave us a new appreciation for how much we don't know, and how much the next generation does know."

But training can also include robust courses on technical subjects. Tata Consultancy Services has offered a range of training opportunities on both ends of the spectrum in the past 18 months, said Surya Kant. The company trained 200,000 employees in different digital technology functions, delivering 89 percent of the content through a custom digital learning platform. Employees

Danielle DuMerer, chief technology officer for the City of Chicago, talked about the role industry must play in computer science education during a panel including other industry leaders from Tata Consultancy Services, BP, Strategy&, and Lumity.

gained over 349,093 competencies through a combination of one-time "nanocourses" and longer in-depth courses. TCS also motivated employees by using gamification, pitting employees in friendly competition with their peers to see who could gain the most skills.

"Upskilling your employees is the best investment you can do to keep pace with the changing needs of today's economy," Kant said. "Skills become obsolete, people never do."

Upskilling is necessary to tap into the creativity and innovation of all employees. The latest tech tools for productivity and connectivity have infinite applications for industry, but teams will not likely find those applications unless everyone understands the full range of possibilities, said Murtaza Sitabkhan, with BP.

"We still have a lot of baby boomers in our workforce," Sitabkhan said. "Tech wasn't as much of a part of how they operated. With the newer workforce, they see opportunities for digital and computer where others wouldn't have in the generations before them."

At the city of Chicago, training takes a more informal tone.

"We do a lot of peer learning," DuMerer said. "We offer lunch-and-learns and ways to engage with experts in the domain."

Applying CS to diverse disciplines requires input from everyone

With more employees up to speed on the latest technology, organizations bring more brains to the question of how to apply computer science to their core business functions.

"We're having to grow this muscle around digital and info-tech at a faster rate than ever before," Sitabkhan said. "Information technology has been around for a while and has evolved through all industries. It's fundamentally changing the work of process engineers."

The healthcare industry has room to grow in applying computer science, said Steve Betts, noting the progress he has witnessed at Health Care Service Corporation.

"Blending that deep knowledge of healthcare in with the digital environment and creating integrated teams has been the centerpiece of our new operating model," Betts said.

And if Chicago can overcome the perception that there are no tech opportunities in local government, it stands to leverage technology across many functions, DuMerer said.

"Tech and data are really powerful tools to making better policy decisions," she said.

Reconsidering educational requirements for CS-rich careers

The four-year degree has long served as the foundation of a strong computer science career, like most other professional careers. Employers require a four-year degree as a minimum standard for employment, only occasionally waiving the requirement for candidates with many years of experience.

With the rising cost of college education, and the growing shortage of qualified computer science workers, some industry leaders are beginning to reconsider their educational requirements.

Many students today can no longer afford a college degree without incurring massive student debt, so they are choosing to opt out of or delay their college careers. However, with online learning centers for coding, intensive coding camps, and other nontraditional training opportunities becoming more prevalent, many potential job candidates are developing needed skills without pursuing a college degree.

But under the current structure of many human resources departments, those candidates' applications may get thrown out immediately.

Those students are calling out for a change.

"How do we assess someone's skills?" asked Chicago Public Schools student Abisola Olawale. "We shouldn't need a degree to get a job or an internship. If you're willing to learn something, a degree shouldn't be the only metric used for that job."

To open up career opportunities for more candidates, some organizations are working to shift their requirements, but the process has met resistance.

"This was a big hurdle for us," said Danielle DuMerer, chief technology officer for the city of Chicago. "We worked with our department of human resources. It was not a quick process, but we got to where some job positions would waive the degree requirement with experience. If you're trading off the degree for experience, it still means it's hard to get the entry-level job."

Across all industries, hiring managers are beginning to shift their attitude to hiring for aptitude and attitude, instead of degrees or experience. Kelley Mavros, a partner with PwC's Strategy&, spoke of her personal experience concerning the shift.

"I have an MBA, but I'm not sure that was exactly what I needed," Mavros said. "I'd much rather have the person who is dedicated and can learn. Convincing my HR department of that is hard."

As a response to both the shortage of qualified workers and the inaccessibility of college for many candidates, companies like Tata Consultancy Services are introducing in-house training programs.

"We have experimented with taking people who don't have four-year degrees and then we train them in the company for the next six months," said Surya Kant, president North America, UK and Europe for Tata Consultancy Services. "It's like a university in the company that trains them. Many times they turn out to be much better at certain jobs than folks with four-year degrees."

Million Women Mentors

Million Women Mentors (MWM) supports the engagement of one million STEM mentors, both male and female, to increase the interest and confidence of girls and women to persist and succeed in STEM programs and careers, including computer science fields. MWM is an initiative of STEMconnector® in collaboration with over 60 partners reaching over 30 million girls and women, more than 45 corporate sponsors and 35 state leadership teams—many of which focus directly on digital fluency. With a drastic shortage of girls and women studying and entering computer science-related fields, MWM encourages programs and mentorships that actively increase gender diversity.

MWM has surpassed its initial goal, securing 1.8 million pledges and currently fostering over 850,000 mentor-mentee relationships. TCS is a founding partner of MWM and has achieved over 55,000 mentoring relationships since 2014. TCS also made a commitment in 2013 to support the technology needs of MWM, and have ever since had a dedicated in-house team to provide in-kind services. Initially, TCS built the MWM web platform to serve as the face of the initiative and capture mentor pledges. The platform was expanded to host individual state team pages, enabling them to build their local coalitions and successes. TCS then helped match demand from states across America, by zip code, against companies with mentors to support these youth serving organizations. We further added features to support tracking and reporting of progress against pledges to help measure impact.

Learn more at **MillionWomenMentors.org.**

goIT @ TCS

goIT is TCS' signature community engagement program in North America that increases interest in STEM and computer science through design thinking, mobile app development, and mentorship from TCS employee volunteers. Primarily focused toward middle school students underrepresented in computing fields, goIT offers a free and flexible program for schools, non-profits, and other youth-serving institutions to help students engage actively in computational thinking by using a student-driven exploration of community-centered issues. Students work in teams to identify a problem, generate possible solutions, wireframe their prototypes, develop and test their mobile apps, and present their work to peers and judges. In turn, goIT participants are introduced to design thinking as a problem-solving framework, acquire critical thinking experience while troubleshooting designs, improve their ability to work in teams, and refine their communication skills through public presentations. Each TCS volunteer completes extensive training, covering youth psychology, design thinking, educational systems, and tools for mobile app development to aid their preparation as a mentor. Since its launch in 2009, goIT has engaged over 13,000 North American students across 50 cities and over 170 events, with promising results. In 2016, goIT inspired more than 4,400 students, engaged over 1,000 TCS employee volunteers, resulting in 40,000+ hours of high-impact skill building for students. **Are you interested in bringing goIT to your community? Send an e-mail to northamerica.csr@tcs.com.**

Ignite My Future in School

Tata Consultancy Services has partnered with Discovery Education to launch **Ignite My Future in School**, a multi-million dollar and first-of-its-kind initiative to use computational thinking as a catalyst to transform education in America. This program will enable educators, administrators and school districts to become ambassadors of a transdisciplinary approach and introduce computer science within the context of core subjects such as English, mathematics, social studies, science, and the arts.

Ignite My Future in School will engage 20,000 teachers and more than one million students over the next five years, offered free of cost to them and their school districts. Educators will be provided with high quality professional development content that aligns with existing curricular requirements, enabling them to reach students in a compelling, hands-on manner to learn computational thinking concepts and apply such digital skills to solve real world problems. These instructional courses, content and lesson plans will give faculty the opportunity to try new teaching strategies in their classrooms that are designed to increase student engagement and achievement.

Starting in 2017, Ignite My Future in School will be rolled out in school districts in 10 U.S. cities: New York, Chicago, Minneapolis, Santa Clara, Atlanta, Detroit, Dallas, Charlotte, Cincinnati, and Seattle. It will also be available across the U.S. through a virtual digital platform. Each market will have local learning leaders, who will promote teacher learning communities, connect participants and act as guides for cross-district learning and sharing. Moreover, more than 3,000 TCS employees will be actively involved as mentors and support the building of local coalitions in each city. To learn more about Ignite My Future in School, visit **ignitemyfutureinschool.org.**

UI Labs

UI LABS was the host of the 2016 Tata Consultancy Services/STEMConnector CS Roundtable. UI LABS brings University + Industry together with startups and government to collaborate on problems too big for any one organization to solve on its own. UI LABS has built a portfolio of applied research and commercialization labs that improve its partners' competitiveness and financial performance, and transform entire industries. Across its current labs—the Digital Manufacturing and Design Innovation Institute (DMDII) and City Digital—the organization has more than 300 members from industry, government, community organizations, and academic and research institutions. UI LABS is focused on manufacturing and infrastructure, two areas undergoing rapid digitization. Alongside its partners, DMDII is developing ways connect all stages of the manufacturing lifecycle using data to make U.S. industry more efficient and cost-effective. City Digital is making cities smarter by using sensors and digital technology to improve storm water management, map underground infrastructure, and enhance the efficiency of buildings. UI LABS is committed to preparing students and the local community for the technological change underway, including welcoming local high schools to Digital Days programs at the UI LABS facility, and through an open online course series recently launched on Coursera. The organization is also engaged with the tech community: In 2016, UI LABS hosted its first hackathon, welcoming programmers and coders to use real-world machine data to develop apps for DMDII's Digital Manufacturing Commons. Later this year, UI LABS plans to make data generated through City Digital's smart green infrastructure pilot available through the City of Chicago's open data portal for anyone to access. For more information about UI LABS, check out their website at **uilabs.org.**

About Tata Consultancy Services (TCS)

Tata Consultancy Services is an IT services, consulting and business solutions organization that delivers real results to global business, ensuring a level of certainty no other firm can match. TCS offers a consulting-led, integrated portfolio of IT, BPS, infrastructure, engineering and assurance services. This is delivered through its unique Global Network Delivery Model™, recognized as the benchmark of excellence in software development. A part of the Tata group, India's largest industrial conglomerate, TCS has over 387,000 of the world's best-trained consultants in 45 countries. The company generated consolidated revenues of US $17.6 billion for year ended March 31, 2017 and is listed on the BSE (formerly Bombay Stock Exchange) and the NSE (National Stock Exchange) in India. For more information, visit us at **tcs.com**.

To stay up-to-date on TCS news in North America, follow **@TCS_NA**.
For TCS global news, follow **@TCS_News**.

To learn more about TCS Corporate Social Responsibility initiatives in North America, visit **on.tcs.com/NACSR**

For more information, contact **northamerica.csr@tcs.com**

About STEMconnector®

STEMconnector® is a leading national consortium of companies, institutions of higher education, non-profit organizations, and public sector partners acting to improve all parts of STEM education in the United States and across the world. With programs and initiatives focused on all parts of the STEM ecosystem, STEMconnector® helps organizations develop their STEM strategy and maximize their return on investment, focusing on cross-industry and cross-sector collaboration. STEMconnector® currently works with over 150 sponsors and partners to provide information, collaborations, and effective collective action. For more information, visit **stemconnector.org**.

Follow STEMconnector on Twitter for more information about what's going on in STEM: **@STEMconnector**.

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