

# Building Systemic Capacity to Scale and Sustain Equity in Computer Science through Multi-Stakeholder Professional Development

Julie Flapan

CS Equity Project, Center X  
University of California, Los Angeles  
Los Angeles, CA, USA  
flapan@gseis.ucla.edu

Jean J. Ryoo

CS Equity Project, Center X  
University of California, Los Angeles  
Los Angeles, CA USA  
jeanryoo@ucla.edu

Roxana Hadad

CS Equity Project, Center X  
University of California, Los Angeles  
Los Angeles, CA  
rhadad@ucla.edu

**Abstract**—The CSforALL movement has made great strides preparing teachers in computer science (CS) with professional development (PD) toward broadening participation in computing. These opportunities develop teachers’ understanding of CS content, alongside culturally-relevant practices and equitable access. However, while a focus on teachers is necessary, it is not sufficient for systemic, scalable, and equitable implementation. Comprehensive PD programs need to include teachers, school counselors, and administrators. This paper uncovers a statewide research-practice partnership’s approach to a replicable multi-stakeholder PD model that addresses the following research question: How can a comprehensive CSforALL model effectively engage teachers, counselors, and administrators to work in unison to ensure equity sits at the heart of scaling and sustaining CS education for all students? A university-district research-practice partnership developed a week-long professional learning experience for teachers, counselors, and administrators that linked equity at the classroom, school/district, and policy levels. With the intentions of iteratively improving on the PD and learning about attendees’ CS education interests and experiences, the RPP collected and analyzed observations, interviews, and surveys. Findings reveal (1) a multi-stakeholder comprehensive PD model has positive impacts for the capacity-building of CS education leaders; and (2) a focus on equity across all strands of the PD program develops a better understanding of why equity needs to be at the center of CS implementation, allowing different stakeholders to work together to recognize collaboration is needed to respond to the challenges faced at each level of implementation.

**Keywords**—equity, computer science education, professional development, teachers, counselors, administrators, research-practice partnership

## I. INTRODUCTION

### A. Computer Science Education

Computer science is power. As computing and digital media touch every aspect of our lives—from what we eat to what we buy to who we vote for—it is crucial that all youth gain an understanding of computer science (CS) and the possibilities it presents regardless of race/ethnicity, gender, sexual orientation, socioeconomic status, or disability. The CSforALL movement has focused its efforts on building capacity of teachers to expand learning opportunities for students. While teachers are key for scaling CS, more actors in the education system need to be part of this broader effort: specifically, school counselors and school

leaders/administrators. A focus on classroom instruction and curricula alone will not be enough to ensure long-term sustainable change as educators can only do so much with low funding, school-day scheduling conflicts, and limited pathways for underrepresented students. The support of counselors and administrators is key to making CSforALL a reality, and the CS education community needs to intentionally include them in a collective effort to ensure equitable outcomes for CS in schools.

This is especially true in California. The state has one of the largest economies in the world and one of the most diverse populations in the country—a “majority-minority” state of 6.2 million students who are over 60% Latinx, African American, and Native American [1]—yet students of color, low-income students, females, and English Learners are extremely underrepresented in computing due to disparities in learning opportunities falling along race, gender, and socioeconomic lines [2]. Only 0.5% of the state’s 1.9 million high school students took Advanced Placement Computer Science in 2016, and while 53% of these students are Latinx, 50% female, and about 5% African American, only 15% of AP CS A test-takers were Latinx, 27% female, and 1% African American [3].

### B. Goals of this Paper and Research Question

This paper uncovers a statewide research-practice partnership’s approach to addressing equity and access to computer science education by seeking to answer the following research question: How can CSforALL efforts at the classroom, counselor, and district/county levels work in unison toward ensuring equity sits at the heart of scaling and sustaining CS education for all students?

What follows is a description of a summer five-day professional development (PD) model titled “Summer of CS” developed by a research-practice partnership to scale teacher PD, build education leaders’ capacity for local implementation, and contribute to the research base to expand access to equity-minded CS teaching and learning opportunities across the state. The goal of this project was to create an evidence-based model that both builds capacity and can be replicated, thereby serving as an effective, cost-efficient approach to meet the diverse needs of this geographically expansive state. Without data-informed equity-minded implementation, efforts to expand CS may not only be short-lived, but they could have the unintended consequence of simply increasing opportunities for students who already have access to this knowledge. This paper will

describe the value of a multi-stakeholder approach to PD as indicated by teachers, counselors, and administrators, as well as why it is crucial to center equity at such PD events.

## II. LITERATURE REVIEW

This work is informed by research that examines equitable implementation, various stakeholders' impact on instructional improvement, as well as work that has explored what models are effective in CS PD and PD in general.

Scott, Martin, McAlear, and Madkins [4] describe the various "complex" and "interconnected" barriers to maintaining inequity in CS as 1) structural (disparities in access to rigorous, engaging, and relevant curriculum; lack of diverse role models and peer networks; implicit bias affecting recruitment and placement), and 2) social/psychological (misconceptions about what is CS; perceptions of CS as lacking cultural relevance; stereotype threat; stereotypical cues in classroom environments) [4]. In order to avoid reinscribing the inequities that have been denying large numbers of students of color, low-income students, English Learners, students with disabilities, and females access to quality CS education [2, 5], there needs to be intentional and strategic development of resources and supports that target the individual barriers, while being effective in the overall educational system in which they work [6].

Teachers are the focus of a majority of the studies examining CS PD because their ability to implement and encourage effectively has had significant impact on students' attitudes towards computing [7, 8]. Teachers are on the front lines of broadening participation in computing and their advocacy is imperative in diversifying CS. With effective PD that establishes CS in a way that is culturally relevant and generates a broader understanding of what constitutes CS, teachers can act as change agents to ensure historically underrepresented students are fully included [9].

However, teachers do not work in isolation and cannot do this work alone. Counselors also play a role in serving as gatekeepers to computing courses, encouraging or discouraging students based on implicit biases, rather than students' abilities and interests [2, 10, 11]. As such, counselors must also understand ways to make CS a more equitable field [12].

Administrators are also essential in CSforALL efforts by providing instructional support and leadership. Teachers and counselors rely on principals, superintendents, and curricular leads to develop strong learning environments where teachers feel supported. Education leaders are responsible for carving out time for teachers to collaborate and create a school culture where continuous improvement is prioritized. These leaders need to make data-informed decisions about how to structure school schedules toward expanding equal opportunities for learning by well-prepared teachers [13, 14]. Ongoing collaboration and communication with school leadership and district administration are critical for the effectiveness and long-term sustainability of PD programs. Even PD programs with all other core features sometimes do not have long-term effects on teaching practices and student learning when there is no support from school leadership [e.g. 15]. Administrators need to work closely with teachers and counselors to get effective training that is of sustained duration, focused on CS content, and supports an ongoing professional learning community [13, 16], while

promoting the appropriate pedagogical and social-emotional practices that create a healthy learning environment for all [6].

PD can only affect student learning if it involves the entire school community [17]. Because teacher pedagogy is heavily influenced by the school and district contexts in which they work [18], success cannot be measured only by how effective individual teachers and counselors are in promoting CS, but by how all of the factors that play a part in the implementation of equitable CS instruction interact with one another [17]. Research on teaching and learning often analyzes teacher practice outside of district policies [18], but for CS to truly be for all, it is imperative to examine how the system that involves the classroom, the counselor's office, and the county work together.

## III. METHODS: RESEARCH-PRACTICE PARTNERSHIP AS A NETWORKED IMPROVEMENT COMMUNITY

Research-practice partnerships (RPPs) are long-term collaborations that foster an equitable partnership with a focus on problems of practice that produce unique analyses [19] toward the improved use of research in decision making [20], and educational outcomes [21]. As such, our RPP builds on several existing collaborations between local education agencies and university researchers who have been engaged in CS expansion efforts for several years; the RPP includes district administrators, county office of education leaders, teachers, and education researchers representing diverse geographic regions across this state.

This RPP chose to form a Networked Improvement Community (NIC) that meets regularly to identify issues impacting CS teachers and district leaders in real time, while discussing how data across regions can help address those issues in different regional settings toward advancing understandings about what works where, when, and under what conditions [19, 22, 23, 24]. The partnership was guided by the following six core principles of NIC improvement science methods focused on implementing research findings in everyday settings [22]: 1) making the effort problem-specific and user-centered; 2) focusing on variation in performance toward advancing efficacy reliably at scale; 3) looking at how local conditions shape practice toward making clearer hypotheses for change; 4) measuring outcomes and processes, including those that are unintended; 5) engaging in rapid cycles of research, feedback, and iteration; and 6) quickening improvement by working across the networked community [25].

The initiating members of the RPP began by identifying the following **problems of practice** with the objective of broadening participation in computing on across the state:

- How can the preparation of CS teachers for broadening participation of computing and capacity building best be scaled, supported, and sustained?
- How can education leaders from districts and county offices of education guide and support the implementation of CS education to ensure that it is equitable, scalable, and sustainable?

To address these problems of practice, the RPP identified a complex web of factors that must be disentangled and responded to with PD and policies to support teachers', counselors', and administrators' efforts to broaden participation in computing.

Our partners felt that isolated teacher PD's are often seen as one-offs, with limited follow-up and lacking connection to larger structural inequalities. In order to address these factors, the partnership has focused on the following goals:

- Build the capacity and preparation of the state's high school CS teachers through equity-focused PD;
- Build education leaders' (school principals, administrators, counselors, school board members) leadership capacity to keep an equity focus on all CS initiatives;

In an effort to address the goals listed above, the partnership organized a "Summer of CS" CSPdWeek during the summer of 2019—modeled after other successful evidence-based CSPdWeeks in Colorado and Indiana [26] that brought together teachers and counselors. What lacked in these other PD models, was a focus on school administrators and leaders responsible for making key decisions that affect the entire school community. These positions include school principals, CS coordinators, and county and district-wide CS or technology administrative leaders. One of the concerns expressed by the RPP founding partners was the sustainability of such a large and expensive PD. They had participated in other regional approaches to PD, but were unable to replicate these models at scale. Therefore, the RPP intentionally designed this CSPdWeek to serve as a model and inspire districts to take what they learned and custom design and implement similar PDs at scale on a local or regional level. The Networked Improvement Community aspect of our RPP allowed the partners to design features of Summer of CS that could be replicated in regions across the state.

This specific 2019 Summer of CS included the following PD programs: CS Fundamentals, CS First, CS Discoveries, CS Principles, Exploring CS, Counselors for Computing, as well as a newly developed Administrator Workshop. The Administrator Workshop and accompanying CS Equity Implementation Guide for Administrators were created by our RPP. All of these PD programs are actively involved in the broader national CSforALL movement, and share a commitment to broadening participation in computing. The classroom-based curricula for teachers are also standards-aligned with Common Core, NGSS, and/or CS standards. Attendees were encouraged to register as 3-person teams representing their specific local education agency (including at least 1 teacher, 1 counselor, 1 district administrator). Additionally, a high-profile lunch panel with an elected official was organized to highlight the perspectives and experiences of educators, counselors, administrators, students, researchers, and policy makers, while collectively wrestling with what is needed across their different areas of expertise for broadening participation in computing.

Data sources from the Summer of CS included quantitative data generated from a Qualtrics survey administered to teachers and counselors, as well as a separate Google Forms survey completed by administrator workshop attendees. Reports and visualizations generated from Qualtrics and Google Forms assisted in the analysis of the data.

Qualitative data from interviews and open-ended survey items were also collected and analyzed. Interviews were recorded with the permission of participants and then transcribed. Researchers noted the prevalence of different responses, group differences in responses, and any outliers from

the majority of respondents. Key findings were summarized, and example responses are provided to support quantitative findings.

#### IV. FINDINGS

##### A. *The Importance of Multi-Stakeholder PD*

The driving research question—How can CSforALL efforts at the classroom, counselor, and district/county levels work in unison toward ensuring equity sits at the heart of scaling and sustaining CS education for all students?—helped shine a light on whether or not a multi-stakeholder approach would be effective in promoting equitable CS education practices that were scalable and sustainable. Given their many different commitments and responsibilities, would teachers, counselors, and administrators, as well as invited policymakers, students, and researchers, find the time spent at Summer of CS valuable?

The top-line findings from the surveys were shared with the RPP partners during a video meeting and in a draft report. Together, we made sense of that data and reached the following conclusions. The findings across surveys and interviews reveal that people highly valued this multi-stakeholder approach to CS PD. Analyses of post-surveys completed by 206 attendees of Summer of CS revealed that 15% (n = 31) came to the event specifically to connect with other teachers, counselors, and administrators interested in implementing CS in their schools. This finding suggests that people across the state are seeking out opportunities to connect with other teachers, counselors, and administrators in the CSforALL movement. The post-survey included this agreement/disagreement rating on the likert-scale statement "I found it beneficial to come to a professional development opportunity at the same time and place as professional developments for other educational stakeholders (i.e., teachers, administrators, counselors)," the majority of respondents either agreed (48.57%) or strongly agreed (48.57%). This suggests that while not all came to the gathering with the goal of meeting other educational stakeholders, the majority found it useful to do so, realizing the value of meeting other stakeholders by the end of the week. Furthermore, 40 of the 43 people who reported attending social events designed to create community-building opportunities across stakeholders (e.g., bowling, baseball game, etc.), agreed that they valued these specific contexts for spending time with others in the CS education landscape. All of these data support the fact that CS educational stakeholders find value and desire opportunities to engage with others in CS education.

On this same post-survey, when asked to specifically articulate what people learned from others in this multi-stakeholder learning community (and, therefore, the value of bringing multiple stakeholders together during the same event), people shared how having a multi-stakeholder event helped: 1) clarify the range of roles people must take on in the larger CSforALL movement, as well as 2) counter the feeling of isolation people felt when trying to implement CS.

The ways that people gained new understandings of the range of roles different stakeholders must assume were shared in statements such as:

- "I got to hear first-hand experiences with CS, student perspectives and also to see student created artifacts. **I learned about a struggle around CS that I never knew existed and how people are fighting to ensure that CS exists for all.**"

- “I learned about how **counselors can impact** which students are in classes by advocating for them. I learned about the **legislation** going around about CS and how much this is needed in our schools and **how we need to advocate** for these learning opportunities for all of our students.”
- “I learned a great deal about the **perspective of a Computer Sci support person's isolation yet sense of being overwhelmingly needed.**”

Statements such as these illustrate how important it was for various stakeholders to learn about each other's struggles and achievements, which could inform their own responsibilities and roles while implementing CS.

The importance of challenging one's isolation by connecting with other stakeholders in the CSforALL community was visible in comments such as:

- “**CS teachers tend to be alone** (I certainly am). This collaboration with other teachers is invaluable. In addition, working with other stakeholders at other levels during informal times has made for an interesting experience and **makes the whole greater than the sum of the parts.**”
- “I learned that **I am not an island onto myself.** The challenges are mostly the same (big or small schools, types of population served, etc.)”
- “We are all in this together.”

Statements such as these reflect the larger sentiment from post-survey takers about how important it was to bring multiple stakeholders together for CS PD.

PD facilitators echoed these ideas in interview as well. All six facilitators who were interviewed agreed that bringing together multiple stakeholders at the Summer of CS was incredibly important. For example, one PD facilitator noted:

I think it is very important for all educators to interact with each other in regards to **CS education and equity** in the workforce. **Too often we work in a bubble**, on our own. There are **numerous ways that teachers, counselors, administrators, and support staff can help in getting more access to CS education.** These include; access to funds for training and computers, making room the school's schedule to offer these courses, making the course material engaging and inclusive, recruiting a diverse group of students to take courses, encouraging after school clubs, field trips, and competitions.

Similarly, another facilitator explained:

I do think it's **important for teachers to interact with other stakeholders, largely because of the equity issues that are present in CS.** Teachers are essentially the face to the community for CS. **It's important for them, as the first contact in CS, to be in contact with various stakeholders:** students, teachers, maybe industry leaders, other school admin, community college CS program coordinators, and so forth, so that they can help not just communicate an equitable message to all subgroups of the population, but also to **help**

**develop an equitable strategy for recruitment to help balance out the inequities that we see.**

Interestingly, these PD facilitators were very explicit about how multi-stakeholder PD was crucial to keeping equity at the center of CSforALL. More specifically, facilitators saw value in the ways people could learn about new perspectives across roles in the CSforALL movement, as well as create opportunities for collaboration toward equitable implementation. For example, a different facilitator explained, “**The more people involved, the more people they have to work with, to fall back on, to plan with, to run ideas by**” and that people need to “work together” toward equity in CS. Yet another facilitator shared, “The most beneficial is usually when they can **collaborate with each other and form an informal Professional Learning Network with each other to support each other as they go forward.**” This is best facilitated by gaining access to diverse perspectives among CS education stakeholders. As articulated by the fifth facilitator, bringing together multiple stakeholders:

**gives teachers new perspectives, provides resources, and helps in networking...** We often don't know problems/issues districts, counselors, and other stakeholders face in hiring CS educators or offering CS courses. On the other hand these stakeholders often don't understand what CS is about and problems CS teachers face in the classrooms. **Bringing them together gives both sides opportunities to get a different perspective and talk about issues.** I also feel we learn a lot about the political issues involved in K-12 CS education - role of [universities] and the state government...These PDs have helped me learn about what is happening at the state level in CS education.

As stated by a sixth facilitator interviewee, just as “**diversity matters in computer science,**” so too should there be diversity of stakeholders present at professional development gatherings: “**teachers should interact with administrators, counselors, parents, among many others.**” This, in turn, can ensure that “[CS education] implementation can be informed by counselors, admin, [and] parents' needs and wants.” Only by bringing together multiple stakeholders can the conversation begin around how to sustain equity across varying needs and wants, roles and responsibilities in the CSforALL movement.

Beyond discussing issues of equity across multiple stakeholders and creating opportunities for collaboration, one facilitator appreciated how bringing together multiple stakeholders helped her **feel part of a larger movement across the state.** She explained, “I saw that California cares deeply about diversifying their courses and opportunities from the discussions I had in my session as well as discussions over lunch. **My dream conference includes time where stakeholders are mixed together in smaller groups to talk to each other more about how they can work together.**” As another facilitator explained, when educators were able to have contact with other stakeholders in the CS education movement, “They were able to hear and work with each other and learn those different ways. All of that helped change their perspective about **‘hey, this isn't just teaching another course at my school ... it's much more than that.’**” This was echoed by yet another facilitator who described how coming together across responsibilities and roles helped gel “the idea that **we're all in this together, we all have a common goal to bring CS to our**

**kids.** And there's not these people up here and these people down here, but we're all a cohesive group with the same goal."

Data collected following the administrator portion of the workshop revealed how administrators also appreciated the multi-stakeholder approach to Summer of CS. Of 24 administrator survey-takers, **11 administrators explained that they came to the workshop in order to connect with other teachers, counselors, and administrators.** Across the survey-takers, 62.5% strongly agreed and 37.5% agreed with the statement "I found it beneficial to come to a professional development at the same time and place as professional developments for other educational stakeholders (i.e., teachers, administrators, counselors)." Furthermore, 61% strongly agreed and 39% agreed with the statement, "I found information from other Summer of CS attendees valuable for my work." Administrators appreciated PD networking opportunities, stating: "**It was good to sit in a room with other professionals that were talking about the same subject,** talking about the importance of it, and learning about where they were in that process and what pitfalls that they had experienced....I think the **networking part was really, really good.**"

In these ways, a multi-stakeholder context for PD proved invaluable to the experience of teachers, counselors, administrators, and facilitators alike, who all recognized their participation and commitment to the larger effort to bring CS education to the entire state.

#### *B. The Importance of Focusing on Equity Across All Strands of Professional Learning*

One of the guiding philosophies of the RPP is a commitment to the equitable design and implementation of CS education programs. This commitment was mirrored by the interests of the attendees for Summer of CS. In the post-workshop survey administered to the teachers and counselors who attended the Summer of CS, the most commonly selected answer out of nine options for "What are your top three reasons for attending Summer of CS?" was "I want to find ways to implement more equitable CS programs in my district or school" (n=35). All administrator workshop survey respondents agreed that they understand what equity means in the context of CS education (65% strongly agreed) and why equitable access to CS instruction should be a priority (83% strongly agreed).

In response to the question: "During Summer of CS, what new perspectives or experiences did you learn about from other education stakeholders present during the week who play different roles in California schools than you do?" attendees described learning about equitable implementation from other stakeholders. This ranged from understanding the differences in vocabulary and mindset ("equality vs equity"), to learning about barriers to equitable CS implementation for special populations, including access to calculus and CS existing only in Advanced Placement tracks. Several teachers reported getting ideas for how to bring equitable practices into the classroom (e.g., "I learned computer science concepts and strategies to **make the curriculum equitable and accessible for all students,**" and "I hope to use this class as a way to **understand what my [special education] students are doing out of my class and how to help them better.**")

Beyond the classroom, attendees reported on getting a better understanding of the need for an organized CSforALL movement from other stakeholders. They learned about legislation aimed at making CS equitable throughout the state, as well as the need for their role to include advocating for equitable CS education. As one administrator explained, "I developed a greater sense of urgency to promote equity in CS."

Some of the attendees learned about the inequity that existed in the state by learning about the challenges other stakeholders faced in comparison to their own situation. This led to feelings of gratitude for what they did have (e.g., "My district has a stronger commitment to equitable CTE and CS education and has progressed farther into implementation than many other districts and regions") and surprise at what others had to deal with ("e.g. **I learned that other schools have CS as an elective with different availabilities** due to other classes being offered at the same time or other reasons.")

Conversations in the administrator workshop revealed that education leaders are particularly concerned about equity in relation to economic opportunity. Leaders from districts that were large and small, rural and urban, wanted to make sure that their students had promising job prospects and careers once they graduated. As one administrator said:

I think there is a changing landscape in K-12 ed ... [we are] asking K-12 to be more mindful of opportunities after HS. Before was just "get kids to graduate and you were doing your job," but now "have discussions about career-tech ed, what does industry need, the labor-tech demand." **We're here because we don't have enough people who code or go into CS in our state;** that awareness, and maybe responsibility if you see it that way, has filtered down into K-12, not just post-secondary. As admin, we have a different role to play than just one year ago.

They saw CS as a force for equity, as a way for students to get out of poverty, and they were concerned that the schools were not providing them with this opportunity. One administrator said, "We're graduating our kids, but we're preparing them to work at Walmart—70% of them—**but if they could learn CS they could be anywhere and do anything.**" It was therefore frustrating to them that their students' current financial situation was preventing them from ever accessing the economic potential CS provided, due to lack of access to transportation, hardware, or even WiFi.

To many administrators, equity was not just about reach or access, but also about quality and rigor. One administrator lamented that the technology class her students took focused on word processing, slide presentations, and spreadsheets, and that students did not have access to "engaging or rigorous curriculum" related to computing. Another administrator was uncomfortable with the disconnect between what the teachers taught in CS and what was needed in the workforce ("**If you have no industry experience, what do you really know? Don't you think the kids deserve that?**").

The need to collect and use data to inform equity-centered CS implementation was also a common theme in the administrator workshop. Administrators spoke of collecting data from local employers to understand where their needs are and from their own districts to determine where gaps exist. More often, however, administrators in the workshop mentioned the power of data as a tool for advocacy. They saw data as a way to underline the importance of the need to disrupt the status quo in order to provide more opportunities to more students. For them, data serve as a way to educate and communicate more effectively with teachers, the school board, or funding agencies regarding **“how the labor market is connected and how we can have an impact on how we’re feeding the labor market with what we’re doing in high school programs and PreK-8”** or “students who take one CS class are more likely to graduate.”

Administrators commented that the session made them realize they had to be “proactive and intentional about recruitment efforts,” and discussed using peer mentoring models where existing underrepresented CS students could mentor and attract others, or using marketing material with logos on buttons or t-shirts to create buzz in a school.

Notably, the attendees of the administrator workshop left the session wanting more guidance. Only 36% of respondents strongly agreed that they understood barriers that stand in the way of an equitable CS education program. Similarly, only 43% of respondents strongly agreed and 13% of respondents disagreed that they had ideas and resources for overcoming barriers to equitable CS education. In response to a question about how to improve the workshop, one participant called for “more actionable steps around breaking down equity barriers, beyond just identifying them.” While this workshop opened up many opportunities for education leaders to explore ways they can support equity in computer science, there is still more guidance needed to develop concrete action plans to take their learning back to their local contexts.

## V. DISCUSSION & CONCLUSION

### A. *The Importance of Multiple Stakeholders Participating in High Quality PD at CSPD Week*

The findings above highlight the fact that teachers, counselors, and administrators alike highly valued the opportunity to meet other CS education stakeholders, learn about the varying roles people play and efforts they were engaged in, and feel a sense of community within the larger CS movement to ensure *all* students gain access to quality and rigorous CS education. Across the board, people attending the Summer of CS found significant value in the time they spent with other stakeholders, learning about their perspectives and priorities from different professional roles and activities that they did not realize before the PD. By seeing themselves as part of a larger community with a shared goal of equity in computer science, participants did not feel as isolated as they once did. Participating in a comprehensive professional learning experience like Summer of CS, the diverse stakeholders began to understand the different challenges each role faces in scaling and sustaining equitable computer science. These findings

reflect the value of bringing leadership together with teachers and counselors during PD opportunities. Furthermore, this research confirms that professional learning for teachers cannot occur in a vacuum. To increase effectiveness, PD must include conditions for learning both within schools and across the system level.

The Summer of CS is a prime example of a PD model that aims to incorporate the individual indicators of high quality professional learning along with supports for systemic implementation more broadly. By incorporating professional learning opportunities for teachers, counselors, and school leaders, models like Summer of CS help build capacity with numerous stakeholders at the school level while building broader capacity at a systems level, thereby resulting in widespread scalable and sustainable equity-minded CS learning in its relevant context.

Such findings suggest that, in order to continue supporting the CSforALL movement across contexts, it will be important to continue designing PD opportunities that support multiple stakeholders to learn together, as was organized during the Summer of CS. However, simply bringing people together to the same place is not enough. Close attention must be paid to ensuring that multiple stakeholders engage in authentic and meaningful interactions with one another. In the case of Summer of CS, a policy panel discussion and luncheon was organized for people to meet and hear from varying perspectives across the CS education landscape. To build community and collaboration across roles, social events during the evenings where various stakeholders could interact with one another in a relaxed environment. Social events can help foster a sense of community with time set aside for productive networking and interaction, both during the time assigned for professional development working hours, as well as after-work hours. This way those who work across varying levels of effort are aware of each other’s roles toward building equitable and sustainable CS education.

Relatedly, the effort to bring multiple stakeholders together cannot end after the PD is over. As found in prior research [e.g., 16], educators in the world of CS highly value contact with others in the field because they often feel isolated as the only CS teachers on their school campuses. Building opportunities for educators to interact with counselors and administrators during a CSPdWeek can help counter that feeling of isolation within school campuses, allowing for educators to find other CS champions from their school communities. Building these opportunities for multi-stakeholder interaction allows for bonds to be built across different regions in the state, so that people can learn from each other’s varying approaches to implementing CS education. As expressed in open-ended survey responses and interviews described above, multiple stakeholders coming together allow for new bridges to be constructed between varying roles in the CS education landscape.

As Darling-Hammond, Hyler, and Gardner, [13] emphasize, professional learning is most effective when it is of sustained duration and provides ongoing support and continued coaching. Unfortunately, it is often in the hands of individual

motivated teachers, counselors, and administrators to make the most of those connections and plan continued learning opportunities. In addition to each of the PD providers offering important and ongoing learning opportunities to connect, Summer of CS helps connect educators to national networking and capacity building communities such as the Computer Science Teachers Association and CSforALL Teachers. More intentional follow-up can be done to sustain newly formed relationships across stakeholders. An important area for further research involves figuring out ways to allow continued networking and interaction to occur among multiple CS education stakeholders beyond a comprehensive CSPdWeek. How can conversations continue beyond the intensive time spent together during the summer? While individuals may exchange contact information and reach out to one another for advice or support, more is needed to institutionalize such interactions and better ensure the networks continue after the initial CSPdWeek.

### *B. Keeping Equity at the Center of CS PD Efforts*

The findings above emphasize how various stakeholders attending the Summer of CS shared a commitment toward equity in CS. There was a collective belief that equity should sit at the center of PD experiences. Educators, administrators, and counselors alike recognized that youth are receiving differential access to computing education based on race/ethnicity, class, gender, home language, immigration status, and more. These same educators, administrators, and counselors want to support CS education that counters such inequity, ensuring that *all* students have access to rigorous and meaningful computing learning experiences and they want to learn actionable steps for how to make that happen.

As such, efforts must be made in CSPdWeeks to prioritize communities that do not have resources or access to quality CS education. As emphasized by administrators, examining localized data is an important way to inform an equitable approach to implementation. A critical component of Summer of CS is the commitment of administrators to gather CS education related data (number of courses in their schools, number of students, demographics of their students, pass rates etc.) from their own districts. These data help ground educators in the reality of their schools and districts and the inequities that may exist, as well as provide evidence for why they need financial and institutional support in expanding their CS efforts. The intention of Summer of CS was to foreground the workshops through reflection on the data and what it suggests in terms of equity in CS education in their schools and how teachers, counselors, and administrators can expand access to students who currently don't have these opportunities.

In selecting PD providers to replicate Summer of CS, it is recommended that equity guides the direction of CS PD experiences for all stakeholders; PD providers must be chosen who focus on equity explicitly. PD providers and resources should not be companies seeking to sell their latest gadgets or technological tools, but instead be providers who are authentically driven by the shared equity values in CSforALL. In addition to explicitly shared values of equity and expanding access to underrepresented students in CS, providers must move beyond access and diversity, and attend to inclusion and engagement of students in high quality CS [27]. This includes

culturally responsive teaching practice to engage students of color, girls, students with special needs and others who are underrepresented in CS [4]. How are they considering ways to address the funds of knowledge [28, 29] that youth are bringing into learning spaces, and ways to connect computing to the interests, needs, and desires youth have toward positively impacting their communities [30, 31]?

Furthermore, are the PD providers chosen during the CSPdWeek paying attention to rigor and quality of educational content? Are the PD providers aligning their curricula with state CS, ICT, and NGSS standards? PD providers need to be explicit about their approach to computer science; including computational thinking, problem solving, and creativity in their curricula and instruction in ways that support more equitable but also rigorous CS learning experiences for students. Relatedly, data indicators should be inclusive of access and also indicators of learning CS. For example, it is not enough to look at the increase of numbers of AP test takers, but take into account the disaggregated data on pass rates to ensure equal opportunities and outcomes for both teaching and learning rigorous CS.

For equity to truly be at the heart of CSPdWeek efforts for teachers, counselors, and administrators, PD conversations should be informed by current and accurate data. Real-time data are needed to ensure that multiple stakeholders in the CS education landscape are clear about where their efforts are missing the mark, as well as where their efforts are meeting success at closing equity gaps.

Because of the systemic and complicated nature of issues that have an effect on equitable implementation of CS, teachers, counselors, and administrators can feel overwhelmed by the task at hand. PD participants need to be provided with tools to address the equity gaps found in the data. Educators need further support to develop actionable steps that all stakeholders can take when they return to their schools and districts.

The Summer of CS model effectively incentivizes small teams from districts, schools, or counties to attend the PD so that upon return, teachers, counselors and administrators will have a team to further develop their vision for CSforALL. Building capacity for teachers, counselors, and administrators is a systemic approach to ensure that multiple levels in the education system are attending to issues of equity and addressing opportunity gaps from various vantage points. More research is needed to compare the outcomes of teacher-only approaches to multi-stakeholder approaches to PD, in order to affirm the value of counselors and administrators in discussions around equity, access, and inclusion in computer science.

CS cannot be viewed in isolation of the complex demands and ever-changing constraints and unequal structures of the broader school system. Local education agencies face herculean challenges of managing school budgets, staffing, and competing demands of the broader K12 system. Adding to the mix is figuring out where CS belongs in the curriculum, how to prepare teachers to teach it, and how to incentivize students to take it. The Summer of CS comprehensive PD program brings together stakeholders to collectively respond to these challenges and share a commitment to an equitable approach to ensure access and inclusion for all students at all schools in the system.

The systemic approach offered by Summer of CS to build capacity among teachers, counselors, and administrators helps

build an ongoing community of practice to respond to these challenges while advancing a collective vision for CSforALL.

Educators and policymakers alike share a concern for scaling and sustaining equitable CS. The Summer of CS is intended to serve as a replicable model to inspire districts, counties, and other statewide systems of support to customize similar PD programs at the local level. As a proof-of-concept, it is a goal that state budgets will support this model with funding so that local education agencies will work together to replicate this model with a sustainable cost-sharing structure to provide equitable, scalable, and sustainable computer science teaching and learning opportunities at all schools in California.

#### ACKNOWLEDGMENT

This material is based on work supported by the National Science Foundation under Grant # 1837780. We would like to thank our RPP partners Jared Amalong and Louise Stymeist of Sacramento County Office of Education; Steve Kong, Steve Dunlap, and Jessie Gurbada of Riverside Unified School District; Bryan Twarek of San Francisco Unified School District; Sophia Mendoza of Los Angeles Unified School District; and Michele Dawson and Dylan Lira of Compton Unified School District. We would also like to thank our research partners at AIR: Joel Knudson, Julie Kochanek, and Joey Wilson.

#### REFERENCES

- [1] CSBA Analysis: California Department of Education, DataQuest. 2018-19 enrollment by ethnicity. Retrieved on October 24, 2019, from <https://bit.ly/361GSJg>.
- [2] J. Margolis, R. Estrella, J. Goode, J. Jellison-Holme, and K. Nao. *Stuck in the Shallow End: Education, Race, and Computing*. Cambridge, MA: MIT Press, 2008/2017.
- [3] A. Scott, S. Koshy, M. Rao, L. Hinton, J. Flapan, A. Martin, and F. McAlear. *Computer Science in California's Schools: An Analysis of Access, Enrollment, and Equity*. Oakland, CA: Kapor Center and CSforCA, 2019.
- [4] A. Scott, A. Martin, F. McAlear, and T.C. Madkins, "Broadening Participation in Computer Science: Existing Out-of-School Initiatives and a Case Study," *ACM Inroads*, 7(4), 2-16, pp. 84-90.
- [5] K. Bobb, "Unifying Equity and Access in Computing," *Medium*, 2018.
- [6] J. Goode, J. Flapan, and J. Margolis. 2018. *Computer Science for All: A School Reform Framework for Broadening Participation in Computing*. In W. G. Tierney, Z. B. Corwin, & A. Ochsner, ed. *Diversifying Digital Learning: Online Literacy and Educational Opportunity*. Baltimore, MD: Johns Hopkins University Press, 45-65.
- [7] L.J. Barker, C. McDowell, and K. Kalahar, "Exploring factors that influence computer science introductory course students to persist in the major." In *ACM SIGCSE Bulletin*, vol. 41, no. 1, 2009, pp. 153-157.
- [8] H.K. Tillberg, and J.M. Cohoon, "Attracting women to the CS major," *Frontiers: a journal of women studies*, 2005, pp. 126-140.
- [9] J. Goode, "If You Build Teachers, Will Students Come? The Role of Teachers in Broadening Computer Science Learning for Urban Youth" *Journal of Educational Computing Research*, vol 36, no 1, 2007, pp. 65-88.
- [10] J. Oakes, *Keeping Track: How Schools Structure Inequality*. New Haven: Yale University Press, 1985.
- [11] J. Oakes, J. "Opportunities, Achievement, and Choice: Women and Minority Students in Science and Mathematics," *Review of Research in Education*, vol 16, 1990, pp. 153-222.
- [12] A. Munson, B. Moskal, A. Harriger, T. Lauriski-Karriker, and D. Heersink, "Computing at the high school level: Changing what teachers and students know and believe," *Computers & Education*, vol 57, no 2, 2011, pp. 1836-1849.
- [13] L. Darling-Hammond, M.E. Hyler, and M. Gardner. *Effective Teacher Professional Development*. Palo Alto, CA: Learning Policy Institute, 2017.
- [14] L. Sutchter, A. Podolsky, and D. Espinoza, D. *Supporting Principals' Learning: Key Features of Effective Programs*. Palo Alto, CA: Learning Policy Institute, 2017.
- [15] L.M. Desimone, A.C. Porter, M.S. Garet, K.S. Yoon, and B.F. Birman, "Effects of professional development on teachers' instruction: Results from a three-year longitudinal study." *Education Evaluation and Policy Analysis*, vol 24, no 2, 2002, pp. 81-112.
- [16] J.J. Ryoo, J. Goode, and J. Margolis, "It takes a village: supporting inquiry-and equity-oriented computer science pedagogy through a professional learning community." *Computer Science Education*, vol 25, no 4, 2015, pp. 351-370
- [17] G. Diaz-Maggioli, *Teacher-Centered Professional Development*. ASCD. 2004.
- [18] P. Cobb, K. Jackson, E.C. Henrick, T.M. Smith, and MIST team. (2018). *Systems for Instructional Improvement: Creating Coherence from the Classroom to the District Office*. Cambridge, MA: Harvard Education Press, 2018.
- [19] C.E. Coburn, W.R. Penuel, and K.E. Geil, *Research-Practice Partnerships: A Strategy for Leveraging Research for Educational Improvement in School Districts*, New York, NY: William T. Grant Foundation, 2013.
- [20] V. Tseng. *Partnerships: Shifting the Dynamics Between Research and Practice*, New York, NY: William T. Grant Foundation, 2012.
- [21] B.J. Fishman, W.R. Penuel, A.R. Allen, and B.H. Cheng (Eds), *Design-based Implementation Research: Theories, Methods, and Exemplars*. New York, NY: Teachers College Press, 2013.
- [22] A.S. Bryk, "Support a Science of Performance Improvement," *Phi Delta Kappan*, vol 90, no. 8, 2009, pp. 597-600.
- [23] A.S. Bryk, L.M. Gomez, and A. Grunow, *Getting Ideas Into Action: Building Networked Improvement Communities in Education*, Stanford, CA: Carnegie Foundation for the Advancement of Teaching, 2010.
- [24] D.M. Berwick, "The Science of Improvement," *The Journal of the American Medical Association*, vol 299, no 10, 2008, pp. 1182-1184.
- [25] A.S. Bryk, L.M. Gomez, A. Grunow, and P.G. LeMahieu, *Learning to improve: How America's schools can get better at getting better*. Harvard Education Press, 2015.
- [26] T. Camp, E. Schanzer, J. Goode, O. Astrachan, and E. Campos. 2017. *CSPd Week: A Scalable Model for Preparing Teachers for CS for All*. In *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education (SIGCSE '17)*. ACM, New York, NY, USA, 645-646. DOI: <https://doi.org/10.1145/3017680.3017681>
- [27] Microsoft and NCWIT. *Guide to Inclusive Computer Science Education*. Retrieved October 1, 2019 from <https://www.ncwit.org/resources/guide-inclusive-computer-science-education-how-educators-can-encourage-and-engage-all>
- [28] L.C. Moll, C. Amanti, D. Neff, and N. Gonzalez, "Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms." *Theory into Practice*, vol 31, no 2, 1992, pp. 132-141.
- [29] N. González, L.C. Moll, and C. Amanti, C. (Eds.), *Funds of Knowledge: Theorizing Practices in Households, Communities, and Classrooms*. New York, NY: Routledge, 2006.
- [30] J.J. Ryoo, C. Estrada, T. Tanksley, and J. Margolis, *Connecting Computer Science Education to Students' Passions: A critical step toward supporting equity in CS education*. University of California, Los Angeles, Center X: Computer Science Equity Project, 2019.
- [31] S. Vakil, *Ethics, Identity, and Political Vision: Toward a Justice-Centered Approach to Equity in Computer Science Education*, *Harvard Educational Review*, vol 88, no 1, 2018, pp. 26-52.