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Rac(e)ing to computer science for all: how teachers talk and learn about equity in professional development

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ABSTRACT

Background and Context: Though computer science education is marked by a pronounced racial participation gap, there is little research about effective ways that teachers can be supported in creating racially-just and equitable computer science learning opportunities for students.

Objectives: This paper examines how teachers engage in learning about race and equity in computer science education during professional development.

Method: Drawing from data collected from 94 participants attending a summer week-long Exploring Computer Science workshop, this mixed-methods study revealed how key curricular and instructional features of professional development foster race-conscious discussions and shifts in beliefs and agency around broadening participation in computing.

Findings: Given the importance of developing teacher capacity to increase opportunities for students of color in computing classrooms, the findings of this study highlight how intentionally integrating race education in the center of professional development for teachers can support teachers' equity-based beliefs and practices.

Implications: Professional development for teachers that seeks to broaden participation in computing is supported by long-term professional learning that explicitly center issues of race and equity in the curriculum.

As teachers gather on the morning of the second day of the Exploring Computer Science summer professional development, the classroom is abuzz with conversation. Listening closely to conversations that are taking place about the reading from "Stuck in the Shallow End: Education, Race and Computing", from the night before, it's apparent that teachers seem to avoid conversations around race. Comments such as those that follow take a colorblind tone: "It's a conflation between race and poverty; growing up in the Bronx I didn't get to go to pools until I moved to Long Island"; "Poverty is the issue. Regardless of race, the military kids do well"; "It all comes down to the link between race and poverty and lack of exposure."

Over the past decade, computer science education has become infused in schools across the United States, and yet, there has been a severe and persistent gap in access, participation, and achievement in computer science learning experiences by race. In fact, computer science has one of the most pronounced racial participation gaps of any subject in high school, in terms of enrollment and achievement (College Board, 2019), a gap that continues to become more pronounced in college (Zweban & Bizot, 2018) and in industry professions (John & Carnoy, 2017). Not only does this denial of opportunity influence individual civic and economic participation in students' future lives, but as a field, computer science's race problem limits the industry's social perspectives, which can materialize in discriminatory and even dangerous innovations. Yet, often discourse around computer science education, even when discussing equity issues as the vignette above demonstrates, can take on colorblind language, minimizing the influence of race in steering opportunities to participate meaningfully in computing.

While we know from computing education research that computer science teachers and other school educators often hold deficit-laden perspectives about the suitability of computer science for students of color (Gretter et al., 2019; Margolis et al., 2017) and employ colorblind language when talking about equity (Goode et al., 2020), we are left wondering how teachers can learn about racial inequities in computer science through professional development, and how this learning can support teachers' capacity to make computing more inclusive.

This paper reports on a research study that examined how teachers talk to one another about race and equity during professional development, and how the design of the two-year professional development influenced their understandings on equity and computing. The study also probed the ways in which teachers' sense of agency served to disrupt silence and colorblind discourse within the professional development setting through discussions of structural and pedagogical beliefs and strategies that create race-conscious, inclusive learning spaces for students. We situate this research within a critical framework that spotlights how systems of oppression operate within schools that operate under a guise of neutrality and meritocracy, particularly in "high-status" classrooms such as computer science.

Review of literature

Politics in education

Since the inception of state-sanctioned schools, education has been viewed by many as a neutral space. Teachers are not to infuse their curriculum with politics, notions of societal inequities are kept locked away, and discussions around the -isms: racism, sexism, and ableism, should not occur inside school walls (Apple, 1990; Freire, 1970; hooks, 1994; Nieto, 2006). The long history of pretending that politics and social issues outside of the classroom do not directly impact teaching practice or student learning are ever present in teacher education and professional development programs; the tension of disrupting these unwritten rules is both uncomfortable and scary. This desire to act in an objective and impartial fashion continues to invade dialogue even in spaces that are focused on moving beyond the facade of neutrality. This manifests in a variety of ways including silence around inequities, specifically those related to race, as well as colorblind discourse and the use of code words as an avoidance tactic (Wells, 2014).

Within this study, we aim to better understand the impact of this attempted neutrality on teacher education, and specifically the way in which this occurs within conversations about race in computer science professional development. The study outlined in the paper examines how teachers approach, dialogue, and learn about race and equity in the context of the equity-focused Exploring Computer Science (ECS) professional development. This paper provides insights on how teachers use colorblind discourse to avoid engaging in raced conversations, as well as how potential germination of race-focused conversations is stymied due to the challenge of having politically charged conversation in a space that has traditionally been viewed as apolitical. We also outline the importance of sustained professional learning in developing teachers' knowledge, skills, and discourse in addressing issues of race and inequity when considering "Computer Science for All." We do this in order to grapple with the potential for equity-based conversations within teacher professional development settings as well as to understand the specific ways in which teachers rupture their traditional objective roles in order to engage in equity conversations which center students of color and other marginalized populations.

Colorblind discourse in education

Within the field of critical social science research, conversations around colorblind discourse have become a prevalent theme. The term colorblind, while ubiquitous in scholarship and politics, is a colloquial term associated with language that discounts the inequities people of color experience in institutions and systems. This term, which became widely used during a political move in the 1980s (Bonilla-Silva, 2003) in order to quell the racial turmoil of the 1960s Civil Rights era, posits that all people are equal and therefore people should not "see" color. While this was touted as a way to ensure people were viewed as equals, it disregards and thus erases the life experiences of people of color and the impact of racism (systemic and individual) on their minds and bodies.

In her research, Cochran-Smith (2000) encourages us to problematize the language of colorblindness which is pervasive in education scholarship and preparation of teachers. Explaining that we must counter colorblind education by attending to complex questions that dig deep into anti-racist work, she asks us to consider the ways in which we are " … complicit–intentionally or otherwise–in maintaining cycles of oppression" (p. 158)? While this language of colorblindness has been useful in illuminating race and racism in education, it is important to note the ableist language within the term which denotes blindness as the absence of comprehension and understanding, ignoring the knowledge and assets of visually impaired people (Annamma et al., 2017).

The literature on the impact of colorblind discourse is commonly seen as being connected to White educators, however, as Leonardo (2002) points out, "whiteness is a performance … a racial discourse, whereas the category 'White people' represents a socially constructed identity, usually based on skin color" (p. 31). This is an important distinction as it points to the hegemonic influence of whiteness and the way in which this pervasive language of colorblindness maintains cycles of oppression. In viewing whiteness not as an individual person, but as a system of White supremacy which maintains White privilege and the minoritization of students of color, this provides for a broader systemic lens by which to make sense of the racial disparities in schools across the United States.

This is especially dangerous within education as many White people are unaware of the social construction of whiteness and their role in perpetuating White supremacy (Gillborn, 2005). Wells (2014) furthers this point in noting that while education policies often seem "colorblind," when they are embedded in schools wherein race has historically served as a tracking method, these policies are imposed on students of color in ways that further categorize them and push them to the margins through limiting opportunities to a high quality education.

This colorblind language and system of beliefs made their way into education, impacting the way curricula were created, pedagogy carried out, and students of color treated (Loewen, 2018; Sleeter & Grant, 1991; Zinn, 2001). In computer science, White and certain Asian students have been tracked into advanced computing courses based on assumptions that these students should be interested and excel with technology, while the students of color making up the majority of school populations are tracked *out* of computer science classes based on the same racist stereotypes (Margolis et al., 2017).

Disrupting colorblind discourse in teacher education

A useful piece of work around examining colorblind discourse in teacher professional learning comes from Segall and Garrett (2013) research on how White teacher discourse can operate to actively avoid discussions of race. They identify three common themes of avoiding discussions of race within teachers' discourse: 1) evasion, 2) deflection, and 3) individualistic discourses. They define evading discourses as the refusal to "see" race, thus denying power structures that depend on the social construction of race; deflecting discourses as avoiding conversations about race by clinging to other marginalizations such as gender or ability or class or geography, and individualistic discourses as centering notions of "individual choice" and opportunity to dismiss race.

While the discourse that is present is important to recognize and understand, equally important is the discourse that is not present. Silence can be used to halt discussions around oppression and privilege. In her work around silence in discussions about race, Mazzei (2003) found that White teachers who were often silent, felt burdened by continual conversations about race as they were of the mind that in looking past skin color and seeing individuals beyond their race, they were above racism. In other words, just as colorblind discourse frames are operationalized as a way to disengage from tough conversations about race, silence can reflect the unconscious ways teachers are taught not to notice students' race. Mazzei asks, "So what happens when we do not notice, or are taught not to notice, or pretend not to notice? What can happen is that we lull ourselves into a dream state induced by this soporific silence. A silence that shields and veils until finally, something, someone, shatters the dream" (p. 1126).

As whiteness is held within this dream, Cochran-Smith (2000) argues that educators (regardless of race/ethnicity) must begin the work of unlearning racism; work that is neither quick or easy and instead involves an interrogation of the courses and curricula taught in schools, an interrogation that asks educators to both think deeply about the racist assumptions engrained in educational spaces as well as owning their complicity in maintaining systems of oppression. She uses the term blind-vision to describe this work, which she defines as "the process, grappling (sometimes blindly), with the tension, contradiction, difficulty, pain and failure inherent in unlearning racism" (p. 165). This

requires that teachers do deep self-work and move beyond only viewing their role as a content expert. This becomes especially relevant in a field of computer science which is often viewed as being apolitical and removed from bias and other – isms that shape student learning opportunities.

In fact, Cochran-Smith and Lytle (1992) suggest that challenging colorblindness must begin in pre-service and in-service teacher education programs where teachers and teacher educators have the space to discuss issues of race, ethnicity, class, as well as action plans for change. Other research reports on approaches to infuse pre-service and in-service teacher education programs to include opportunities and frameworks that address and support teachers in unlearning the deficit views that are often held about students of color (Battey & Franke, 2015; Solorzano & Yosso, 2001; Valencia, 1997). These scholars note that developing teachers' understandings of systemic inequities is desperately needed because teachers may wrongfully blame students of color and their families for not participating or academic failure without recognizing the structural barriers unfairly impacting learning opportunities for students of color.

Further, Cochran-Smith and Lytle (1992) illustrate how this hegemony manifests within teachers of color who are frustrated by conversations about race in noting a difference in perspective as the reality of being White in the United States is very different from the reality of being Black in the United States (hooks, 1994). While the result of this difference in perspective manifests in many ways within educational spaces, frustration on the part of teachers of color can lead to a refusal when teachers "refuse" to participate in conversations brimming with colorblind language rather than fall into the "ruse of consent" (Simpson, 2017); consent in this case being to agree with the conversations which deflect and evade the prevalence of racism in this nation. While Simpson speaks specifically in her work about Native communities in calling for a push-back against settler colonialism, this call is important in considering the work around colorblindness as it is vital that research focuses not only on the discourse White teachers engage in, but also the way in which teachers of color can be drawn into this hegemonic discourse, and how they may refuse to participate as a form of political practice. As Simpson (2017) discusses in her work, the notion of refusal can offer " … a possibility for doing things differently for thinking beyond the recognition paradigm that is the agreed-upon 'antidote' for rendering justice in deeply unequal scenes of articulation" (p. 29). This intentional refusal to participate in race discourse with other teachers is important to consider as there is often an expectation of people of color to engage in the labor of this work, when in reality this is on the shoulders of White teachers who are not experiencing racism every day (Ahmed, 2012). Instead, refusal gives us wider insights about why people, particularly Black, Indigenous, and other people of color, either engage or refuse to engage in conversations around this race within computer science professional development. We are informed by the concept of refusal in this research as it helps us to shift the lens by which we approach participant observations, allowing for a nuanced approach of considering teacher discourse that does not center on whiteness and the specific needs of White teachers.

Race, professional development, and computer science education

The concepts of colorblind discourse and refusal speak to the importance of recognizing that schooling is a political practice and thus political identities must be an accepted part

of a teacher's identity. As Cochran-Smith (1995) argues, this requires teachers to embrace their role as social change makers which is the shift that is required in order change the narrative and alter the dysfunction deep in the root of our educational institutions. As computer science enters the core school curriculum in states across the United States, there is much to do in terms of addressing the stereotypes people have about who can and should excel with computing. Part of this effort requires deep analyses of how decisions in computer science impact everyone's daily lives in ways that are directly shaped by programmers' cultural belief systems (e.g. see Benjamin, 2019; Noble, 2018). Computer science and the ways it affects our daily lives needs to be connected to the real political, social, historical, and cultural contexts impacting our sense of ethics and impacting our educational systems and everyday lives (K. A. Scott et al., 2014; Ryoo, 2019; Vakil, 2018). Educators are in a position to consider and enact an agential role in broadening participation in computing (Goode, 2007). In particular, educators need professional development that addresses issues of identity and feelings of isolation that computing teachers encounter in their own contexts, as part of a general goal of broadening participation in computing (Gretter et al., 2019).

Although research across other content areas has shown the importance of centering equity work within professional development, such as for mathematics teachers (Battey & Franke, 2015; Battey et al., 2007), intentionally addressing equity within computer science is especially important due to the gaps that are seen both in regards to computer access for students as well as access to jobs in computer science fields. For example, on the 2015 Advanced Placement Computer Science test only 4% of Black students and 9% of Latinx students took the test with a lower overall pass rates than the national average (Ericson, 2016; Wang & Hejazi Moghadam, 2017). This is furthered by gaps within higher education with only 11% of degrees in computer science being awarded to Black students and 9% awarded to Latinx students during the 2012 school year (Wang & Hejazi Moghadam, 2017). These inequities mirror the industry which has a legacy of racism, sexism, and elitism (O'Mara, 2020), suggesting larger forces of exclusion are at work. As Margolis et al. (2017) note in their book focused specifically on understanding and challenging these gaps:

> We turn on the television, switch to a channel of a basketball game, and without blinking an eye expect to see the court dominated by black male players.
>
> We switch to CNN to watch a board meeting of a major technology company or a young start-up in Silicon Valley, and do not blink an eye at the lack of African American, Latino/a, or female faces. These images of who belongs where lie deep within our psyche. Often, the way the world seems to "look," the segregation in these activities, is taken for granted and rarely questioned; the segregation seems normal, and as such, has become "normalized". (p. 13)

This desire to increase access for students, however, is not a new phenomenon in the field of education, and specifically within computer science as can be seen in the "CS for All" movement (Barnes, 2017; Wang, 2017). In fact, tens of millions of dollars from the National Science Foundation have been directed in recent years to focus directly on efforts to broaden participation in computing in K-12 computer science education, resulting in the development, implementation, and scaling of multiple national curricular and professional development programs (Cuny, 2015). While this movement holds the desire to increase access to under-represented populations at its core, typical professional development opportunities for teachers focus on opening pathways for participation as well as teaching computer science skills

development rather than the pedagogical moves that center discussions of race (Menekse, 2015; Ravitz et al., 2017). In fact, there are currently no published studies or reports about how teachers learn about race and broadening participation in any CS-focused teacher professional development programs outside of ECS.

Though increasing access for students as well as supporting teachers in skill development is important, so is creating space for teachers to interrogate their own understanding of the system in which they work; a system that continues to create barriers for students of color. This normalized discourse and system of beliefs was seen in a Gallup study conducted in 2016 which showed that "Teachers are more likely than parents to say a lack of exposure is a major reason why women and racial and ethnic minorities are underrepresented in CS [computer science] fields" (p. 4). Educators are in a unique position to enact inclusive teaching practices that can provide exposure, encouragement, and meaningful learning experiences to historically underserved populations.

Therefore, engaging teachers in professional development such as ECS, with equity at the very foundation of the experience (Goode et al., 2012), can provide opportunities to disrupt longstanding patterns of homogenous student participation. In this professional learning setting, there exists an opportunity for teachers to engage with culturally relevant and sustaining pedagogy (Gay, 2013; Django-Paris & Alim, 2017), discuss and understand the inequities at the heart of school systems, and embrace their active role in creating social change. Through the lens of computer science, culturally relevant pedagogy involves connecting with homes and communities, building relationships with students to know how to build on their cultural assets, and engaging with the sociopolitical context (Goode et al., 2020; Madkins et al., 2019; Margolis et al., 2012).

Unlike other subject-area teachers who are typically tasked primarily with curricular and pedagogical issues, educators advocating for systemic change and inclusion in computer science have identified multiple educational structures and belief systems that impede equity and inclusion in learning computing. As represented in Figure 1, prior research has
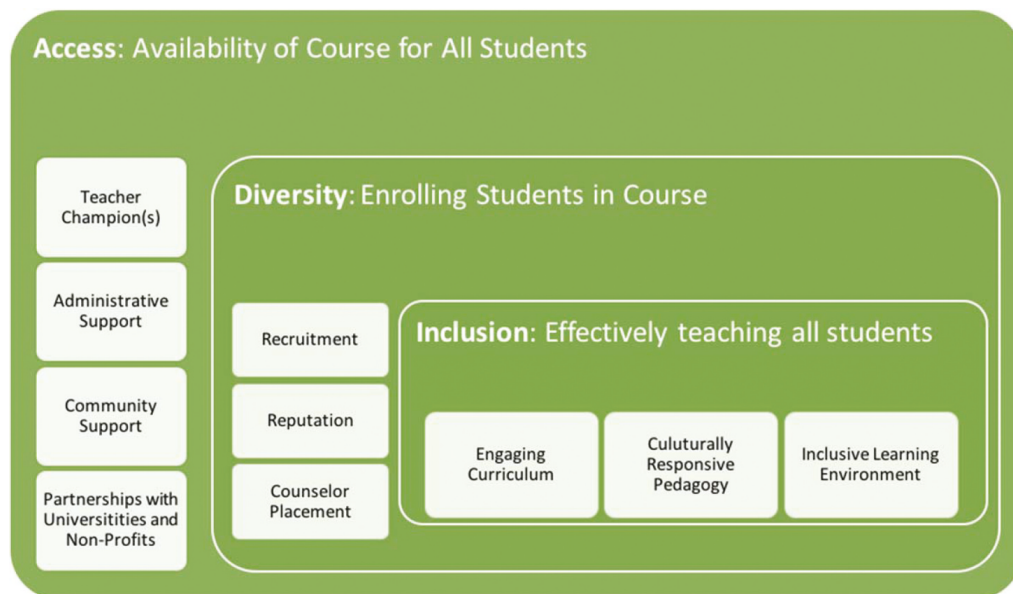

Figure 1. Broadening participation in schools.

demonstrated how racial inequities in the distribution of school-level availability of computing courses (A. Scott et al., 2019), routing of students into computing classrooms (Margolis et al., 2017), and access to culturally responsive curriculum and pedagogy (K. A. Scott et al., 2014) each serve as gatekeepers in engaging students of color in computer science learning experiences. This study seeks to understand how teachers might engage in professional learning and enact agency to address these race-based discrepancies in computer science learning opportunities in their schools and in their classrooms.

Methods

This study took place during a summer week-long professional development in which teachers from across the nation participated as part of their two-year preparation for teaching the ECS course. The ECS program of curriculum and professional development was developed out of the desire to support higher access to computer science curriculum for students of color; computer science curriculum that is pedagogically engaging and provides institutional support for high schools (Goode, Margolis, & Chapman, 2014). This program, designed in response to findings detailed in *Stuck in the Shallow End* (Margolis et al., 2017), involves a yearlong high school computer science curriculum which has been widely adopted in major school districts nationwide. The extensive ECS professional development is designed around three pillars: computer science concepts, inquiry, and equity with activities and a teaching philosophy that is based in research on successful teaching and learning, including active, participatory, creative, and engaged learning, thus modeling the types of instruction that is inclusive and effective in high school classrooms.

Research questions

In this study, we sought to understand:
    How and when do teachers talk about race in computer science professional learning settings?
    How do teachers develop knowledge around equity, race, and computer science over the course of participating in professional development?

Participants

This study's 94 participants were all high school teachers who committed to teaching ECS the year following this summer professional development. Of these teachers, 36 were returning for their second and final week of summer professional learning in the program's 2-year professional development program. The remaining teachers all anticipated teaching the course for the first time during the upcoming school year. The participating teachers were geographically diverse and hailed from 24 states. Most participants identified as women (69%), with the remaining 31% identifying as men. Ethnically, 67% of participants self-identified as White, 15% as Black or African American, 10% as Asian, 7% as Latinx, and 3% as other. No teachers identified as American Indian or Alaska Native.

Participants also represented a range of teaching experience, though many participants brought in extensive classroom experience, with approximately 54% having been classroom teachers for longer than a decade. Interestingly, most teachers (60%) reported having had some experience teaching a core computer science course such as ECS, AP Computer Science Principles and/or AP Computer Science A in the past. These teachers reported teaching computer science (25%) and math (24%) as their primary subject-area disciplines, although participants held a range of certifications and endorsements.

Data sources and analysis

This research study, which employed a mixed methods approach, collected data before, during, and after this professional development week. Our qualitative data collection focused on answering the first research question focused on teacher in professional learning settings. To capture the dialogue and how teachers talked to each other about race, field notes were taken in three different, adjacent professional development classrooms, each composed of approximately 24 teachers. The co-authors of this study observed the duration of the professional development workshop in each of these three classrooms, took paper notes to avoid disruption during the workshop, and transcribed notes and added observer's comments each evening following the workshop. Throughout the week of qualitative data collection, researchers met daily to discuss emerging themes arising from the data across the three professional development classrooms. After the completion of data collection, all notes were loaded into Dedoose collaborative software in order to be coded by the team.

Upon the closing of the professional development, the researchers met together to devise an original code list based on the initial list of emerging themes, alongside key codes identified from the literature around race discourse and teacher agency. After the first round of coding, the researchers met again together, reviewed and refined the codes, co-coded and checked for internal consistency, and recoded with new code-list. This process required continual credibility checks as codes were developed as both an iterative and collaborative effort.

Finally, we met together once more and merged codes into themes that responded to the research questions posed in this study. For the first research question, as there arose a general agreeance around the avoidance of race across all of the observation notes, the colorblind discourse framework (described above) was used. While coding using the four types of colorblind discourse (individualistic, deflective, and evasive) served as a powerful analysis heuristic, based on conversations across the team, we decided to add silence to the codes as this would both extend the previous literature around colorblind discourse as well as broaden our data analysis framework.

The quantitative data, which were collected prior to the start of the professional development and coded post-professional development was used to answer our second research question focused on teacher beliefs. These data were collected from pre-professional development surveys and post-professional development surveys and provided data to capture teacher learning around equity and agency over the course of the week-long professional development workshop. These surveys included a series of nine Likert-scale questions about teacher beliefs, self-efficacy, and agency in equity and

computer science. Each of these items asked participants to answer prompts on a 4-point scale from "Strongly disagree to Strongly agree." The post-professional development survey also included open-ended response items for teachers to expand on their thinking. A total of 58 teachers completed both pre- and post-professional development surveys.

For the second research question, the colorblind discourse framework similarly inspired our coding specific to the varying dimensions of teacher agency that was enacted when discussing equity issues in computer science i.e. access, recruitment, belief systems, pedagogy, etc. In doing this analysis, the quantitative survey data were analyzed through a comparison of mean differences from pre- to post-surveys on each of the nine survey items related to equity. This analysis included determining the bivariate correlation on each item and the effect size using Cohen's d standardized mean difference. Further, we measured the internal consistency of these items using Cronbach's alpha to determine how closely related these items are as a group and to measure the reliability of this equity scale of items.

Critical approach to our methods

We acknowledge the challenges in conducting observations in which we are both "looking" and "listening" for dialogue that centers on issues of race and intersectional notions of equity. While there is much more work to be done around issues of intersectionality, including race, gender, and socioeconomic status, in this study, we are focusing in on race. We approach this carefully, especially in learning about experiences of teachers of color, as we recognize the potential for causing more harm than good. However, we also feel that by not writing on the issues of race in computer science classrooms, and not including the experiences of both White teachers and teachers of color, we would be perpetuating the harm students and teachers of color are subjected to daily. Therefore, we go about the work of looking, listening, and writing about race and teachers' interactions with race, as respectfully and responsibly as we can.

The ECS professional development provides a space where teachers are deeply committed to equity, yet there is still work to be done with regards to engaging with teaching as political work (Nieto, 2006) as deeper discussions about the inequities students face and the structural barriers impacting such inequity are not engaged. Rather, the tension between breaking down the barriers and truly addressing the systemic inequities are both heard and felt through the guise of colorblind discourse on the part of teachers. While oftentimes teachers are not explicitly resistant to discussions around race, their implicit resistance is present within discussions where racial inequities are at the forefront. We argue that this resistance is not based on lack of teacher agency, interest, or engagement, rather that it is due to the system in which teachers exist. As conversations in schools are often mediated by governmental policies which are controlled by private entities, teachers are forced into the logics of technical control which limit their ability to engage in processes of resistance (Apple, 1982). Schools have an air of neutrality about them in that they are "usually overtly insulated from political processes and ideological argumentation" (Apple, 1990, p. 83) which impacts the conversations that teachers feel they are able to engage, thus promoting objective silence rather than resistance and ruptures of traditional norms of schooling.

The ECS professional development was developed out of a desire to support teachers in raced and gendered conversations that move beyond surface level understandings of inequity in our schools, toward engaging in action. Space is created throughout the week for teachers to grapple with difficult conversations and work through tensions caused by the larger schooling system. Teachers were asked to read chapters from *Stuck in the Shallow End* (Margolis et al., 2017), and participate in two discussions around this text that included sharing journal reflections, small group discussions focused on questions of racial inequity and institutional barriers to computer science education, and group presentations/conversations about the schools described in the book and how they compared to teachers' own classrooms/schools.

Further, during the week, teachers also encountered curricular lessons that center race and cultural knowledge in computer science. Importantly, we acknowledge that these conversations can often be challenging because, as cited in the literature above, teachers are often expected to be "colorblind" and treat all students the same, rather than engage in conversations that disentangle differences and barriers to success. Teachers are usually expected to maintain their classrooms as neutral places while avoiding conflict which, in other contexts, could potentially promote growth or new ways of thinking. Our participants have grown up within an educational system that promotes the continuation of the assumption that education is apolitical and neutral, so while our teachers are participating in this training with the intention of creating more equitable classrooms and educational norms, they are still grappling with the ingrained beliefs of the current system and all its inequities. It is with this understanding and appreciation of the knowledge and colorblind contexts in which teachers work that we present these findings.

Findings

Colorblind discourse in professional development

Our first research question inquired about the ways that teachers talked about race in computer science professional development settings, and when these moments took place during the week-long workshop. In order to avoid rupturing the traditional norms inherent in the system, teachers commonly engaged in colorblind discourse which permeated many of the conversations. While this colorblind discourse was more prevalent amongst White teachers and those in their first year of ECS professional development, we still observed instances of this avoidance of talking about race across teachers of color and participants in their second year of ECS professional development. The discourse we examined extends earlier research (Goode, Johnson, & Sundstrom, 2020) and includes analysis of both spoken colorblind language and, how silence was employed during conversations that focused on race.

The colorblind approach to dialogue presented itself in four distinct, yet often overlapping, frames: 1) individualistic framing which occurred when teachers considered individual choice and opportunity to be a central cause of inequities while dismissing race; 2) deflective framing which occurred when teachers would cling to other marginalizations such as gender, socioeconomic status, or geography; 3) evasive framing which occurred when teachers refused to "see" race, thus denying power structures that depend on the social construction of race; and 4) silence which occurred when teachers were

silent around race and racial inequities, which often served to limit conversations around oppression and privilege. This is important framing in the tension between breaking down the barriers and truly addressing the systemic inequities that are both heard and felt through the guise of colorblind discourse on the part of teachers.

Individualistic discourse

While individualistic framing was not as common throughout the conversations, the presence of this discourse was powerful in operationalizing individualized choice as the reason that students of color are often absent from computer science classrooms. Within this frame, teachers continually blamed students of color and their families for their lack of motivation and differing definitions of success. Bill, a first-year White teacher stated that "the biggest problem is kids don't want to be in it," and disagreed with the metaphor used in the text regarding the fact that students of color are "stuck in the shallow end" of computer science due to historical and systemic inequities. Another teacher, Constance, a first-year Black teacher stated that "if they don't participate, it's by choice," when discussing the lack of Black girls in computer science classrooms. During this same conversation, Constance stated that the metaphor does not hold true in her school. While she later admitted to having to recruit for her AP Computer Science classes hence making an implicit connection between access and grades after being pushed by the facilitator, she held strong to her beliefs that participation is based on student choice. Teachers who used this framing continued to show resistance by leveraging the notion that systemic issues are not the cause of lack of participation for students of color in computer science classrooms.

Deflective discourse

Deflective framing permeated teacher dialogue both explicitly through the identification of other factors of marginalization besides race as well as implicitly by clinging to material reasons, career paths, and the lack of exposure to computer science rather than identifying racial inequities. Much like silencing around race, these conversations often avoided race altogether. For example, in a poster presentation describing factors impacting students' access to quality computer science education, most groups did not mention race, however, did mention the following categories as possible reasons for lack of diversity in computer science classrooms: the urban and rural binary, specifically the fact that rural students are "stuck in the shallow end," gender, socioeconomics, family obligations, language barriers, and lack of parental involvement. For example, Anne, a first-year White teacher stated that "it's a conflation between race and poverty," and further identified socioeconomic status as the main barrier to computer science courses. Many others, including Matthew, a first-year White teacher had similar views. He argued that it's "not so much to ethnicity, per se, but socioeconomics," and stated that, "poverty is the issue, regardless of race." He used the example that all military kids do well, which he used as an example to prove that the basis of inequities is socioeconomics. It was clear through these conversations that teachers were operating within a discourse which not only deflected the importance of race but also silenced the racial inequities by refusing to identify race as a potential barrier to access.

Evasive discourse

While these frames were used extensively within teacher's conversations both when prompted by the discussion questions provided by the facilitators as well as during break, by far the most common colorblind frame was an evasion of race through a refusal to acknowledge its existence. When using this frame, teachers often blamed unsupportive administrators and expressed the fact that counselors were often the gate-keepers that keep students out of computer science rather than racism being an issue. For example, Jacob, a first-year White teacher said, "most of our teachers are pretty equitable, are trying to do what's best for the whole student body" but that "it depends on the administration." This was followed by Bill arguing that he did not believe that racism or politics were holding his students back. Jane went so far as to note that, "admin can be a problem – I think our problem is our principal does all the scheduling and reads each student's papers and pushes for apps and pushes for a foreign language course, instead of pushing for tech classes, even though technology is in the name of our school!"

Along with this, teachers continually acknowledged the lack of computer science teachers as well as minimal opportunities for teacher training both with regards to computer science concepts as well as pedagogy. This, along with lack of funding to support teacher training and materials for computer science classrooms was consistently identified as a potential barrier. An example occurred when Constance asked, "are they really keeping people from computer science? My experience has been that they need to have teachers to teach it." She continually argued that teachers aren't trained to teach computer science which is keeping students from taking it. Many of these conversations also focused on lack of interest on part of students as well as a general lack of exposure to computer science throughout students educational career. Belen, a second-year Black teacher stated that "it's not that kids don't want to participate, but they have no interest, it's about exposure, so it's not so much a race thing."

Other teachers explicitly refused to see race altogether. For example, Molly, a first-year White teacher stated during her poster presentation that, "a student asked if I was racist and I was like, oh my gosh no. I cannot see a difference in colors. People are just people to me." Another teacher, Jane, a first-year White teacher said, "I have trouble seeing inequity. When I walk into school, they're all my babies [no matter what race, gender, etc.]. They're my children for the year." While these two teachers more explicitly refused to "see" race in these conversations, thus denying power structures that depend on the social construction of race, all of their dialogue points to a larger issue at hand; many teachers, no matter their level of experience or race, continually avoided conversations around race. This example illustrates not that teachers are apathetic or do not care about their students, but rather that there are structural inequities within our school systems that cause fear and discomfort around issues and conversations about race.

Listening to the silence

Often throughout the week-long professional development, teachers employed silence to refrain from talking about race. This silence occurred in a variety of forms including a general disengagement from the activity, such as fiddling with technology, rather than engaging in the conversation, as well as operationalizing silence using code words. Rather than discussing race, teachers used words such as equity, homogeneous, diversity, and culture rather than explicitly addressing race. While all of these words have

the potential for transformative and powerful conversations with regards to race, within many of the conversations between teachers, these were used as a way to avoid talking about the topic of race as this seemed to be an uncomfortable space for many of the teachers.

Seeking to understand when and why individual educators choose silence over engaging in conversations about inequity in computer science education around *Stuck in the Shallow End*, one of the researchers chatted with Kimberly, a first-year Black teacher who was particularly quiet during conversations about segregation in CS. While walking together during a break, the co-author asked her what she thought of the conversations about *Stuck in the Shallow End*. Kimberly reflected a moment and shared that during this professional development, she liked to "sit back and listen." She noted that you could "tell a lot about people based on what they say," although she did not divulge what she thought of her colleagues during these conversations. Instead, Kimberly explained that she had already read a lot of literature about equity issues in public education and was not surprised by the findings in *Stuck in the Shallow End*. She noted that since she regularly had conversations about equity in public education with her colleagues at home, she chose instead to remain silent during the professional development conversation. This exchange suggested that Kimberly chose silence to cope with discomfort she may have felt with the professional development conversations and fellow participants.

Complicating colorblind discourse

When thinking about the operationalization of colorblind discourse, there exists a common misconception regarding which individuals use colorblind frames. While research often suggests that this discourse is used most commonly by White teachers, the conversations had during the ECS summer professional development continually illustrated that it is not only the White teachers who engage in these frames, rather teachers of color engage in evading, deflecting, and individualistic discourse as well. This can create complications between teachers of color who feel comfortable engaging in race-based conversations and teachers of color who use colorblind frames to resist race-based discussions.

During the *Stuck in the Shallow End* conversations, these complications played out in two different ways. In one instance, Constance, a first-year Black teacher who regularly used colorblind language, engaged in a discussion with Jocelyn, a returning Black teacher who showed comfort and willingness in having race-based conversations. As an assignment from the previous day, teachers were asked to write in their journals about the *Stuck in the Shallow End* metaphor regarding segregation in swimming. Jocelyn, the returning teacher, wrote about her own experience with swimming, having been exposed only because of her mom's job, unlike her Black friends. While her son is now enrolled in swimming because of her exposure as a child, many of her friends think that "she is crazy" because of the historical and cultural history of swimming for African Americans. Once the conversation between her and Constance ensued, Jocelyn's steadfast beliefs about the impact of history on current practice wavered. Constance began the conversation by asking, "are they really keeping people from CS? My experience has been that they need to have teachers to teach it." Jocelyn followed this up by saying, "when they gave it as an option, no one wanted to take it. Just like the swimming thing, they had no interest in it

because they weren't exposed." Constance continued to push the fact that it is up to the individual as well as ensuring that teachers are trained and the conversation ended with Jocelyn stating that, " … it's not so much a race thing."

This exchange illustrates the complex nature of race-based conversations, even between teachers of color. In this encounter, as soon as Jocelyn received pushback from Constance, she eventually agreed with her views rather than attempt to create conflict. This points to a potential tension that teachers may experience when faced with conflict. Since schools rarely value conflict as an opportunity to learn about and better understand others' perspectives, especially when discussing politically charged issues such as race, it may be difficult for educators to push through conflicting ideas in professional development conversations about race and systemic racism.

A second interaction between two teachers discussing *Stuck in the Shallow End* unfolded in a different manner. Nicole, a Black teacher who was comfortable having race-based conversations continually challenged Brett, a Black colleague who employed color-blind discourse. Throughout the initial journaling activity, Nicole and Brett conversed back and forth with Nicole pushing Brett to think differently about his colorblind language. At the beginning of the conversation, Brett noted that "the biggest problem is that [Black] kids don't want to be in it [computer science]." He followed this up by stating that he disagreed with what he read because the metaphor didn't apply to his school. Nicole pushed back, stating that teachers need to ask students and their families why they are not enrolled rather than making assumptions. She argued that many of our assumptions are incorrect and therefore it's important that we learn rather than assume.

While this did not necessarily alter Brett's beliefs around inequities in computer science, Nicole's unwavering desire to ensure that everyone at the table reconsidered colorblind perspectives illustrated the importance of standing strong against those who employ colorblind discourse. These conversations highlight the depth and complexity of race-based conversations amongst teachers and the importance of remaining committed to equity conversations even when others voice other perspectives. These observed conversations reinforce how all teachers, including teachers of color, are entangled within systems of oppression that have a stronghold in schools and society.

Centering race in the curriculum

While colorblind discourse was often the norm in discussions specifically about *Stuck in the Shallow End*, there were some teachers who were willing to rupture traditional conflict-avoidance behaviors in order to openly discuss race. We found when curricular lessons themselves focus on race, teachers engage in the discourse differently than when considering school-wide access issues around computer science participation. Instead, our findings confirmed our earlier discoveries about how centering teacher learning about race within the context of curricular lessons can open discursive space for teachers (Goode, Johnson, & Sundstrom, 2020). An (ECS) lesson on cornrow braiding is featured in the professional development, based on the culturally situated design tools developed by Eglash et al. (2006). We discovered that highlighting this lesson as a key part of a rehearsal teaching approach to professional development offers an important setting for teachers to dialogue around race, with a clear focus on the connection to classroom teaching.

In one of the professional development classrooms, a discussion focused on race emerged when a professional development facilitator pointedly asked for teachers' opinions about why many teachers skip the cornrows lesson, focused on African American history and culture, when given the opportunity to teach it. The conversations were rich and animated. For example, Therese, a White first year teacher shared how she had no Black students but, instead, taught a primarily White student population living near American Indian reservations. Therese discussed how she would rather teach a lesson focused on the local American Indian tribal cultures, including their "beautiful art and traditions" which she felt would be "more relevant." Callista, a Black first-year teacher replied that she understood why cultural relevance was important, but that there was important history and culture to learn in the African American experience as well that was just as relevant. Callista emphasized that even if there was only one Black student in the room, acknowledging and celebrating African American culture and history was important.

In the larger group discussion, Meredith, a White teacher who was new to the professional development but had taught ECS for several years already in a primarily white, rural community was willing to share: "I skip this lesson because I have to skip and choose or else, I'll run out of time … But I thought about it, and I don't have an answer to this: I skipped this one and not others, and in my mind why did I think this one and not others? I don't have an excuse other than time, but why was it this one I cut and not something in the robotics unit?" While Meredith didn't have an answer for this, she was openly acknowledging that there may have been some apprehension related to race leading to her decision to skip the lesson. Although Meredith didn't name race specifically or explicitly, revealing this fact to fellow teachers showed a willingness to discuss the topic of computing teaching and race.

A returning Latino teacher named Marco, shared that, at his school, a Black English teacher asked her students to write a paper about what it means to be White and privileged, and the result was "parental uproar." As union president, Marco was representing her and believed that "she didn't do anything wrong, it's just the parents … racism exists and so you have to discuss it. If you don't discuss it, it will continue." In this moment, Marco advocated explicitly that people needed to talk about race in order to address issues of race head-on. Unlike the strategies teachers used to evade discussions about race during *Stuck in the Shallow End* conversations, Marco was pushing teachers to see this truth. A returning, White teacher named Melanie agreed and shared that, while she was "freaked out" about teaching it the previous year, especially as a White person "who had no history" related to the lesson and when she "didn't feel qualified to teach this lesson" rooted in African American history and culture, she saw the lesson as a huge success. Melanie told her fellow teachers that there should be more lessons focused on culture and history because "CS is about people and solving problems."

After the professional development had concluded for the day, two first year teachers, Agatha and Callista, continued to discuss this computing lesson focused on African American history and culture. They discussed the challenges of "cultural appropriation" when Kim Kardashian got a lot of media attention for braiding her hair or how people in Nordic countries get cornrow braids for fashion too. Then Callista said, "You know, we talk about culture all the time, so what's wrong with talking about Black culture? People are nervous about doing this because they're doing something outside their own culture –

but it's a lesson on geometric shapes and great to learn about cultures, so why not teach it?!" She added that when "people limit themselves and stay in their mindsets – they're limiting their students' experiences because of their own biases." Agatha nodded her head but countered that she could sympathize with teachers who "don't want parental conflict." Callista agreed but noted that the teacher who was afraid of parental conflict had changed her mind about the lesson, and she added, "If you hide bigotry, it will continue." Agatha then wondered aloud, if all her students are Latinx, "will they care" about African history? Callista pointed out that whether it was African history or Viking history, it shouldn't matter; it wasn't considered "racist" to talk about kilts, but somehow people were afraid of talking about cornrows. In this interchange, the teachers were willing to talk about the complications of race in the classroom very openly with one another, long after others had finished talking about it during the professional development. While these conversations were not as common across the professional development daily activities, the moments when teachers were willing to explicitly discuss race created important space to grow and learn together around how and why culture, history, and race were central to computing education.

Teacher agency amongst returning teachers

Our second research question focused on examining the development of teachers' knowledge and skills around race and equity in computer science education over the course of their participation in this professional learning program. We discovered two ways in which the data demonstrated growth in teacher knowledge, beliefs, and engagement around these topics. First, across all professional development classrooms, there was a marked qualitative difference between the engagement around conversations and activities connected to race and equity between first year ECS teachers – those new to teaching ECS – and the ECS teachers returning for their second summer with a year of experience teaching the course, accompanied by school-year professional development. Second, in aggregate for all teachers attending the ECS professional development week, quantitative survey results signify growth across a variety of equity-based knowledge, belief, and efficacy items.

The qualitative data brought to light that returning teachers' experience with the ECS curriculum and ongoing school-year professional development, as well as a reread of the text, allowed second-year participants to more openly discuss how race and racism affects their students. Along with this, returning teachers were also more likely to use words like "Black", "Brown", "Hispanic", and "African American" rather than coded language. These teachers also more often identified systemic change as being vital rather than blaming students, their families, and specific communities. Many of the second-year teachers seemed to move beyond the resistance that first year teachers had to engaging in race-conscious discourse and embraced the notion that until there is an acknowledgment of the historical and systemic violence that has occurred in schools for girls and students of color, their students will continue to be "stuck in the shallow end." In essence, we discovered second year teachers were much more likely to be the ones to express agency in disrupting the silence and discourse that serves to deflect, individualize, and evade direct conversations around race and equity issues in computer science education.

While colorblind discourse was pervasive throughout many of the conversations had throughout the week, there were also moments of professional growth; moments that highlighted the importance of engaging in equity-based work and the fact that this type of work takes time and the willingness to feel uncomfortable. These snapshots of growth occurred in many forms; however, they were usually from returning teachers who had a full year of experience engaging with the ECS curriculum. For example, during a conversation around the metaphor used in *Stuck in the Shallow End*, Nicole said "we need to ask why these minority students aren't in our computer science classes" and that "all parents are interested in their child's education" and that "looks different for different families." She argued that some of our assumptions on this are wrong and that "we [need to] learn about each other's' cultures and ethnicities so we don't make assumptions." This was a powerful moment in that Nicole both identified many of the assumptions that were being made as well as offered a potential solution for change. Another example came from Devon, who very eloquently highlighted the long-term effects of the current structure of computer science classes. "My school is 85% Hispanic, and if we offer AP Computer Science and it's 75% white, what are we telling our students? We are telling them that that's the way it's supposed to be." He followed this up by saying that "just because it's being offered doesn't mean anything is being fixed" and that "if the demographics in the courses don't reflect the demographics in the school/community, it just reinforces the stereotypes."

Other teachers leveraged their own experience in school as a means of professional growth. For example, Andrea, a returning Black teacher interjected during a conversation wherein teachers were using colorblind discourse to avoid talking about race. She very honestly stood up and shared the following vignette.

> When I started taking AP classes, I noticed that there were less people who looked like me. When it came time to apply to colleges, my counselor encouraged me to apply only to state schools …. I've had experience being limited and being pushed toward opportunities that won't help me advance. In my school, I saw this as well when teachers would say things like, 'We need hospitality classes, not computer science classes'- [I was] the only advocate to explain that if we don't offer computer science classes we are contributing to this economic disproportionality.

While many of the other teachers had relied on colorblind discourse as a crutch, Andrea's willingness to be vulnerable was a powerful moment in demonstrating the effects of explicitly addressing race as a barrier to computer science courses. Teachers also acknowledged the importance of agency in supporting their students and ensuring that students of color have access to computer science courses. Jenny, a returning teacher noted that "we are the only adults in the school and have to advocate for our students."

For other teachers such as Ella, a returning White teacher, being explicit about race and gender were important to her and fed her growth from years one to two in the ECS professional development pathway. In reflecting on her professional learning, she shared:

> I didn't even know what computer science was until coming to the Exploring Computer Science training last year. I did not always think the human connections were what was important – I had taught programming, Scratch, hour of code – but it was always focused on 'the doing' – but I now feel I have learned in the last 2 years that computer science is a lot less about the doing, and really more about the thinking.

More specifically, Ella explained how important it was to her to support students thinking about the connections between computing and human culture/history. She described teaching lessons that involved learning about the history of cornrow braids in relation to African American history (through African roots to slavery to Middle Passage to slavery to the Civil Rights Movement) and then creating various cornrow designs using a computing tool. Before ever teaching it, Ella felt hesitant, making assumptions that only the African American students would engage deeply with the lesson, but she was thrilled to see that all her students were "so incredibly focused on the cornrow curves that … kids would come in during enrichment to keep working on it." Based on this experience, Ella realized how critical it is to provide opportunities for youth to learn about computing in relation to culture, history, race, and gender explicitly, and that she needed to be open and willing to sharing and talking about these issues within the context of computer science because those "human connections" were at the heart of this learning.

Teachers learning around equity at professional development

In addition to seeing differences in equity and racial discourse by returning teachers, we also documented changes in teacher knowledge and beliefs around a series of quantitative survey items collected from teachers both before and after their participation in the summer ECS professional development week. Specifically, as outlined in Table 1, there were statistically significant increases in teachers' beliefs and attitudes on the following items:

- An important part of being a computer science teacher is examining one's own attitudes and beliefs about class, race, gender, disabilities, and sexual orientation.
- Issues related to racism, sexism, and other inequities should be openly discussed in computer science classrooms.

Table 1. Participants' Responses on Computer Science Equity Pre-PD to Post-PD.

	Pretest		Posttest		Pretest vs. Posttest			
	Mean	SD	Mean	SD	r	DM	p	ES
Teachers attitudes and beliefs ($n = 54$)	3.22	0.77	3.63	0.56	0.28	0.41	**0.001**	0.61
Discussion of inequities in the classroom ($n = 54$)	2.91	0.85	3.35	0.68	0.58	0.44	**<.001**	0.57
Responsibility as a teacher is to challenge school arrangements that maintain societal inequities ($n = 54$)	3.28	0.71	3.61	0.53	0.19	0.33	**0.003**	0.53
Incorporate diverse cultures and experiences into the lessons/discussions ($n = 54$)	3.63	0.49	3.67	0.48	0.03	0.04	0.687	0.08
Connecting students' prior knowledge with concepts ($n = 54$)	3.80	0.41	3.83	0.38	0.02	0.03	0.622	0.08
Incorporating a variety of teaching methods in CS will help students be successful ($n = 54$)	3.80	0.41	3.83	0.38	0.27	0.03	0.569	0.08
Allow student choice when designing CS learning activities ($n = 52$)	3.42	0.54	3.60	0.50	0.36	0.18	**0.038**	0.35
Responsibility of CS teachers to work with counselors to ensure course enrollment reflects school demographics ($n = 54$)	3.30	0.72	3.74	0.44	0.31	0.44	**<.001**	0.74
Effective CS teachers should have college-level mastery of CS ($n = 54$)	2.20	0.63	2.59	0.81	0.20	0.39	**0.003**	0.54
9 Item Sum Score	29.43	3.56	31.85	2.84	0.33	2.42	**<.001**	0.75

DM indicates the mean difference (End of ECS professional development – Beginning of ECS PD); ES is the effect size (Cohen's *d* standardized mean difference); r is the bivariate correlation between the End of ECS professional development and Beginning of ECS professional development.

- Part of the responsibility of the teacher is to challenge school arrangements that maintain societal inequities.
- It is important to allow for student choice when designing computer science learning activities.
- Part of the responsibility of computer science teachers is to work with counselors to ensure course enrollment reflects school demographics.
- Effective computer science teachers should have a college-level mastery of computer science.

Taken together, the cluster of these nine quantitative items highlight an overall shift in teacher belief and knowledge over the course of the week after participating in the professional development. The data shows a remarkable increase in teachers' reporting of their equity knowledge, skills, and responsibilities as a teacher, with a bivariate correlation of $r = .33$ and an effect size using Cohen's d standardized mean difference of .75. Reliability for these items as a group is acceptable (Cohen's alpha = .78 for all items), though Cohen's alpha increases to .80 (strong) when eliminating the final question about college mastery from the set of items included in this analysis.

Further, teachers also responded to a post-professional development survey prompt asking them to note any changes to their own thinking around equity as a result of participating in the professional development workshop. Teachers reported various aspects of change. Some teachers noted how this experience exposed them to equity-related issues. As one teacher wrote, "I was quite surprised by the level of inequity that I hadn't thought about before. I'm new to it, but I will definitely be more mindful. I'm sure I'll understand and have more feedback after teaching this year." Other teachers took the opportunity to articulate a clear sense of agency by noting their own role in broadening participation in computing. A teacher reflected, "This professional development helped me understand not only the broad conceptual nature of computer science but also how critical the professional development is to change the way computer science is taught so that we are intentionally more inclusive and welcoming." Another teacher also reported learning more about aspects of equity in this field, stating, "I now see all of the factors that keep students of color from going into Computer Science and will do my part to combat them."

Still, it is important to add that for several teachers, the knowledge and insights around equity in computer science were not new, and the professional development did not change their thinking. As one teacher responded to this prompt, "Not really. As a female in computer science for about 40 years now, I have seen the inequity firsthand. I am so happy that it is all finally changing for everyone, not just for women." Another teacher also responded that this equity orientation was not new for them, "Since I already incorporate equity practices in my classes – not a lot of change."

Discussion

In an educational discipline marked by power, privilege, and pervasive and systemic patterns of underrepresentation, this study demonstrates how long-term professional development can support teachers in developing an equity-based orientation towards computer science education. Though many teachers initially incorporated colorblind language or used silence as discourse to *not* talk about race and racism, this study

highlights the measured growth of teachers in their equity-based knowledge and sense of agency in computer science, particularly visible for second-year participants.

The steady use of strategies that teachers used to avoid talking about race – individualistic discourse, deflective discourse, evasive discourse, and silence – point to the hegemonic influences present within equity-based conversations. While the silence between White teachers and teachers of color might sound the same, the motivation for this varies – whiteness is connected to meritocracy where White people benefit from engaging in colorblind discourse. This needs to be understood beyond an interpretation of actions and words as what might initially be interpreted as disengagement might be refusal to engage within an historically White space. While teachers of color might engage in colorblind discourse, they are not colorblind as they are experientially aware of racism. The reasons behind this silence for teachers of color vary, with refusal as one mechanism for avoiding these discussions. While education is a political act, the way in which schools are structured often serves to "divorce educators' educational existence from their political existence" (Apple, 1990, p. 102) which impacts the germination of transformative ideas.

Germinating race conscious discourse

Multiple layers of equity discourse took place during this week in professional development that framed discourse around race as both identity characteristics and categories that shape opportunity and access in computer science education. This offered spaces of possibility in both rupturing traditional understandings of objective and neutral conversations occurring in teacher professional development spaces as well as opportunities to continue to nurture the germination of ideas. We found that although often these conversations happened infrequently in large group discussions, teacher learning is happening both during the week and over the course of a year as teachers initially enact this course and re-visit the conversations around race and access in computer science a second year. These findings point to a developmental process for teachers gaining capacity and knowledge around race-conscious discussions.

In an effort to distinguish the spaces wherein germination began to occur with those where ideas that were planted did not continue to grow, we found that teachers' fluency in using race-conscious language are necessary ingredients for digging deeper into equity and access in computer science education. As silence and discourse does not operate the same for all people, it is important to take note of the fact that what is externally observable is not the only important aspect to consider regarding the growth of teachers. For instance, teachers might be noting many of their thoughts and ideas in journal entries, an activity interspersed in the professional development program but not viewed by researchers. As seen in the survey data, both first- and second-year teachers showed growth regarding their belief that race is an important element to discuss in the classroom, therefore, while this was not always present in conversations, this does not mean that seeds of these ideas were not developing in teacher's minds and hearts. Rather, this is a representation of the system that teachers exist in as well as the safety and tension that teachers feel in disrupting the system.

Equity, agency, and the role of teachers in computer science

The results of this study also demonstrate that when equity-oriented conversations emerged, beyond focusing either on simple notions of access or counts of diversity, teacher discourse and belief systems considered both classroom-based pedagogy essential for inclusive teaching, as well as a sense of agency in their schools to "champion" computer science and widen access to computer science coursework. Teachers' change-focused dialogue in professional development reflect a multi-layered perspective on equity that considers the interlocking issues of school access, diversity and representation in computer science classrooms, and the infusion of instructional practices that are culturally responsive and connected to the interests and needs of diverse students. Importantly, while these issues align with prior research around access, diversity, and inclusion as illustrated in Figure 1, this study demonstrates the important role of teachers in understanding and addressing racial equity as part of a systemic effort to broaden participation in computing. Teachers identified specific school policies and educational practices that they felt empowered to change in order to engage more students of color in computing.

Limitations and future directions for research

The conclusions drawn from the qualitative and quantitative findings point to a tension between self-report data and participant observation data. This tension is demonstrated by the conflicting data presented within teacher self-reported growth through the quantitative survey data and the gaps for many teachers in moving beyond colorblind discourse as observed by the research team. In subsequent research, follow-up interviews with participants should complement observations and self-reported data to further interrogate this tension.

Other limitations include the fact that while this study included pre- and post-professional development surveys and extensive observation notes in three professional development classrooms over the course of five days, this study would have been strengthened if researchers could access participants' individual journal reflections and/or engage in formal interviews with participants to probe their own thinking, both about issues related to race in computer science, but also about their decisions when (and when not) to engage in dialogue with colleagues in a professional learning space. Future research in this area should include teachers' narratives of their own engagement in learning spaces focused on race-conscious discussions.

Finally, though we did not set out to distinguish how teachers of color might employ refusal in professional learning settings, this finding points to the need for further research in this area to better understand how equity discussions in computer science professional development settings might be experienced by teachers of color.

Conclusion

In this study, we used a mixed methods approach in order to understand how teachers talked about race in computer science professional development learning settings. Our study also accounted for considering how professional development spaces are a site for

possible germination that did not occur, in many instances, due to the structural constraints placed on teachers. We identified specific moves made by teachers which ruptured traditional objective notions of teaching and married teacher's educational existence with their political existence. Beyond a sense of instructional urgency to broaden participation in computing, the study discovered how over time, teachers developed and articulated a sense of school-level agency to disrupt patterns of underrepresentation and inequitable participation. Though this study revealed how teachers developed beliefs and instructional skills that support equity during the course of the professional development, the findings also raise additional questions about how to conceptualize, nurture, and measure the germination of equity beliefs and practices in a safe, productive learning space for educators.

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