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Preparing School Leaders to Advance Equity in Computer Science Education

RESEARCH

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ABSTRACT

Background and Context: Most large-scale statewide initiatives of the Computer Science for All (CS for All) movement have focused on the classroom level. Critical questions remain about building school and district leadership capacity to support teachers while implementing equitable computer science education that is scalable and sustainable.

Objective: This statewide research-practice partnership, involving university researchers and school leaders from 14 local education agencies (LEA) from district and county offices, addresses the following research question: What do administrators identify as most helpful for understanding issues related to equitable computer science implementation when engaging with a guide and workshop we collaboratively developed to help leadership in such efforts?

Method: Participant surveys, interviews, and workshop observations were analyzed to understand best practices for professional development supporting educational leaders.

Findings: Administrators value computer science professional development resources that: (a) have a clear focus on "equity;" (b) engage with data and examples that deepen understandings of equity; (c) provide networking opportunities; (d) have explicit workshop purpose and activities; and (e) support deeper discussions of computer science implementation challenges through pairing a workshop and a guide.

Implications: Utilizing Ishimaru and Galloway's (2014) framework for equitable leadership practices, this study offers an actionable construct for equitable implementation of computer science including (a) how to build equity leadership and vision; (b) how to enact that vision; and (c) how to scale and sustain that vision. While this construct applies to equitable leadership practices more broadly across all disciplines, we found its application particularly useful when explicitly focused on equity leadership practices in computer science.

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1. INTRODUCTION

As momentum for computer science (CS) education has increased in recent years at the national, state, and local levels, unequal patterns of participation among students of color persist despite more schools offering CS courses to more students across California (Scott et al., 2019). Efforts to broaden participation in computing have been supported in large part by the nationwide CS for All movement, with a commitment to ensuring all students have equal access to CS classes with high-quality instruction and engaging curricula. Despite this growth, large and persistent equity gaps remain in access, enrollment, and success in CS courses, negatively impacting low-income students, underrepresented students of color, female students, and rural students the most (Scott et al., 2019). This is particularly concerning for California, home to the tech industry and one of the largest economies in the world.

Although only 3% of the state's high school students took a CS course in 2017, participation among underrepresented groups remains low when examined by race, gender, and income. Disparities in access are stark, with schools in low-income communities being four times less likely to offer Advanced Placement (AP) CS courses than higher-income communities. While 60% of California high schoolers are Black, Latinx, and Native American/Alaskan Native students, they comprise just 16% of students taking the AP CS A exam and Black students alone comprise just 1% of test takers. Female students make up 50% of the state's high school population, but they are only 29% of students taking introductory CS courses (Scott et al., 2019). CS access is limited for historically underrepresented students, as is access to high-quality instruction in which educators are supported with strong professional development opportunities and rigorous curricula.

Research has uncovered three interlocking factors that contribute to these persistent barriers to underrepresentation and inequity in CS: (1) biased beliefs, (2) technical barriers, and (3) policies (Oakes & Rogers, 2006; Margolis et al., 2008/2017). The biased belief systems refer to the stereotypes educators have about what types of students are inclined to be good at CS. The technical or structural barriers include how students get placed into different courses, and which curriculum and professional development models are offered. Policies at the local, state, and national level regarding teacher credentialing, curriculum standards, and funding can impact the quality and reach of CS learning. However, despite the power school leaders have in allocating resources and supports, school administrators are often overlooked in CS expansion efforts (Zarch et al., 2020).

Building leadership capacity to make decisions that support equity is critical to broadening participation in computing. Administrators have the potential to either provide long-term support to teachers or unwittingly implement policies that undercut expansion efforts. Yet, considering the extensive responsibilities and competing priorities administrators shoulder, they need guidance to make critical decisions about the equitable distribution of opportunities for teaching and learning CS.

In order to address this need, school leaders and university researchers came together in a research-practice partnership (RPP) to develop an administrator guide and workshop supporting leadership implementation of equity-oriented CS education. Through this work, we sought to answer the following research question: What do administrators identify as most helpful for understanding issues related to equitable computer science implementation when engaging with a guide and workshop collaboratively developed to help leadership in such efforts? By answering this question, key approaches to supporting leadership in equity-focused efforts are provided. In what follows, the theories and existing literature informing this effort are shared, followed by a description of our RPP approach, methodology, findings, and implications for broadening participation in CS education.

2. LITERATURE REVIEW & THEORETICAL FRAMEWORK

Implementing equity-oriented and engaging CS learning experiences in public schools is neither easy nor straightforward. Teachers are often the focus of efforts to broaden participation in computing because of their direct contact with students in classrooms and their ability to implement culturally responsive teaching practices to engage historically underserved students (Goode, 2007; Ryoo, Goode, & Margolis, 2015). Yet, teachers also need support from administrators to provide instruction and leadership to spur technical changes to the learning environment. School leaders are responsible for creating a school culture where equity and inclusion are valued, make data informed decisions to organize school schedules and course offerings, and expand opportunities for teaching and learning (Darling-Hammond, 2017; Sutcher, et. al 2017). Administrators are ultimately the ones responsible for determining the appropriate pedagogical and social emotional practices that create equitable schools (Ryoo, 2014; Goode, Flapan et al., 2018).

Ensuring that CS is for "all" requires that diverse stakeholders – teachers, counselors, and administrators – are equally informed about the benefits of CS, while

difficult decisions must be made about: (a) which curricula to implement; (b) which professional development (PD) opportunities to offer; (c) how to ensure students are not missing opportunities to enroll in CS or tracked out of CS based on race, gender, home language, etc.; and (d) how to build CS into existing course schedules (Flapan, Ryoo, & Hadad, 2020). Administrators also carefully consider the local political and educational contexts of their school community that impact these decisions. It is important for school leadership (principals, district or county leaders, CS coordinators, lead teachers, teachers on special assignment) to examine the equity implications of bringing CS into schools in order to avoid simply inserting ineffective or disengaging CS on top of an already inequitable schooling system.

Our nation's history of racism and other forms of discrimination and bias is manifested today in structural school inequalities that result in unfair and unequal learning outcomes. CS education is one window into how these inequalities get reproduced in our public education system (Margolis et al., 2008/2017). To interrupt that cycle, school leaders must transform their practices with an eye toward equity around class, language, race, ethnicity, gender and gender identity, and intersections of multiple identities. Yet, administrators can benefit from an explicit process to examine their role in computer science education reform and the power they hold in its equitable implementation. We have found Ishimaru & Galloway's (2014) conceptual framework of equitable leadership practices as a helpful guide toward CS education in the broader context of equity, leadership, and organizational change.

This project aligns with Ishimaru and Galloway's (2014) framework of equitable leadership practices that prioritize improving the schooling experiences of minoritized students who have been discriminated against based on race/ethnicity, class, home language, and/or ability. These practices[1] are outlined below:

- Constructing and enacting an equity vision: leadership collaborates with the entire school community, while prioritizing the perspectives of those most marginalized, to jointly define what equity should look like while taking steps to enact that vision;
- Supervising for equitable teaching and learning: leadership ensures that educators are provided appropriate PD and support to engage in equitable teaching practices while also holding all staff accountable to such learning and practice;
- Developing organizational leadership for equity: leadership supports others in also becoming leaders across the community, from teachers to students to parents;
- Fostering an equitable school culture: leadership ensures community members feel heard, builds respectful and authentic relationships, and addresses issues of racism, bullying, etc.;
- Allocating resources: leadership distributes resources to students who have been historically underserved, moving away from the "sameness is fairness" that benefits the privileged;
- Hiring and placing personnel: recruitment and retention of minoritized staff is prioritized;
- Collaborating with families and communities: related to the first practice, leadership engages regularly with families and community in ways that support a collective equity vision;
- Engaging in self-reflection and growth for equity: leadership engages in life-long learning regarding the ways power directly impacts educational and personal practice;
- Modeling: leadership "leads by example" and follows through on equity promises;
- Influencing the sociopolitical context: leaders use their institutional and cultural power to serve as allies to teachers, students, and parents/community members.

We leveraged Ishimaru and Galloway's framework to build leadership capacity for equitable CS education, in order to expand opportunities for teaching and learning CS in schools, while prioritizing the needs of low-income students, Black, Latinx, and others that are underrepresented in computing. This project has produced two specific interventions that help build capacity and align with equitable leadership practices: (a) The CS Equity Guide and (b) the Administrator Workshop.

3. STUDY CONTEXT

3.1. COMPUTER SCIENCE EDUCATION IN CALIFORNIA

In response to the unequal CS learning opportunities experienced by California's 6.2 million students who are over 60% Latinx, African American, and Native American (Scott et al., 2019), diverse stakeholders came together in 2012 to form the Alliance for California Computing Education for Students and Schools (ACCESS), a multi-stakeholder coalition advocating for equity in CS, now known as CSforCA. This group included various elected officials, district leaders, CS teachers, higher education faculty, industry leaders, and parents, all committed to equity in CS education (*csforca.org*).

The CSforCA coalition helped set in motion the scaling of CS in the state: (a) Governor Brown signed legislation and appointed an advisory board to develop a multi-year strategic CS implementation plan, and (b) the California Department of Education made recommendations to

the State Board of Education to adopt Computer Science standards.

3.2. RESEARCH-PRACTICE PARTNERSHIP

Building on this state-wide momentum, university researchers and school leaders representing 14 local education agencies ("LEA" refers to a school district or regional county office of education) formed a research-practice partnership (RPP) with a shared commitment to build leadership capacity in equity-oriented CS implementation. The collaboration represents a range of urban, suburban, and rural public school contexts to address real problems of practice through shared analyses that build on the strengths of both researcher and practitioner perspectives (Coburn, Penuel, & Geil, 2013) toward the improved use of research in decision making (Tseng, 2012) and educational outcomes (Fishman, Penuel, Allen, & Cheng, 2013). Our RPP drew on several characteristics of Networked Improvement Communities, a form of RPP in which participants leverage data across contexts, building on the varied perspectives and experiences of different settings to advance understandings about what works where, when, and under what conditions (Bryk, 2009; Bryk, Gomez, & Grunow, 2010; Berwick, 2008; Coburn, et al., 2013).

The RPP determined that the best way to build leadership capacity for equitable CS implementation that addresses inequitable schooling structures would be through the development of a guide for equitable CS implementation used in conjunction with an interactive administrator workshop. Both were collaboratively created and piloted in the summer of 2019. While the RPP is ongoing and continually iterating on the guide and the workshop, this research was conducted from April 2019 to May 2020, focusing on the guide and workshop as they existed within that timeframe to answer the research question: What do administrators identify as most helpful for understanding issues related to equitable CS implementation when engaging with the administrator guide and workshop?

3.3. A GUIDE FOR EQUITABLE IMPLEMENTATION OF CS FOR ADMINISTRATORS

The first resource developed to build administrator capacity for leading equitable CS education implementation was a guide for CS for administrators, titled "the CS Equity Guide." This guide was intended to be a starting point for translating an equity vision into practical steps for implementation, along with additional resources for support. The main development of the guide initially centered on the experiences of two early-adopter administrators who had pushed to implement CS more fully in their districts. In order to build on their experiences, researchers interviewed administrators from other districts and counties throughout the state, asking them:

- What would you have wanted to know about CS implementation before you were tasked with this role?
- What were your priorities and challenges in the first 6 months of implementation?
- What is most important for a new district leader to know about implementing high-quality CS?
- What are the issues that district leaders need to pay attention to in terms of equity in CS education?
- What resources do you use when you have questions about CS implementation?

Researchers and district leaders grouped the content into categories and produced a 46-page downloadable guide in PDF format, as well as a printed version, that incorporated links to resources and quotes from administrators that provided detail about specific situations (an updated version of the guide can be found at *csforca.org/csequityguide/*). Chapters of the guide included Developing Pathways; Students and Recruitment; In the Classroom; Preparing and Supporting Teachers; Funding; Family, Community, and Industry; and Out-of-School Learning. CS education researchers and other administrators read initial drafts of the guide and provided feedback and additional content, some of which are detailed in the findings below.

3.4. THE ADMINISTRATOR WORKSHOP

The second key strategy for building administrator capacity was the development of a one-day workshop targeted at leaders from the school, district, and county levels. A subgroup of the RPP met weekly for two months and used experiences from previous workshops and the feedback from the CS Equity Guide to develop the Administrator Workshop.

The first Administrator Workshop took place during "Summer of CS," a 5-day CS professional development week hosted by Sacramento County Office of Education in June 2019. To respond to the systemic nature of CS education implementation, the goal was to create a unique multi-stakeholder regional professional development experience for teams of teachers, administrators, and school counselors. To enable its sustainability, designers developed the professional learning program to allow flexibility and regional replication. Funded as a pilot project by grants and corporate gifts, Summer of CS was made available to educators and administrators from smaller districts and rural counties that would normally struggle to gather the resources and assemble for a quality CS professional learning experience. In addition to individual workshops, attendees came together to engage in a panel

discussion with policymakers, industry, researchers, and education professionals. Social events were also planned throughout the week to encourage networking among all stakeholders.

The Administrator Workshop began with a grounding activity, which set the tone for the interactive workshop and reviewed norms to encourage respectful dialogue. Participants engaged in a think-pair-share activity to examine bias and challenge stereotypes by reflecting on early experiences that shaped their own career choices. Participants shared responses with a partner, and then with the whole group, describing how their own biases might influence the decisions they make as administrators.

In order to provide the participants with context, our research partners from the Kapor Center provided demographic data on who is and is not currently receiving CS education in California. Then, our RPP partner from San Francisco Unified School District provided a case study describing their choices in CS implementation, where they have had success, where they are still struggling, and their strategy to face those challenges.

This was followed by a carousel brainstorm activity composed of six challenges that complicate equitable CS implementation. These challenges, based on topics from the CS Equity Guide, were posted along the wall and participants used post-it notes to contribute questions or suggestions for addressing each challenge. The workshops concluded with an action planning activity and a curated list of resources to help support participants in achieving their goals.

4. RESEARCH METHODS

Our RPP engaged in "participatory knowledge building" (Santo et al., 2017) by leveraging the principles of Plan-Do-Study-Act (PDSA) cycles to iteratively improve on the guide and workshop toward answering our research question regarding what supports education leaders want in order to better understand issues related to equity-oriented implementation of CS education in public schools. The process included: (1) developing a plan for scaling equitable CS education (Plan), (2) carrying out the plan with tools and workshops (Do), (3) observing and learning from the results (Study), and (4) identifying modifications that could improve the usefulness of the tools and supports (Act). We collected and analyzed the following data sources: (a) meeting notes and recordings, (b) collaborative documents, (c) observation field notes of the workshop that focused on interactions between administrator participants, (d) post-workshop participant surveys, and (e) interviews with district and county administrators/leaders that informed the creation of the Guide and offered feedback following the pilot Administrator Workshop.

Our RPP research partner, the American Institutes for Research, led data collection and analysis of the guide and workshop feedback surveys and interviews in their role as external evaluators of the RPP. The research team collected and analyzed data sources related to meeting notes and recordings, collaborative documents, observation field notes, interviews informing the guide and workshop, and post-workshop interviews of the facilitators.

4.1. DATA COLLECTION AND ANALYSIS FOR THE CS EQUITY GUIDE

Members of the RPP identified a set of district administrators and other leaders of the CS education community whose experience and insights could provide valuable feedback about the guide. Researchers conducted interviews with 15 of these stakeholders using a cognitive interview style designed to elicit an understanding of how a reader mentally processes and responds to information. The interview protocol asked respondents to think aloud as they reviewed subsets of the guide, sharing their understanding and reactions to what they read. The protocol also asked several questions about respondents' reflections on the guide overall. To enable respondents to offer detailed reactions about specific elements of the guide, the research team asked each respondent questions about only a subset of the guide, which means that no respondent reviewed the guide in its entirety during the interview. Respondents received a copy of the guide in advance of the interviews, and also saw the pages of the guide during the interview when they spoke with the research team.

For general observations about the guide collected from the full set of interview respondents, researchers developed a set of codes to capture key dimensions of interest to the RPP, then assigned these codes to portions of the interview transcripts. Within each code, researchers identified common themes across interview respondents. For individual chapters of the guide – each of which was reviewed by only a subset of interview respondents – researchers also listed specific suggestions about content and language for consideration in the revision process. These data provided evidence for careful review and discussion among the research teams and the broader RPP to surface what worked and did not work for various leaders in relation to the guide.

4.2. DATA COLLECTION AND ANALYSIS FOR THE ADMINISTRATOR WORKSHOP

To gather reactions and feedback about the Administrator Workshop, researchers collected data from workshop attendees in three phases. In Phase One, observation field notes were collected by three researchers scattered at

different group tables around the workshop room, using an agreed upon protocol. The researchers took notes on the dialogue between the participants as they occurred, focusing on their responses to the workshop activities and their interactions with one another. Phase Two, which followed the Summer of CS in June and July 2019, involved collecting survey responses from workshop participants and interviews with a subset of this group, in order to gauge attendees' motivations for participating in the workshop and their immediate reactions about the event's quality. In Phase Three, another round of surveys and interviews conducted in April and May 2020 sought to understand any changes in thinking or behavior that had occurred during the subsequent school year.

The workshop survey was administered to gather input on these key constructs: participants' reasons for attendance, the overall workshop experience, attention to equity, post-workshop plans and actions, and recommendations for improvement. Items in the 2019 survey had been used in surveys to evaluate professional learning events for other NSF-funded RPPs in the CS field; the 2020 survey used many of the same items, as well as newly developed items specific to the Administrator Workshop and to post-workshop activities. Researchers consulted with colleagues with survey expertise and with workshop designers and CS experts to ensure that these new items were psychometrically and substantively appropriate and clear to potential respondents. Of the 24 survey respondents in 2019, the majority (63%) identified as female; 43% of respondents in 2020 were female. Respondents represented a variety of professional roles, primarily district administrators (32% in 2019, 36% in 2020), county or state administrators (24% in 2019, 21% in 2020), and school administrators (16% in 2019, 14% in 2020). The respondent pool also featured diversity in school leadership experience, with 22% reporting 15 years or more in school leadership and 17% reporting none at all. In contrast, leadership in CS education efforts was more limited, with 87% of respondents reporting having 5 or fewer years in 2019 and 80% reporting the same in 2020; 22% of respondents in 2019 reported having less than 1 year or none at all. Researchers generated descriptive statistics of survey results to summarize feedback.

Interviews were also conducted with eight workshop attendees drawing on their experience at the workshop; additional interviews with six attendees in spring 2020 supplemented these perspectives. Researchers analyzed interview data to help frame survey responses as well as specific examples of participant actions taken after the workshop and recommendations for improvement.

Observation notes were partially coded independently by two researchers, who then calibrated their codes by discussing differences between them, and then completed the coding of the observation notes independently.

5. FINDINGS – IMPORTANCE OF PAIRING A GUIDE WITH PROFESSIONAL DEVELOPMENT

Survey and interview data about the CS Equity Guide and Administrator Workshop revealed the extent school leaders appreciated the professional learning opportunities and resources designed to meet their specific needs. Though the observational nature of the study design and the relatively small numbers of respondents do not allow for causal claims, the feedback from practitioners is instructive in order to iteratively improve upon these resources. The main objective is to ensure these resources are responsive to the needs of school leaders in real time, and that the research is actionable and applicable to school and classroom implementation. The following findings describe overall reactions administrators had to both the guide and workshop, as well as key features of both that administrators identified as most useful to their practice.

5.1. CS EQUITY GUIDE: KEY FEATURES SUPPORTING LEADERSHIP CAPACITY

Administrators expressed appreciation for both the content and format of the CS Equity Guide. In particular, interview respondents emphasized the value of a resource created with input from administrators who had already experienced success in their implementation of CS education and the practical advice they offered to meet implementation challenges. One workshop participant explained that the guide was particularly useful because "It's a book full of advice for answering questions that people pose to me every day. Instead of me saying, 'Oh yeah, I had experience with that, and here's what I did,' I just...point to the exact same answer in the CS Equity Guide, and it just gives it more clout." Another participant shared, "The CS Equity Guide is my Bible. It is the single best document that I have ever seen to aid in CS implementation."

The key aspects that administrators identified as valuable included: (a) a clear focus on equity that identifies why equity matters and what it entails; (b) accessibility to a range of audiences; and (c) the importance of pairing the guide with learning opportunities and ongoing professional discussions. These elements are described in detail below.

5.1.1. Focusing on Equity

Overall, data collected suggest that administrators benefit from materials that support their understanding of equity and how to apply this understanding to their leadership.

For some administrators, the value was in the ways the guide "spoke directly to administrators in some practical ways that could make some applications" of equity work. Another person noted, "I love it especially because it's not really a guide for equity—it's a guide for implementation through the lens of equity, and that is really what we need." Keeping equity as the driving force for how to plan and implement CS education was valued by administrators.

However, there were areas where the same respondents felt the guide did not go far enough to address key equity concerns. For example, one interviewee called for an explicit assertion that equity should entail an unequal distribution of resources: "It seems to me that it's missing the underlying thing, which is that underserved communities should have more resources than non-underserved communities." Other respondents called for more details about why equity matters or what it entails. Some wanted more attention paid to districts that are in rural areas or composed entirely of underrepresented populations. Others asked for the language of the guide to be more inclusive, using language such as "theirs" instead of gendered pronouns, or using the term "Latinx" a gender-inclusive reference to Latinos/as, and referring to guardians as "caretakers" rather than "parents" to encompass family diversity and the range of families and students served by CS. Furthermore, respondents recommended attention to disparities in access to the same opportunities and resources – cautioning, for example, against the assumption that all students have computers at home.

Overall, interview responses suggested that equity should be prioritized because, as one respondent explained, "Equity is something that really resonates with administrators and educators right now in general. It's an area that has to be talked about in a practical way." Another interviewee advocated for the importance of administrators doing some self-analysis of their understanding of equity in CS education, using data to reinforce why an equity focus matters.

This feedback suggests that administrators want PD materials to be very explicit about what equity means and why it is important. In order to inform the thinking and behavior of administrators, the application of equity principles to real contexts may be more useful than theoretical conceptions of equity. As such, our RPP has responded to such feedback in a revised version of the guide.

5.1.2. Accessibility to a Range of Audiences

A challenge in creating an implementation handbook like the CS Equity Guide is its relevance to a wide variety of users. The content needs to speak to both those who have never tried bringing CS into their schools, and those who have some experience already. As one person explained, "I think it's effective to a point, but I think a lot of our CTE [career and technical education] teachers—they're still just trying to get kids to take the class." As such, administrators who are still figuring out how to motivate interest in CS need help with key early-implementation steps of bringing computing into their schools, while seasoned administrators with more mature programs can benefit from support in navigating the issues that emerge in more advanced stages of implementation.

Another important focus needed in the CS Equity Guide is greater attention to diversity of contexts. For example, administrators reviewing the guide noted that there are particular challenges facing CS leaders in rural or smaller school districts. Similarly, approaches to CS education differ in important ways between elementary and secondary schools. To be useful in a broad range of education settings, the CS Equity Guide needs to acknowledge and address these issues.

Creating a resource that can address a variety of contexts and serve a range of users means that not all content will be relevant or valuable to every user. For administrators who are already incredibly busy and may not have the energy or time to read through every page of an implementation guide, it is important to create a resource that can be easily digested and detailed, but well-organized so that administrators can access the materials they need when they need them without having to read the entire document. Suggestions from interview respondents included an orientation to the guide provided at the beginning of the document, or even a PowerPoint presentation or video that can help orient the user to its content. Making content available in a more dynamic format than a static PDF file can make it easier to reflect the increasing availability of new resources in the field.

5.1.3. Importance of Pairing the Guide with Learning Opportunities and Ongoing Professional Discussions

While administrators identified valuable aspects of the CS Equity Guide, they also emphasized the importance of integrating the guide into professional learning opportunities and daily practice to help administrators translate the ideas into action. As one respondent explained, "Unless the practitioners at my district feel motivated to do something, it's not going to change. I don't think it's sufficient, and that's where leadership comes in, and that's where I think the conferences, the workshops, are important." Supporting real shifts toward equity-oriented leadership requires more than a convincing implementation guidebook. Administrators with responsibility for CS education can benefit from professional development opportunities with other leaders who can support their learning, challenge

their thinking, and share resources. Importantly, education leaders outside of CS need to see the value of CS education and have opportunities to learn about the benefits and obstacles so that they can help prioritize equity-focused planning and implementation. As such, offering the CS Equity Guide alone is not enough, and parallel efforts should create space for administrators to also work with one another and learn from more experienced district leaders.

5.2. ADMINISTRATOR WORKSHOP: KEY FEATURES SUPPORTING LEADERSHIP CAPACITY

Administrator Workshop participants consistently expressed positive reactions to the learning experience. As one interviewee explained, "I feel like it's one of the better professional developments I've ever attended." Indeed, all survey respondents immediately after the workshop in summer 2019 agreed that it met their expectations. One interviewee noted, "My expectations were really about how do I structure this information in a way that will not burn people out or discourage them and I thought you guys did that really well." All survey respondents in 2019 likewise agreed that the benefits of attending were worth the time they invested (67% strongly agreed), and that it was a useful experience for administrators leading CS programs (67% strongly agreed). The majority of respondents (95%) further agreed that the workshop helped them develop more knowledge about CS education (45% strongly agreed, and 5% disagreed). Responses to identical questions in the spring 2020 follow-up survey suggest that participants' positive reactions to their experience persisted well into the school year: All survey respondents again agreed that the benefits of attending were worth the time they invested (67% strongly agreed) and that the workshop was a useful experience for administrators leading CS programs (67% strongly agreed).

Data collected from workshop participants further provided evidence of lasting benefits into the 2019–20 school year. More specifically, a set of survey items asked about activities that sought to build the capacity of educators to deliver CS content to students. One quarter of respondents indicated that their organization had started to offer guidance for teachers to implement CS programs in their school in the 2019–20 school year. Likewise, one quarter of respondents indicated that their organization had established a districtwide or schoolwide CS team or committee during this school year. Similarly, survey results reflected efforts to expand CS coursework in participants' organizations following the 2019 Administrator Workshop. Nearly 1 in 5 respondents (19%) reported that their organization started introducing new CS courses into their school or district for the first time during the 2019–20 school year; 19% of respondents indicated that they started introducing new CS courses into a district or school that already had CS courses. Although these concrete actions are promising, they also represent behaviors from a minority of attendees. Developers of further workshops might look for ways that can enable participants to translate what they learn into changes throughout the school year.

Survey, interview, and observation data were also triangulated to explore key workshop features most useful for building CS implementation leadership capacity. These included: (a) supporting administrators' understandings/views of equity; (b) using real data from administrators' LEAs as tools for understanding CS implementation decisions; and (c) providing administrators with networking opportunities toward building professional learning communities across regions. Data illustrating these features are detailed below.

5.2.1. Understanding Equity

One of the central purposes of the workshop is to center equity in decisions for implementing CS education. Workshop attendees largely agreed that this focus on equity – what it means, why it is important, how it applies to CS education implementation – was important for their PD experience. Over half of survey respondents (58%) attributed their motivation for attending the workshop to equity-related purposes. As one participant explained in an interview, "I really want to support increasing the equity and access for all students, and I really want to be a part of this movement."

Following the workshop, all survey respondents agreed that they increased their understanding of what equity means in the context of CS education (65% strongly agreeing) and why equitable access to CS instruction should be a priority (with 83% strongly agreeing). In response to an open-ended survey question about new perspectives or experiences that respondents gained through the workshop, one participant proclaimed that the workshop "really twisted my view on equity—in a good way!" Another survey respondent added, "I developed a greater sense of urgency to promote equity in CS." During the 2019–20 school year following the workshop, 40% of respondents reported that their organization tried to identify barriers to CS education for the first time and 27% indicated that their LEA took action to address barriers that stand in the way of an equitable CS program for the first time. While these results are promising, it leaves room for continued growth and persistence to support administrators in meeting the challenges of equitable implementation.

The workshop sought to encourage an examination of equity through explicit discussions about definitions of equity, as well as distinctions between the concepts

of equity and equality. Equity was also the focus of conversations throughout the meeting, as in a think-pair-share activity during which an attendee described a friend who struggled in traditional school settings, yet found a viable career in CS after attending a coding bootcamp. He shared how this influenced his LEA to prioritize access and agency for students: "Our team's been intentional – maybe not all kids will take CSA (AP Computer Science A) or CSP (AP Computer Science Principles), but let's give them enough exposure early on and throughout experiences in school so that they can make those decisions themselves." Another person reflected on the importance of having diverse teachers teaching CS, arguing that "the first way into inclusion is role-modeling of teachers – diversity of teachers – and I wish they defined what a computer scientist looks like." Soon after, another participant shared that in reflecting on their career pathway, "social capital and privilege" were incredibly important and "the amount of tracking we have in our systems at a very young age [results in] students' trajectories [being] predetermined." Reflecting on issues such as teacher and student diversity, tracking, social capital, and privilege generated discussions that challenged participants to think critically about key equity issues.

Still, administrators want more support. In the spring 2020 follow-up survey, 44% of respondents disagreed that they have the resources and support needed to pursue CS education efforts equitably in their organizations. One participant recommended that workshop conversations about equity should go deeper by providing "more actionable steps around breaking down equity barriers, beyond just identifying them." These data highlight the importance of making professional development for administrators action-oriented, supporting leadership in applying definitions and understandings of equity to their own practice and making sure administrators feel ongoing support.

5.2.2. Using "Real Data" and "Real Experiences"

Additional features of the Administrator Workshop include a review of CS enrollment and student demographic data from across the state, as well as learning from CS implementation examples from various RPP partners. Feedback from participants suggests that grounding the professional development experience in such "real data" and "real experiences" is critical for administrators.

More specifically, half of the interview respondents expressed appreciation for an opening presentation focused on the state of CS education equity. As one person shared, "I definitely gained a lot more knowledge about what is happening much more broadly." Three interviewees also expressed appreciation for a workshop presentation offered by a school district leader about their CS implementation pathway. One such individual reflected:

> That made me feel better. They were in the same boat. They made some changes. Maybe … they have some advantages I don't have, but they did something that is changing outcomes: 'This was our reality. This is what we actually did, and we got improved results.' That was inspiring.

Learning from others' experiences helped participants "know how it's done" and see how other districts manage "competing interests…finding qualified teachers, resources, curriculum." Open-ended survey responses and interview data collected in spring 2020 underscored this priority; three interview respondents expressed their interest in learning about models of effective CS education programs in future workshops. Participant perspectives suggest that learning directly from actual data and lived experience are important features of effective professional learning for administrators. The carousel brainstorm activity helped lift up attendees' experiences and illustrates the value of drawing on the experiences of practice, and how shared reflections help focus on leading with equity:

> *A small group of administrators considered their responses to a hypothetical scenario in which a district's CS students are primarily White and Asian males, yet a teacher views participation as a reflection of "just who is interested in CS" rather than an equity problem. In a discussion of the group's reactions to the challenge, some participants emphasized the importance of data to uncover priorities and roadblocks. According to one participant, "The part I feel is missing is I don't see any students on here, I don't see any parents…I would hope they are all included." Another person in the small group agreed, replying, "Where are student surveys? [They should be asking] why aren't students (girls, kids of color) taking the course? They [students] might inform that discussion." Yet another reflected on some of the structural barriers to access, noting that "sometimes when it is offered as an elective it competes with other courses."*

As the administrators considered how navigating conflicts in the master schedule may be important to broadening participation, they reflected on what might or might not work through the lens of their own schools. They identified what needs further examination with data and the need to raise school-wide awareness of CS education and its value. By grounding administrators' learning about CS

implementation in real challenges that arise in school districts and LEAs, administrators think together about what bringing CS into their schools could or should look like.

5.2.3. Networking

Opportunities for networking – where participants established and maintained connections with colleagues in CS education from other organizations – were among the most prominent of the benefits administrators gained from the workshop. When asked why they chose to attend the professional development and what they hoped to gain, 46% of survey respondents mentioned the appeal of networking with other administrators. As one participant explained, "I appreciate the opportunity to meet with administrators and hear the obstacles they are facing in implementing strategies around CS." Other comments echoed the importance of meeting face-to-face with colleagues who were already committed to the same effort to keep equity at the center of CS implementation.

Immediately following the workshop, all survey respondents agreed that it was beneficial to attend professional development with other education stakeholders (63% strongly agreed). According to one respondent,

> 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 they had experienced, what difficulties they were having, and just using that time to network .... I think the networking part was really, really good. It was really beneficial.

When breaking down the specific components of the workshop that were most useful, attendees highlighted how opportunities to self-select into small groups for conversations about a shared challenge was incredibly valuable. One respondent explained, "Especially district staff, you're a little bit isolated, so I just enjoyed ... having the opportunity to talk with other people who are doing the work, learn from them, and hear their stories." The following vignette illustrates a discussion during which administrators sat together to talk, hear each other's stories, and learn from one another.

> *Five administrators sat together at one table and discussed the challenges of leading teachers in a transition from focusing on typing and general computer skills to an emphasis on CS. One principal (S) described her school as "an old school model" where freshman computer classes focus on how to type faster and use Microsoft Office tools instead of teaching CS. She described challenges with enacting school-wide change, despite having a teacher who wants to teach something more meaningful and CS related. Yet another participant (A) voiced frustration with the limited CS opportunities available in their organization despite early student exposure to more rigorous experiences: "In eighth grade they are taking code.org and then come to high school and are opening word docs..." S replied, "The kids aren't the problem, it's the teachers. They are worried about the typing and understanding how to indent!" S shared her frustration that her teachers think that teaching typing alone was valuable but she didn't think this was enough. Other group members shared similar concerns about whether the technology courses they offered were really adequate and rigorous enough to prepare students to learn CS. They shared ideas about how to create shifts in their school communities.*

This vignette shows how networking happened within the workshop allowed administrators to learn from each other to address real CS implementation questions in their local contexts. A few weeks after this workshop, S shared that she was overhauling the tech courses at her school and preparing teachers to focus on an introductory inquiry-oriented, equity-minded curriculum that would replace the typing class. She had shifted her school from featuring no real CS coursework to offering introductory CS with the purpose of broadening participation in computing. She attributed this change to the ideas she learned from colleagues at the workshop.

Participants experienced the benefits of networking not only through the exchange of ideas during the workshop, but through connections that led to ongoing interactions over the course of the school year. Although these connections varied in frequency and level of engagement, all survey respondents in spring 2020 reported that some form of interaction with other workshop participants took place at least once during the 2019–20 school year. All respondents indicated that they read emails, discussions, and resources shared by other participants at least a few times in the last year, and more than a third (37%) did so on a weekly basis. Moreover, 87% exchanged CS education ideas and resources with other participants, 81% discussed barriers to implementing CS education with other participants, and 69% introduced their colleagues to other workshop participants at least a few times in the last year.

Administrator professional development focused on building networking opportunities and professional learning communities may be especially important in the field of CS, where schools, districts, and counties may not yet have well-established programs that enable CS education leaders to work with peers within their own

systems. Building these opportunities for networking well beyond the workshop may be an important step in realizing the full potential of the workshop.

6. DISCUSSION

The decisions school administrators make can have a substantial impact on how responsive their schools are to students who have been historically disadvantaged (Gardiner & Enomoto, 2006). Unfortunately, many school leaders indicate that their pre-service leadership education did not provide sufficient training on equity issues (Gardiner & Enomoto, 2006; Zaretsky, Moreau, & Faircloth, 2008). The development and dissemination of the CS Equity Guide and the Administrator Workshop aimed to narrow this gap, with the specific goal of remedying issues of underrepresentation and unequal access to CS education. This research investigated supports to help administrators implement CS in a way that addresses inequitable schooling structures within an unequal education system.

Survey, interview, and observation field note findings highlighted key features of both the CS Equity Guide and the Administrator Workshop that participants found most useful for building their leadership capacity. With both resources, these findings included the importance of: (a) offering a clear focus and explanation of "equity;" (b) engaging with data and implementation examples in ways that deepen the understanding of equity; and (c) providing networking opportunities. The input received from workshop participants and users of the guide is consistent with the conceptual framework outlined by Ishimaru and Galloway's (2014) equitable leadership practices. These practices include leadership capacity, responding to inequities, and developing a school culture that is sustained through inquiry and a focus on equity. In an effort to map these findings to the research on equitable leadership practices, we offer an actionable construct that is specific to equitable implementation of CS. In response to the research question, we have summarized key points from Ishimaru and Galloway's equitable leadership practices and organized these findings into the following three areas of support that school leaders gained from participating in the Administrator Workshop while using the accompanying CS Equity Guide: (a) building equity leadership and vision; (b) enacting that vision; and (c) scaling and sustaining that vision. We explore these areas in greater detail below.

6.1. BUILDING EQUITY LEADERSHIP AND VISION FOR COMPUTER SCIENCE EDUCATION

The findings reveal features of both the CS Equity Guide and the Administrator Workshop that help administrators better understand the challenges and ways to respond to them in order to make CS education equitable. Building equity leadership and vision sets the stage for how administrators will make decisions about the design and implementation of CS education. By understanding their role, and articulating the kind of organization they want to lead and how they want to lead it, administrators define the values that guide their decisions and actions (Frattura & Capper, 2007) through a process of engaging in self-reflection and growth. Ishimaru and Galloway (2014) state that leadership practice for equity requires the ability to "(a) examine individual and collective practices and underlying biases and assumptions, (b) dialogue about equitable teaching and learning grounded in systemic and historical understandings of disparities, and (c) collaborate to change educational practice to provide a high-quality education for each student" (pg. 113).

As the first activity of the Administrator Workshop, facilitators led a process where participants brainstormed a collective definition of equity to keep focus, while simultaneously creating a safe space to engage in deep conversations about equity and the individual role every stakeholder plays in advancing equity or subconsciously reproducing inequitable structures in our schools. As participants learned more about themselves and each other, they examined their unconscious biases and how their positionality influences the decisions they make about students and the opportunities they make available to them. Administrators expressed appreciation for the opportunity to examine their identities, biases, and assumptions. Yet, they also articulated a desire for more guidance to address these biases beyond just identifying them; in other words, how to build from administrators' conceptions of equitable leadership to embrace practices consistent with those conceptions.

Participants found the CS Equity Guide and the Administrator Workshop useful in both shaping their understanding of equity, as well as providing a path for how to use that understanding to provide more access to their students. Although the workshop did not dive deep into developing a vision for equity, it set the stage for administrators to better understand what is needed and who should be a part of that vision creation upon return to the LEA. Facilitators offered additional resources, exemplars, and actionable steps to move visions of equitable CS education to reality.

6.2. PUTTING EQUITY VISION INTO PRACTICE

Constructing and enacting an equity vision is linked to effective school reform efforts and student outcomes (Mayrowetz & Weinstein, 1999). Such a vision prioritizes eliminating systemic disparities, and lifts up the voices of

those who have been historically marginalized (Ishimaru & Galloway, 2014). One of the greatest challenges for administrators when it comes to CS is understanding what CS is, what CS is not, and why every student should have access to this discipline. Both the CS Equity Guide and the Administrator Workshop helped administrators understand CS and its importance, while also helping to develop a common set of equity-focused principles when identifying curriculum and professional learning opportunities for teachers.

The Administrator Workshop helped build equity leadership and put this vision into practice by having administrators investigate what equitable implementation actually means and examine data to determine where their LEA stands in terms of equitable CS education. A researcher presented the context of equity and access in CS and provided a data tool for administrators to identify equity gaps across the entire state, as well as their own regions, schools, and districts or counties. This examination of both the state-wide and community-focused data enabled administrators to (a) connect to a larger movement and understand their role in that movement and (b) address the gaps in their own community by introducing new CS courses into their schools.

Clarifying values for equity is one important step, but how those values get enacted in school budgets is one tangible way to ensure it. As readers of the CS Equity Guide pointed out, the reallocation of resources to underserved communities must be made explicit and done with intention in order to interrupt inequitable systems. Identifying the funding mechanisms to support this vision remains a challenge. Restrictive budgets and collisions with entrenched inequitable systems can make equitable implementation feel out-of-reach for some administrators, so leaders need to be exposed to various entry-points, paths, and sequenced opportunities that lead them toward a more equitable implementation of CS that is both scalable and sustainable.

6.3. SCALING AND SUSTAINING LEADERSHIP FOR EQUITY IN CS

The CS Equity Guide and Administrator Workshop sought to scale and sustain effective leadership practices through school- and community-level efforts. By featuring the Administrator Workshop during the Summer of CS, administrators were able to engage and support alongside their teacher and counselor team. With equity in CS as the foundation for each professional learning experience, these diverse stakeholder teams develop a shared vision for equitable CS education from multiple vantage points that would share in the commitment and vision to equity in CS. This distributed form of leadership can assist capacity building within schools, contributing to school improvement (Harris, 2004).

As the CS Equity Guide and Administrator Workshop were positioned to develop leadership for equity, they aimed to foster an equitable school culture by enacting a shared vision for equity in CS. With a small team reflecting on their personal and professional roles to interrupt inequity, teachers, counselors, and administrators could take inventory and collectively develop an inclusive school culture that values the voices and contributions of students and their multiple identities. When leadership includes and empowers staff and is guided by a shared vision, the influence on student achievement is substantial (Marks & Printy, 2003).

Attendees also used the workshop as a way to make connections that could extend their networks to individuals in other districts. Such an opportunity enabled participants to find support and build their own learning communities to hold each other accountable for the action plans they created in the workshop. These connections allowed them to exchange ideas and discuss challenges with other participants throughout the school year. Findings also indicated that having access to a guide written by early-adopter administrators helped them feel supported and connected.

Finally, we considered how the learning could be sustained in the long term by exerting influence through coalitions (Darling-Hammond, Hyler, & Gardner, 2017). One means of doing so was by encouraging administrators to join alliances such as CSforCA, CSforAll, the Computer Science Teachers Association, and other professional associations. By getting involved in the larger movement and engaging in what Anderson (2009) describes as *advocacy leadership*, administrators can make real change in the classroom, connecting the education sphere with the goals of community and the common good (Anderson, 2009).

6.4. LIMITATIONS OF THE STUDY

Changes to administrator leadership capacity are heavily influenced by the schools, districts, and larger socio-political context in which they work. This study is limited by not measuring these factors and the ways in which they influence individual administrators' efficacy in promoting and implementing equitable computer science education. In addition, the administrators that were surveyed, interviewed, and observed were a small sample size, and were self-selecting because they chose to attend a workshop that focused on equitable CS integration. It would be useful to expand on this research by including quasi-experimental elements and collecting data over a longer period of time to better understand how these resources impacted implementation.

7. CONCLUSION

The implementation of CS education provides school leaders with a clear example of how their leadership practice can interrupt inequality that is so deeply rooted in our education system. While most education leaders would agree that equity is an important goal, they are often unsure of specific actions that are at once measurable, scalable and sustainable. The CS Equity Guide and the Administrator Workshop provide a roadmap for administrators to enact equity.

Our experience illustrates the various stages of the process of developing an equity vision and how administrators plan on getting there. Some already have a vision, some are struggling to put that vision into practice, while others are just learning about CS and why it is important. The workshop could be strengthened by helping administrators along various stages in CS education implementation, with the guide and workshop articulating the constant tension that always exists between what is ideal in equitable implementation and what is possible at that current moment.

In order for administrators to feel supported beyond the workshop, we plan to develop ongoing professional learning communities to translate equity visions into action. Since some of the action plans administrators developed were nebulous at the conclusion of the workshop, it will be even more important to provide guidance and structure to school leaders as they navigate the continued challenge of equitable implementation of CS. As school leaders experience this tangible and practical application of equitable leadership practices in CS, we hope that they will apply these practices beyond CS and thread equity more broadly throughout their school context.

As we navigate the dual crises of racial inequality and the COVID-19 pandemic, our work to build equitable leadership capacity has never been more urgent. With increased attention to anti-racist education that centers the need for equitable policies and practices on a systemic level, school leaders are tasked with upending inequality by leveraging their positions of power and influence. More research is needed to examine what school leadership will look like in these post-pandemic spaces and how these efforts to scale equitable policies and practices will increase meaningful teaching and learning opportunities in CS education specifically and more generally in our systems of public education.

NOTE

1 Ishimaru and Galloway's (2014) leadership practices are aligned with six national Interstate School Leaders Licensure Consortium standards which have been adopted in over 40 states in the country.

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COMPETING INTERESTS

The authors have no competing interests to declare.

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