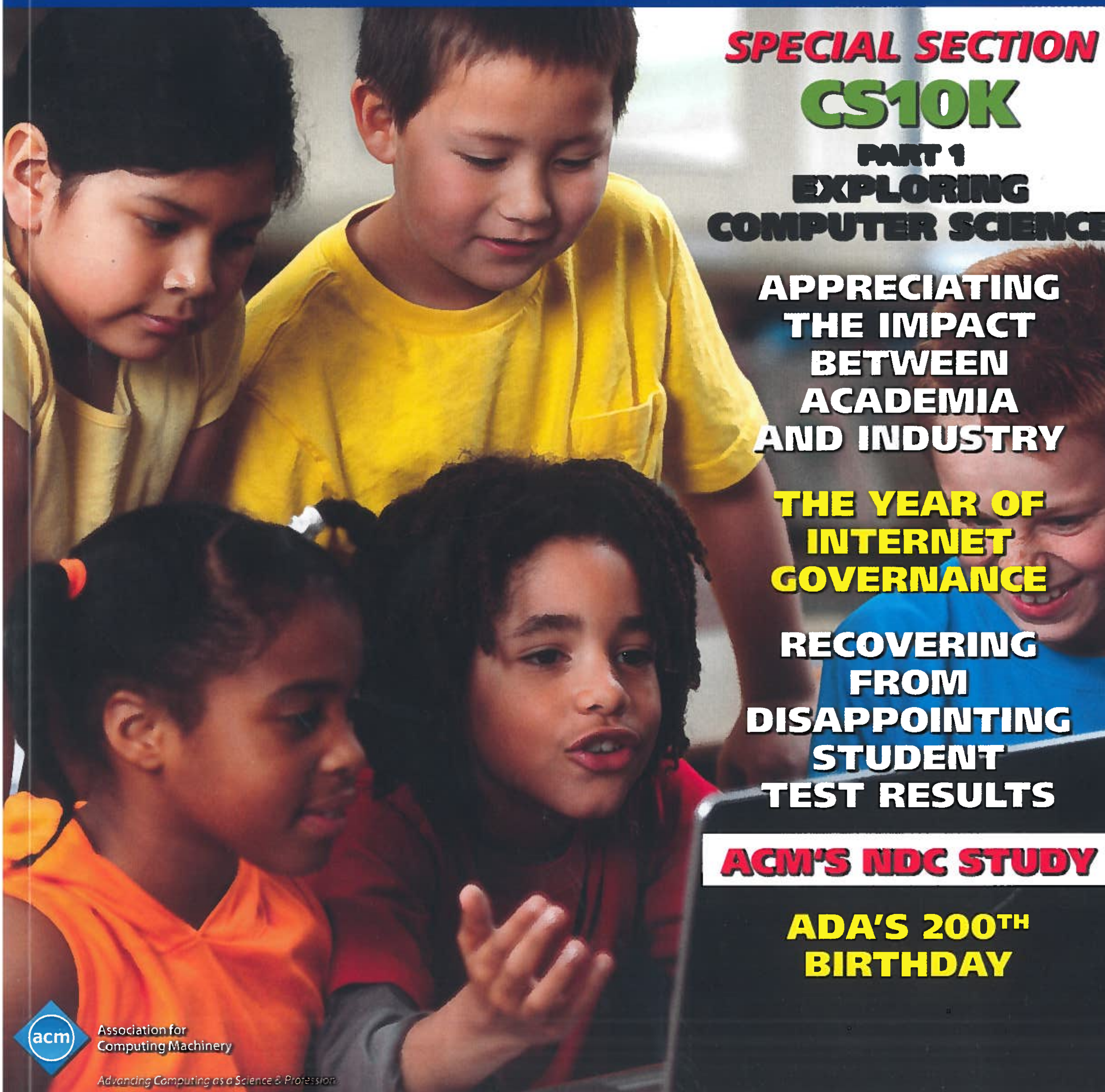
2015 SEPTEMBER
VOL. 6, NO. 3

acm Inroads

PAVING THE WAY TOWARD EXCELLENCE IN COMPUTING EDUCATION



SPECIAL SECTION
CS10K
PART 1
EXPLORING COMPUTER SCIENCE

APPRECIATING THE IMPACT BETWEEN ACADEMIA AND INDUSTRY

THE YEAR OF INTERNET GOVERNANCE

RECOVERING FROM DISAPPOINTING STUDENT TEST RESULTS

ACM'S NDC STUDY

ADA'S 200TH BIRTHDAY

Association for Computing Machinery
Advancing Computing as a Science & Profession

An Equity Lens for Scaling: A Critical Juncture for Exploring Computer Science

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The computer science education community has been on a wild ride recently. After decades of feeling like we were speaking to the wall, today numerous non-profits, industry, state and national politicians, policy makers, school districts, social media, and parents are beginning to pay attention and speak out of the need for more access to K-12 computer science education and for broadening participation in computing. As we write this article, a steady beat of news media has been covering the lack of diversity in technology and why computer science education is critically important. Even politicians are getting into the act. Broadening participation in computing has gone from being under-the-radar to being a presidential topic of attention. And along with this increase of attention have come opportunities to expand and scale up educational programs.

Exploring Computer Science (ECS) is one of the programs that has expanded and scaled in the last five years. And, with this growth, come new questions, pressures, and challenges. We write this article at a time when we are reflecting on these challenges and questioning how we assure that the ECS mission of equity and democratizing computer science knowledge for all students remains strong.

We begin the article with a brief summary of Exploring Computer Science development and expansion. We then review a part of our early history that exemplifies how numbers are often the first indicator of success in broadening participation, yet numbers can also be superficial and misleading. We follow this with a discussion of what we need to learn now, the challenges before us, and how we measure programmatic success. We hope that the questions posed in this article will be useful for the larger community and for programs that are also beginning to scale, whether they are ECS, Computer Science Principles, or other curricular efforts to broaden participation in computing.

THE EXPANSION OF EXPLORING COMPUTER SCIENCE

Exploring Computer Science was designed and released in 2008 in response to research findings showing how great disparities in computer science (CS) learning opportunities often fall along race, gender, and socioeconomic lines [12]. Persistent structural inequalities (in terms of access to teachers and classes), widespread biased belief systems, and policies combine to deny access and equitable computer science learning opportunities for females, African Americans, Latino/as and other underrepresented groups of students. Computer science education, as it turns out, is a window into how inequality gets reproduced in the United States and how fields become segregated.

ECS was established to challenge the structural inequalities, belief systems, inequality, and segregation associated with computer science. The ECS program includes both the curriculum and a teacher professional development program, and was built through university/K-12 partnerships with local school districts. The goal of the ECS program is to bring quality and engaging computer science into the schools. The ECS curriculum introduces high school students to the fundamental areas and concepts of computer science; the curriculum deliberately scaffolds the first to the last unit so that all students, from novices to more experienced students of all backgrounds, are able to enter and feel that they belong in the class [9]. More accessible entry does not inhibit rigorous learning standards, however. The ECS curriculum forwards a rigorous, college-preparatory set of CS content learning objectives and computational practices that all students are expected to learn through introduction, reinforcement, and application of key concepts. The closely associated ECS teacher professional development program immerses teachers in inquiry and equity-based instructional practices shown to be effective in STEM education [9,16].

The ECS program has experienced tremendous growth due to support from the National Science Foundation over the last seven years, scaling to numerous regions across the country. Beginning as a partnership with the Los Angeles Unified School District in 2008, the program was expanded to San Jose, California schools in 2011. The same year the Chicago Public Schools officially adopted the ECS curriculum and through the CS4All initiative launched by the Chicago Mayor in 2013 all students will be enrolled in ECS within the next five years. Other regions have quickly followed suit with pilots and subsequent larger-scale implementations: the state of Utah and Portland, Oregon region in 2012, Washington, DC and Boston in 2013, and Milwaukee in 2014. Since then, these programs have grown while significant new programs across the country have been added through Code.org partnerships, continued support of NSF, and local area supporters. In 2015-16, there will be ECS programs in twenty-five regions across the United States.

We are writing this article to share with the larger community the questions we are currently asking ourselves. Instead of declaring success over the rapid scaling and expansion numbers, we are now asking:

- Beyond the numbers, how do we know if ECS (and other programs) are serving all students well?
- How can we assure that our mission of equity is sustained as we scale?
- How should we define success?
- How should we measure it?

While we have asked most of these questions from the very beginning, they become ever more urgent as we and other programs expand nationwide. We believe that these questions will need to be answered by a community much larger than the ECS team. In effect, this article can be regarded as part of our current proposed research agenda for the broadening participation in computing community.

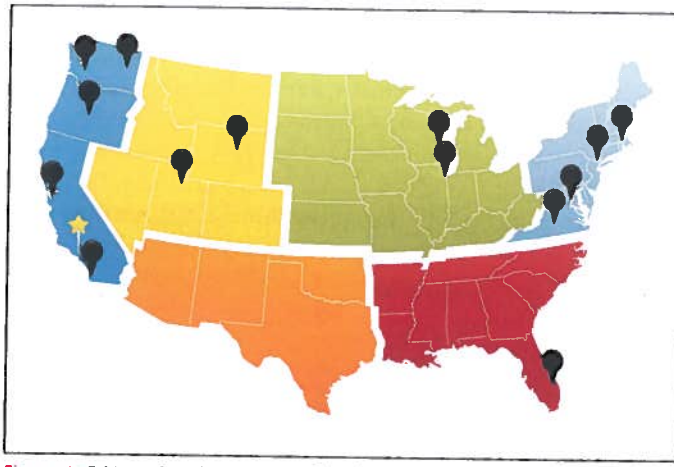

Figure 1: ECS National Expansion Sites in 2014

LESSON FROM OUR EARLIER WORK: THE SUPERFICIALITY OF NUMBERS

In 2004, building off research presented in *Stuck in the Shallow End: Education, Race, and Computing* [12], we were committed to addressing the disparities in CS learning opportunities nationwide. Our first strategic initiative took place in partnership with the Los Angeles Unified School District (LAUSD) [17]. This initiative addressed the disparities in access to Advanced Placement Computer Science (AP CS), the only college-preparatory computer science course that existed in the district at the time. We partnered with LAUSD to bring AP CS into more schools with high numbers of African American and Latino students in under-resourced communities. We saw this as an equity initiative.

Within two years, these efforts led to a dramatically higher number of classes and students. Through district policy memos, outreach to principals, teacher AP CS professional development, and the procurement of a common AP CS curriculum for all classrooms, the number of courses increased from 11 to 23, and the number of students enrolled in AP CS increased from 225 to 611 students. Not only did the total number of students increase, but also the number of girls quadrupled, Latinos quintupled, and African Americans doubled [8]. We found that the combination of a common AP CS curriculum, AP CS professional development, and district support mechanisms were effective for motivating schools to offer additional, more rigorous courses in computer science.

Yet, despite these numbers, and the increased availability of professional development (PD) for AP CS teachers, we learned something that seems so obvious now: *the programming-centric focus of the AP CS course and the advanced, college-level status was* *not an accessible entry point for most students in the district.* Despite the enrollment increase of females, African Americans and Latino students in AP CS, the scores remained low, revealing disparities in preparation. This remains true today. We would never consider introducing math to students via AP Calculus, so why did expect that this approach would be successful in CS? Today, while the numbers of AP CS enrollment have increased, the representation of females, African American and Latinos remains low, as do the test scores [10,18].

This experience from our earlier work with AP CS highlights for us that focusing on quantitative metrics sometimes provides little more than a head-count of students enrolled in a course. It does not tell us if students are prepared, engaged, and challenged with computing, or disengaged and marginalized. It does not tell us about the nature of student learning. Only with validated learning measures and deep qualitative evidence are we able to make any claims about student learning and meaningful engagement in the learning of computer science.

"PIVOTING" FROM APCS TO EXPLORING COMPUTER SCIENCE

Despite the dramatic growth of AP CS student enrollment in LAUSD, the persistent low test scores and lack of student engagement caused us to pivot in 2007 towards creating a new course, Exploring Computer Science. We designed ECS to scaffold students' knowledge and provide an engaging, rigorous, and college-preparatory course aimed at introducing all students to computer science. The course is especially important for students who do not have the "preparatory privilege" of being introduced to computing outside of school through such vehicles as summer camps, private tutors, and multiple computers at home.

To carry out the ECS curriculum, teachers require robust opportunities and supports to enact the necessary inquiry and equity-based instructional strategies effective for reaching diverse learners. We created an accompanying inquiry and equity-based ECS PD model for teachers. The major components of the ECS PD model are: immersion into inquiry, teacher learner observer model (where teachers practice teaching and observing lessons), development of a teacher learning community, and the introduction of equity practices [10].

After a measured beginning, ECS numbers started to rise quickly and steadily. In 2008-09, we began with six pilot teachers and by 2014 over 30 ECS teachers in LAUSD teach ECS. In LA, approximately 2500 students are enrolled annually each year. Now in 2015, 15 years after we began our initial CS equity work, our numbers are again "impressive." And, in LA, the student ethnicity demographics reflect those of the district. In 2013-14, the students were 73% Latino/a, 11% African-American, 8% White, 7% Asian. The female enrollment is 46%. Expansion efforts nationwide have also attracted more diverse students than typical computer science courses.

We especially wanted to know how students are engaging with computational practices which will help scaffold them to more advanced learning of CS and/or scientific/engineering and academic thinking in general.

But, despite these numbers, once again we see the need to go beyond student enrollment counts as evidence of success, and instead do a deep-dive focus on student learning. We ask: how do we know the impact of ECS on student learning? How do we learn if all students are being served well? We continue to be spurred on by the educational research questions posed by Nasir and Hand in their article about science learning [15]: what is the nature of the learning environment that encourages deep engagement for diverse participants? How can a learning environment support not only the acquisition of skills and knowledge, but also a deep sense of connection?

ASSURING QUALITY AS WE SCALE: ARE GOOD THINGS HAPPENING FOR ALL STUDENTS?

The critical question pressing the ECS research agenda is: are good things happening for *all* ECS students, especially those from groups that have been traditionally underrepresented in the field? Here again, numbers are not a sufficient indicator. Rather, how do we know if students who have been traditionally underrepresented in the field are engaging with and understanding how computer science is relevant and meaningful for their lives? We want to know what students are learning, how all students develop a sense of agency, engagement, and interest that will support their further curiosity in the field and beyond. What are the projects they are most proud of? Why? How did they engage with the problem-solving that is so central to doing computer science? How do they see the connection between computer science and their own lives and the lives of their community? [5,14]

In LAUSD, annual data collected through pre-and post-student surveys show increased student interest, engagement, and confidence in computing after enrolling in ECS. Data collected in the 2014-15 school year show a significant increase in student interest and that the change of interest was particularly large with female students. While useful indicators of attitudes and intentions with computing, these indicators are not sufficient evidence to describe the nature and depth of ECS student learning of important computer science knowledge and skills.

To collect this evidence, and assure that it is the right kind of data that enables us to make the right inferences about the impact of ECS, we know that we need to partner with learning scientists and experts in measurement. For this reason, three years ago, ECS began a partnership with SRI International's PACT[1] project to develop assessments that measure new ECS student learning. We especially wanted to know how students are engaging with computational practices which will help scaffold them to more advanced learning of CS and/or scientific/engineering and academic thinking in general [3,4]. We also need measures of student learning for teachers to use as they reflect on and strengthen their own instructional practices.

Over the last three years, members of the ECS and SRI teams (along with experts who have provided external review) have worked together to assure that the measures would be in line with the instructional purpose and mission of ECS and that the assessment instruments are "based on the model of inquiry-based learning that ECS is built upon and the learning objectives underlying each unit." A recent statement of agreement between ECS and SRI states:

> *The kind of understanding that ECS students should have about important computational practices goes beyond recalling facts or giving inputs to a program and predicting its outputs. Rather, students should demonstrate "ways of being and doing" when learning and exhibiting computer science knowledge, skills, and attitudes.*

Together with SRI we are committed to designing instruments that successfully assess students' engagement, attitudes, interest, and, importantly, their ability to *apply, evaluate, and explain* what they are learning [3]. As anyone who is familiar with assessment design can attest, this is neither a simple nor an easy project, largely because the very process of assessment development and testing forces us to be very clear and specific about our performance expectations for students. We are also forging new ground in measuring problem-solving and computational thinking practices as they are instantiated in ECS. The ECS assessments have been through two rounds of piloting and are available for research use during the fall of 2015. SRI is developing approaches to scoring these open-ended short-response questions and making them available on line through the CS10K community of practice.

Figure 2: ECS Students Program their Robot

The learning assessments described above are not the only measures that we believe are needed to help teachers and the community assess the depth of learning occurring in the classrooms. Examination of student work artifacts and portfolios are an important source of data on student learning. Think-alouds with students as they are working on problem-solving their projects are another rich source of data. We believe that these types of student learning assessment instruments should be the highest priority for ECS and our extended community.

LESSONS FROM SCALING: KEEPING EQUITY FRONT AND CENTER

As anyone who has had a program scale and grow at a rapid clip knows, one must walk a tightrope between fidelity to the original model, flexibility based on local conditions, and remaining true to the program values. This "tight but loose" tension is described poignantly in the introduction to a series of research articles about scaling educational reforms [19]:

> *The Tight but Loose framework focuses on the tension between two opposing factors inherent in any scalable school reform. On the one hand, a reform will have limited effectiveness and no sustainability if it is not flexible enough to take advantage of local opportunities while accommodating certain unmovable local constraints. On the other hand, a reform needs to maintain fidelity to its core principles, or theory of action, if there is to be any hope of achieving its desired outcomes. The Tight but Loose formulation combines an obsessive adherence to central design principles (the tight part) with accommodations to the needs, resources, constraints, and particularities that occur in any school or district (the loose part), but only where these do not conflict with the theory of action of the intervention (p.1).*

[1] Principled Assessment of Computational Thinking, or PACT, is a suite of related projects funded by the National Science Foundation and led by researchers at the non-profit research organization SRI International in California's Silicon Valley. PACT's broad goals are to improve CS teaching, learning, and adoption, primarily at the secondary level, through an assessment-centric approach that complements curriculum development efforts. We are pursuing our goals through a principled method of developing assessments called Evidence Centered Design (ECD). ECD is a widely adopted and flexible way to create not only assessments for specific curricula but also generalized frameworks for creating assessments for any context or curricula. ECD enables us to build assessments that support valid inferences about a variety of computational thinking practices.

As we scale, we ask ourselves—how do we assure that the mission of equity is central to all ECS-related initiatives? What is the ECS theory of action to make sure this happens? Equity in a school system is impacted at every turn, including structural decisions, belief systems, and policies. Below we summarize several critical examples of how equity is interwoven throughout all of the ECS initiatives and how we hold on to this core value through several different aspects of this work.

Teacher Practice: Growth over Time

In 2012 we embarked on an intensive classroom observation research project to learn what teaching practices look like in the ECS classroom. Over 200 weekly observations were conducted in nine classrooms during a year of instruction. The data revealed instructional practices used in the classroom including encouraging exploration, connecting computer science to everyday life, facilitating inquiry, and encouraging collaboration. The data also identified variation of practice, including the most and least common inquiry and equity-based instructional practices used. The most critical area of variation identified in the research was around teacher facilitation of students' higher-order thinking. Fewer teachers asked questions that prompt cognitive complexity such as "analyzing" and "evaluating," while more teachers asked questions that revolve around less cognitively challenging levels of questioning, such as checking for understanding or remembering. This is very important for establishing productive classroom discourse and critical thinking [14]. Teachers also varied in their curriculum adaptations from "no impact" to "fatal" adaptions—the latter being adaptations that work against the inquiry and equity-based instruction. For a summary of findings, see [7].

These findings are a concern to us. At this time, we do not know if this variation relates to the background and instructional philosophy of the teacher, the number of years the teacher has taught ECS, the number of PD programs the teacher has attended, or the school culture. But, we do know that this issue of cognitively challenging discussions is one that emerges as a challenge in all fields including CS and for all educators at all grade levels and therefore should come as no surprise. We also know that this issue impacts the equitable instruction for students. We are committed to addressing this through additional research, PD, and classroom coaching.

Teacher Professional Development Takes Time, Over Time

The Exploring Computer Science teacher professional development model is more intensive than most. It is not a one-time event. Instead, the ECS PD model is designed to begin with a weeklong Summer Institute, followed by quarterly PDs throughout the school year and culminates with teachers returning to the weeklong Summer Institute to hone and deepen their skills after having taught the course for one year. This cross-cohort overlap during Summer Institutes allows teachers to develop a robust teacher learning community where more experienced teachers can share knowledge with their first-year ECS teaching colleagues. It also allows teaches to revisit the inquiry and equity-based framework of ECS and the first two units that are the critical scaffolding to the problem-solving focus of the course. In order for the model to work as intended, the partnerships must understand the reasons for the model and encourage and support teacher participation. While the process may extend over more sessions than most other programs, we have learned that it takes the full year (pre- and post-teaching) to more fully integrate the curriculum and the inquiry and equity principles and practices. We have also learned that the community building that happens in this model is highly valued by the teachers who are starved for community. In fact, our research on the impact of the PD shows that teachers value their membership in a teachers learning community more than any other feature of PD.

As anyone who has had a program scale and grow at a rapid clip knows, one must walk a tightrope between fidelity to the original model, flexibility based on local conditions, and remaining true to the program values.

In-Classroom Support: The Classroom Coaching Program

Teacher professional development is not the singular solution for supporting teachers as they transition into inquiry and equity based instruction in computer science. Prior research consistently reveals that in order for teachers to master new curricula or educational approaches, they need continuous technical assistance and support in the classroom. The ECS coaching support has been a vehicle through which the ECS curriculum and PD is extended and connected to classroom practice. ECS coaching (classroom visits, reflection conversations, co-planning and co-teaching) occurs between formal PD sessions and helps provide an ongoing structure for facilitating the professional growth of individual teachers. ECS coaching takes the learning that happens in PD (around the curriculum, inquiry-based pedagogy, and equity) and extends the dialogue as teachers enact the curriculum in their classrooms.

While all educators can greatly benefit from in-classroom coaching, this is all the more true for computer science teachers. In most states, computer science teachers are teaching out of their subject, as there is no CS teacher certification. CS teachers are often the only one teaching this subject in their schools, without a department or professional learning community. As CS instruction begins to spread across the country, many teachers will be teaching CS for the first time, and will come from different pedagogical traditions. Considering that CS is riddled with biased stereotypes about the abilities of diverse students, in-classroom coaching is important for supporting teachers in making their classroom environments supportive and engaging for all students. Coaches provide an important support for teachers as they reflect on and work to create an equitable learning environment in their classes.

No Fast-Track for Professional Development Facilitators

While ECS is experiencing rapid expansion, PD facilitators are in high demand. How can this introductory computer science course possibly grow at this rate without expanding the number of PD facilitators? We imagine that every CS program that is expanding will face this same dilemma.

ECS PD facilitators are purposefully recruited from the pool of ECS teachers who have experienced the full ECS model and have taught the course for a minimum of a year. This is very different from many PD models that are provided by outsiders as a one-time event. Unlike more traditional "train the trainer" models, potential ECS facilitators must have had the opportunity to internalize the features of ECS prior to beginning the process of becoming an ECS facilitator. While there is a consistent outline agenda for the PDs, ECS facilitators cannot be primarily "script followers."

While PD facilitator development sessions may require a significant financial investment, we do not support truncating the process. It is not quick and easy to facilitate the development of teacher learners who are often teaching a new subject and transitioning from direct instruction to inquiry and equity practices. Further, since discussions of race, gender, and equity occur during PD, engaging in reflective conversations about these issues in the PD environment is important preparation and support. Of course, on-line resources need to be developed to help supplement the face to face PD, but these should only be supplemental, not replacing real-time face-to-face interactions where community building and teaching practice take place.

IMPLEMENTING AND INSTITUTIONALIZING ECS

We have always recognized that one of the most important tasks of ECS is to encourage the school districts nationwide to adopt the ECS program, fully backed by local and state educational policies without the need for external funding and university support. This still is a goal, and following are some of the current lessons in this regard:

Ongoing Relationship Building and Advocacy

Administrative leadership in large school districts operate like revolving doors. The report "Churn: The High Cost of Principal Turnover" (2014) states that 50% of new principals leave after their third year [17]. The numbers are worse in high poverty schools. And, when leadership changes, it is often disruptive for the entire school community. Policies often change at the school and district levels when a new leader takes over. These changes also occur at the Superintendent level especially in the large urban districts. For example, in the Chicago Public Schools there have been five CEOs over the last six years. In Los Angeles there have been five superintendents in the last nine years.

Despite these changes, one thing seems to remain stable: problems get resolved, innovations get implemented and sustained, often because of trusting relationships between people. It is the reality of a large bureaucracy. And, this is all the more true for K-12/ university partnerships. Therefore, we have learned that there is a constant need to build and nurture advocacy networks within the school, district, and state level. And, this is often best accomplished with local people who know the district and state culture, have "skin in the game," and are truly committed to equity within a particular district.

We have also learned that the communication between the ECS organizers and the school community must be consistent and ongoing. We cannot be deceived into thinking that signing a contract with the District will be sufficient. Enduring program advocacy and relationship building between many different partners must be a continuous process. And, while the network of informed supporters must include the principal, it must go beyond. Principals are extremely busy, juggling many different issues, and sometimes a program like ECS is better supported by the STEM coordinators or individual teachers who understand both the ECS program and their school pacing and culture, and the best ways to get things done and resolved. We also must partner with the district and school leaders who are aligned with the equity mission of ECS. This is both a top-down and bottom-up process.

Policies and Infrastructure: Watch Out for the Unintended Consequences

Every reform, especially one that is going at bullet train speed, needs a strong foundation and a well-oiled infrastructure to sustain the reform. Very recent events in the LAUSD are an example. Despite the fact that ECS has enjoyed a longtime and strong university-district partnership that has been consistently and steadily growing since 2008, a recent change of district administrators and a formal Code.org/LAUSD contract have revealed "official" regulations that are now being called forward by the district. Many of these regulations were (and still are) in contradiction to each other, or inherently unclear especially when applied to a new area like computer science.

One critical example of contradictory regulations are those around teacher certifications and determining which teachers can teach ECS. Since ECS is classified as both a Career Technical Education (CTE) course and a college-preparatory course in California, it falls into an undefined category with no clear teacher certification regulations. The truth is that ECS had existed in that gray area for years, with teachers from different subject areas able to teach ECS. In fact, this may have been an important ingredient of the "secret sauce" of ECS—passionate, creative teachers who are interested in the problem solving of computer science, with a variety of secondary subject credentials. But, with higher visibility of the program, as well as fallout from the LAUSD iPad fiasco, came higher regulation scrutiny and the momentum was stalled for a while this past year because of contradictory and unclear teacher certification regulations. The train was stuck on the tracks for several months while the district tried to navigate regulations from its HR department, the CTE Perkins funding, and the State Commission of Teacher Certification, not knowing which track it could take.

What is happening in Los Angeles is an example of why educational reform must also have a state and local policy component that can help support an infrastructure for ECS and other computing courses. This is why we, along with numerous California partners, helped form the Alliance for California Computing Education for Students and Schools (ACCESS). ACCESS is a statewide organization with a mission to "advocate for equitable access to high quality computer science education for all K-12 students in California and for the requisite educational reform in California to reflect the importance of computer science in educating students in 21st century skills for college and career readiness and global citizenship." [1]

Any partnership that takes place with school districts must be prepared to problem solve so that state, local, district policies on teacher certification, Perkins funding, all fit together on behalf of students learning of computer science. Without clear teacher credentialing guidelines, CS learning frameworks, a place in the master schedule, informed counselors, committed principals and counselors, and strong community support (including teachers, parents, students, Board of Education members) loosely defined regulations (sometimes purposefully loose so that districts can make their own decisions), and lack of infrastructure to bring in a new program, can threaten derailment of the mission to democratize CS knowledge. In a way, ECS growth—especially over the last two years—could be compared to a bullet train running on old tracks in need of repair [2].

As CS emerges from the shadows into the schools, more district regulations may be proposed that seemingly run counter to democratize CS knowledge. In this interim period of working on CS learning standards, CS teacher certification, and making CS count, much of the CS education reform work to date is vulnerable to unintended consequences. This highlights why changes in state policy are important, but also why all the state work must be done in concert with people who understand local traditions and have a commitment to equity. In other words, the "top-down" and "bottom-up" forces need to be working in concert to ensure that well-intended policies do not have a negative impact on local efforts.

Figure 3: ECS Team Visits the White House during NSF 100 Teacher Event in December, 2014

EQUITY MUST BE CONSTANTLY AND PROACTIVELY MONITORED

There is a misleading belief among many that equity will just trickle down if you increase enrollment in a program. But, increases in AP CS course-taking over the last years, without any significant uptick in diversity, shows otherwise [18]. In fact, our work on this issue has demonstrated how we must constantly and pro-actively monitor recruitment, expansion, and equity because in computer science, scaling up could too readily mirror the current race and gender gap in the field.

All programs focused on broadening participation in computing must make choices about which students, schools, and school districts to work with; these choices must ultimately be connected to values, goals, and strategies. In ECS, we work to democratize computer science knowledge for all students. We work to assure that the ECS program exists in schools that are commonly low-resourced, with high numbers of African American and Latino/a students, assuring access for students who have been previously denied learning opportunities. While we have focused on urban areas, we are aware that for accomplishing our goal of serving all students, we need to increase our attention to students and teachers in rural areas and regions in the South that still have not yet been reached.

There are other programs in the computer science education reform community that are also committed to broadening participation in computing, but that lead with the needs of industry to recruit more skilled workers. This is often referred to as the "pipeline" and focuses on how to support traditionally underrepresented students from high school through college into industry or higher positions in academy. Assuring access to jobs and opportunities for all students is a goal we also champion, but our concern is that leading with the needs of industry is often in response to and judged by the biased hiring practices of industry that commonly focus on those who are already judged to be the "best and the brightest." An example of these different orientations can be heard in the language referring to working with students with "high potential" or "youth with promise." While the intentions are usually well meaning here, this language raises important questions: Which students *do not* have promise or potential? What criteria are being used to determine potential? Are the criteria the result of a belief in "native" intelligence or interest? Does the "demonstrated potential" come from standardized test scores or from preparatory privilege? What is being done about all the unrecognized and unacknowledged potential in students?

Stuck in the Shallow End (2008) reveals how these beliefs about a narrow strata of students having "high potential" in computer science is laden with racial, gender, socioeconomic biases and plays out in schools through tracking, course assignments, course availability, and instructional resources [12]. As explained by educational researcher Carol Dweck, this type of evaluation of students is the result of a "fixed mindset"—a static view of intelligence that negatively impacts teachers' assessment and attitudes towards students, as well as students' performance in school [6]. Instead, increasing diversity requires a "growth" mindset, which centers on a belief that all students with quality education can grow in their capacity and engagement. Our mission is to build talent, to assure that all students have access to equitable and engaging computer science knowledge.

CONCLUSION: HOW DO WE DEFINE SUCCESS

We define our success as deeply tied to creating learning environments that allow all students to engage, grow, and create with computer science. To do so, we must help change the persistent belief systems about all students' ability to learn and engage with computing. Teachers are key here. We strive for PDs in which teachers acquire new understandings of how biases work within schools, and how to facilitate student inquiry, active learning, and student ownership of their learning. Our research shows how many teachers recognize their students' investigative abilities and creativity for the first time in ECS [13]. In a field with strong biases and stereotypes that assume only a narrow stratum of students are capable of engaging with CS, these new appreciations for how student interest and capacity can grow are critical. And, most importantly, at this time of scaling, we must capture the depth and nature of students' learning in ECS. We cannot compromise quality in the pursuit of quantity.

Yet, there is even a larger frame around the work. For the authors of this article, we do this work not only because access to CS education is a civil rights issue but because the entire world is being impacted. We ask: why is so much time and capital is going into making more violent and misogynist video games (this is just one extreme example), when so many technology advances are still needed for social good in medicine, environment, health, literacy, and humanitarian causes worldwide. Why are so few African American, Latino/a, Native American, and female students in academia in computer science and in the technology industry? We are concerned that whoever sits at the design tables, and who heads up technology projects and corporations, should represent the diversity of perspectives of our population and address the world's pressing social concerns. And, we believe that having students think about these societal issues that are connected to computing is important for any introductory computer science class. The world needs active and informed citizens of the world, and computer science is now a necessary knowledge in order to actively participate in a democracy.

At this critical juncture, as ECS and other broadening participation in computing projects scale and expand, we look forward to assuring that the quality of CS education for all students is as high as the quantity, that equity is front and center in our efforts, and that the larger social consequences of technology changing our world are addressed. **Ir**

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DOI: 10.1145/2794294