EQUITY, ACCESSIBILITY AND ACTION: SUPPORTING DIVERSE LEARNERS IN K-12 COMPUTER SCIENCE EDUCATION

BY

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ABSTRACT

Computer science impacts our lives every day in a multitude of ways. Despite its ubiquity and power to shape the world, the computer science education community continues to struggle with issues of equity. Problems of access, opportunity, influence and achievement are pervasive and while a handful of scholars have investigated specific approaches to improving equity in computer science education, little research has been done to study the beliefs and practices of teachers in the field across all grade levels and from varied locales. Using a basic qualitative approach, this study examined how 10 teachers selected for an equity-oriented fellowship conceptualized equity in computer science education and used a wide assortment of strategies to create equitable access and outcomes for diverse learners both within and beyond their classrooms. To achieve a deeper understanding, fellowship data was analyzed and compared across all fellows and multiple data types for similarities and differences. Implications for research, and practice are discussed.

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CHAPTER 1: INTRODUCTION

Computer science (CS) impacts our everyday lives in an almost ubiquitous manner despite its short history relative to other science disciplines (Grover & Pea, 2013). Efforts within the field have given rise to technological innovations and new levels of functionality that allow us to interact with each other and our world in transformative ways (Ryoo et al., 2013). Whether by allowing us to conduct business or schooling online, using an app to monitor eye health, or harnessing social media to organize for political purposes, CS and its associated products and services are a source of power undreamed of fifty years ago. Those with computational abilities are more likely to have increased social and professional agency (Grover & Pea, 2013; Vakil, 2018). Yet, broadening participation in science, technology, engineering, and mathematics (STEM) related fields such as CS is an ongoing challenge dating back decades (Aspray, 2016) which affects persons who identify as Black, Latinx, and women (College Board, 2019; Google & Gallop, 2020) as well as students with disabilities (Blaser & Ladner, 2020; Ladner &Israel, 2016).

To address these challenges, CS education is being widely introduced in K-12 schools across the United States with an emphasis on giving children the tools and experiences to become informed producers and not merely consumers of technology (Lindeberg et al., 2019). In seeking to achieve the goals of broadening participation for historically underrepresented students, the CS education community must address a range of issues, such as who has access to CS learning and how CS is taught. The journey towards universality of computing education and providing all students the tools to apply computational concepts and practices to their own lives traverses a road historically fraught with issues related to equity, ethics, access, and accessibility (Ashcraft et al., 2017; Ladner & Israel, 2016; Margolis et al., 2017; Margolis & Fisher, 2003;

Ong, 2011). These issues are multilayered and include systemic, political, cultural, and technical underpinnings that must be addressed if the endpoint of equitable computer science for all is to be reached (Oaks & Rogers, 2006).

Definition of Terms

Several equity-related terms warrant definition. First, for terms related to age, gender, race and ethnicity, I will adhere to the guidelines set forth in the seventh edition of the American Psychological Association Style Guide. The style guide recommends the use of "underrepresented" as an appropriate collective term for students who are non-White and I will expand its use to cover other groups that have been historically underrepresented in CS education, including women and girls, and students with disabilities. I use the term underrepresented while recognizing that other terms, such as marginalized, underserved, oppressed or minoritized, are sometimes used in the literature. Terms such as "equity," and "equality" are also commonly used among CS educators and researchers looking to change historical trends related to representation in CS education and by extension, the CS workforce (Aspray, 2016; Margolis et al., 2012). However, we must be wary of how we use these terms and how they have been appropriated to date. Therefore, I use definitions of common terms given by Rodriguez (2016) to help guide this inquiry:

> Diversity: Involves the recognition of the visible and invisible physical and social characteristics that make an individual or group of individuals different from one another, and by doing so, celebrating that difference as a source of strength for the community at large…(The) superficial association of the term diversity with skin color prevents many from appreciating the rich diversity that may already be present in their working contexts (i.e., gender expression, socioeconomic status, multiple ethnic/cultural

associations, bilingual or multilingual expression, special needs/abilities, and so on). Thus, in order to truly understand and value diversity, one must take purposeful steps to explore diversity that goes beyond skin color. (p. 3).

Equity: Refers to the enactment of specific policies and practices that ensure equitable access and opportunities for success for everyone. It is important to differentiate equity from equality. I often hear from pre-and in-service teachers that they "treat all the students same," so therefore they are fair (or equitable). Others often state that they "love all children;" thus, they "want everyone to do the same work and do well." While, it is essential to have high expectations for everyone and assist students to gain access to the discourse of the culture of power (Delpit, 1995), in order to be equitable, we cannot treat everyone the same. To be equitable, we must treat individuals according to their needs and provide multiple opportunities for success.

Social Justice: Defined as the conceptual framework guiding the enactment of specific policies and practices to promote diversity and equity. It is important to note that we might be able to observe the presence of diversity and/or equity in any given context without the presence of social justice, but it is not possible to have social justice without the presence of diversity and equity. In other words, while diversity and/or equity may be enacted, for example, as a result of a mandated policy or expectation in a given school district or working context, it is the deep understanding and presence of mind that enables an individual to internalize social justice as everyday practice—as something we must do because it is the right ideological and epistemological thing to do to enable our community to flourish. (p. 4).

Finally, three related frameworks have widely influenced researchers and practitioners working in equity focused educational endeavors. Culturally relevant pedagogy (CRP) (Ladson-Billings, 1995, 2006) focuses on teachers' intentionality and explicit actions related to long-term academic excellence and having high expectations, focusing on what students know and are able to do as a result of interactions with skilled teachers (Ladson-Billings, 2006). A focus on cultural competence or using students' cultural practices and assets for learning is another key feature of CRP. Part of cultural competence is instilling in students the knowledge and ability to move between cultures, such as home and the dominant culture in schools that oppresses them (Delpit, 2006; Ladson-Billings, 2006). A third major feature of CRP is that a teacher should seek to build socio-political consciousness in their students so that they are aware of inequities, can critique them and ultimately act to ameliorate them (Ladson-Billings, 1995).

Culturally responsive teaching (CRT) (Gay, 2010) is defined as "as using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant to and effective for them" (p. 31). Gay (2013) includes four essential components to CRT. The first component is addressing and replacing deficit narratives and perspectives of students and their communities. The second emphasizes that teachers must seek to understand resistance from critics of this approach, thereby empowering the teacher with the confidence and competence necessary for robust implementation. Teachers must also understand that the overt valuing of one's cultures and the embracing of cultural differences are essential to their humanity and therefore their teaching. Finally, teachers using a CRT approach should use or develop culturally relevant curricula, pedagogies and learning communities (Gay, 2013).

Culturally sustaining pedagogy emphasizes the maintenance of cultivation of students' unique identities in direct opposition to dominant educational contexts in which students go to school and which has historically ignored or marginalized students cultural and linguistic strengths and assets (Paris & Alim, 2014, 2017). Like the first two frameworks, the focus of culturally sustaining pedagogy is grounded in a firm commitment to social justice education and seeing the school and classroom as a site for social and political change (Aronson & Laughter, 2016) as well as restorative justice education work which seeks to provide healing to those wronged by and educational system which is inequitable (Van Ness & Strong, 2014). The three major components of restorative justice work are in addressing harms, providing for the needs of those harmed and in fulfilling obligations derived from injustice (Zehr, 2015)

State of CS Education

By all accounts, the current demand for CS education and the importance of learning CS is growing. This is true for students, teachers, parents, and high school principals (Google & Gallop, 2016; Wang et al., 2016). In fact, most parents across all demographics, including those historically underrepresented, conclude that CS is an important skill for their child to learn (Google & Gallop, 2020). The most recent Google and Gallup study (2020) shows that superintendents now assign greater importance to CS education than in 2016, with nearly 60% agreeing that CS is a top priority in their school district. This support for CS education goes beyond the classroom or district level. Between 2019 and the end of 2020, at least 28 states passed over 40 new laws and regulations promoting CS education while other state education leaders built and innovated upon policies related to funding, teacher education, student support, and programmatic guidance that were previously adopted (Code.org, 2020).

At the national level, CS education stands out as a rare bipartisan issue in a time of perpetual division. On January 31, 2016, President Barack Obama unveiled a policy push for what was termed the "CSforALL" movement (Computer Science for All, 2016). This effort outlined the necessity of CSforALL as it relates to job creation, economic development, student opportunity and equity and proposed extensive funding for states and school districts to implement CSforALL initiatives locally. The focus on CSforAll further provided for new National Science Foundation (NSF) funding to support research related to K-12 CS education. While Computer Science For All was an innovative policy initiative for the Obama administration (Computer Science for All, 2016), former President Trump, in a rare act of cohesion, called for additional expenditures to support CS education (Dickey, 2017).

An Expanding Discipline

As CS education is ascribed greater importance, it is no wonder that CS opportunities in K-12 education have increased dramatically across the United States. Between 2016 and the beginning of 2020, at least 31 states have embraced CS education in a variety of ways, including allowing CS courses to count toward core high school graduation requirements (e.g., CS as a math or science course), adopting CS standards, and allocating funding specifically for K-12 CS education (*2018 State of Computer Science Education Policy and Implementation Advocacy Coalition*, n.d.). School districts across the country, including those in major urban centers such as San Francisco, Los Angeles, Chicago, and New York City are moving toward full implementation of K-12 CS (Rampell, 2014). Consequently, CS is beginning to be viewed as a core academic subject in many school districts (2018 State of Computer Science) and some cities and states now include a CS requirement for high school graduation (Dickey, 2016).

Why CSforALL?

As CS is rapidly integrated into the current education system, rationales for its inclusion vary greatly. Interrogating the rationales for the inclusion of CS in K-12 education is essential and should be exercised in an ongoing manner as the CS education landscape shifts. Whose agenda(s) are being served and for what purpose? Who has a seat at the table in decision making and what voices are heard? What is the end goal of CS education and for whom? How do we best achieve those goals? There are currently more questions than answers and these questions stem from the fact that the CS education community has made certain assumptions about what is valuable and for whom (Lewis et al., 2019).

CS for Economic Opportunity

One of the most commonly given reasons for promoting CS education is the economic imperative for teaching students computer science. The current job market is illustrative of the demand for those with CS skills and many future jobs which involve computing, unlike positions in the past, will not require college degrees or math competency beyond basic high school requirements. Positions requiring CS skills, which are often lucrative, will continue to outpace the number of workers who possess the skills necessary to fill them far into the future (Balanskat & Englehart, 2014; Code.org, 2020).

Other professions apart from computer science also require or may benefit from CS skills and abilities and understanding the role of computing in non-computing disciplines and professions will soon be essential for workplace success (Tissenbaum & Ottenbreit-Leftwich, 2020). Professions with “computational x” components abound and include computational economics, computational medicine and computational biology for example. A subset of the skills associated with CS and their practice are often some of the same skills called for in

business, industry and entrepreneurship. These skills, such as problem solving, the ability to persevere through challenges, testing and iterating on solutions and collaborating effectively with peers, are all practices associated with CS. Clearly, there are economic reasons to consider including CSforALL into K-12 schools and for groups that have been underrepresented, the prospect of greater wealth, social mobility and economic opportunity as a result of learning CS is an important consideration, though far from the only one (Lewis et al, 2019).

STEM jobs such as CS are projected to offer greater earning potential and lower rates of unemployment than non-STEM jobs over the next decade (Carnevale et al., 2013; Code.org, 2020). However, the other side of the economic imperative for teaching CS K-12 is that there is a widely recognized, "pipeline" wherein the need for CS education is linked to the needs of the giant tech corporations that fund much of CS education (Vakil, 2018). These companies are in perpetual need of skilled workers to create the products and services that have made the companies, their CEO's and their investors, radically wealthy and powerful. The tech industry in turn has long been implicated in the questionable use of their products in service of the military (Schoenfeld, 2004) and a host of ethical and political issues related to human rights, privacy, surveillance, and improper social influence (Vakil, 2018). Furthermore, the bias in software products and services that support and create disenfranchisement of Black, Indigenous, People of Color (BIPOC) (Rose, 2010; Tatman, 2016) and persons with disabilities are well documented. For example, Noble (2018) made a compelling argument about inherent biases in the programming of commercialized search engines such as Google, making the case that these products reproduce social stereotyping and racism against underrepresented groups through what she defined as "algorithmic oppression." Therefore, increasing CS education opportunities for

underrepresented groups may lead to both greater economic opportunity and empower individuals from those groups to confront and address injustices that occur as a result of CS.

CS for Informed Citizenry

Clearly, computing is not inherently good or bad. Its value lies in how it is used, by whom, and for whom. Computationally literate citizens in an ever-changing and increasingly digital world understand this. If a goal of public education is producing informed citizens, then in a world of ubiquitous computing, we must surely strive to include critical digital citizenry in that process. To that end, the *Impacts of Computing* concept area in the K12 CS Framework describes how citizens should understand computing well enough to be able to talk about how their own computing actions and behaviors impact others and how computation and data impact their own lives (Alano et. al, 2017). Issues related to ethics and impacts in K-12 CS education are often framed as individualistic, exploring the role the individual CS learner has in unpacking the issues, rights, and responsibilities that come with learning CS (Vakil, 2018). This framing and individualistic treatment, or micro-ethics (Herkert, 2005) come at the expense of empowering CS learners to understand and act on the underlying systems of power and influence that both contribute greatly to funding CS education and the products and services which hold influence over much of our lives. To that end, scholars have recently advocated the wider goal of teaching CS for reasons related to social justice (e.g., Bobb, 2016; Kafai et al, 2019; Lee & Soep, 2016; Vakil & Higgs, 2019). In these social justice-based approaches, it is argued that teaching computing at the K-12 level should be rooted in the exploration and critique of power at the systems level as opposed to centering the individual's responsibilities regarding computing. In making this shift, a justice-centered computing approach seeks to empower while enabling

transparency and facilitating the questioning of the role of technology in education and society more broadly (Vakil, 2018).

CS For Equity

Finally, if we make the case that CSforALL is becoming part of the general curriculum and that it is important for reasons involving economic opportunity and citizenship, then it is also necessary that we consider its equitable application so that all students have access to it. Women and BIPOC have been historically underrepresented in STEM fields (U.S. Department of Labor, 2018). This underrepresentation is especially pronounced in fields that are seen as more technical, such as CS (Barone, 2011). While this underrepresentation in the CS workforce is clear and ongoing, a parallel deficit in educational opportunities to learn CS persists for BIPOC, girls and young women, and students with disabilities (Ericson, 2020; Margolis et al., 2008; Wilson et al., 2010; Weintrop et al, 2019). While the CSforALL community has made efforts to promote gender and (to a lesser extent) racial and ethnic diversity and inclusion across K-12 (e.g., Margolis & Fisher, 2002; Margolis, 2010), up to this time, little attention has been paid to the inclusion of students with disabilities in CSforALL in the broadening participation and equity work central to CS education (Ladner & Israel, 2016; Weintrop et al, 2019). The extent to which students with disabilities are included or excluded from CS education nationally is difficult to determine due to the lack of data available (Code.org, 2020; Blasser & Ladner, 2020). While the lack of data in regards to the inclusion of students with disabilities in CS education is problematic, equally problematic is the exclusion of disability from conversations regarding equity and inclusion, which necessitates the question of what we really mean when we use these terms in regard to CSforALL.

Why Equity?

The rationales for equitable participation in CS education would seem obvious; however, examining the impetus for such sentiments reveals the complexity involved. The first reason for championing equity in CS education stems from the desire to democratize computing. It is based on the moral concern that computing education and the computing workforce reflect the composition of society at large as opposed to being the realm of a restricted set of those privileged enough to be beneficiaries of the knowledge, power, and influence enabled by CS education (Lewis et al., 2019; Ryoo et al., 2013).

Access and Beyond

The term equity has been used in educational research to explore the degrees of access students have to opportunities and educational resources necessary for learning (Darling-Hammond, 2010). This focus on (in)equitable access, and the corresponding movement to broaden participation in computing, has also been an area of focus in CS education research (Margolis et al, 2008; Lewis et al., 2019; Shah et al., 2014) given the widely documented disparities for historically underrepresented student groups (Aspray, 2016; Goode, 2008). Defining equity in terms of access has some affordances, namely that it allows researchers to analyze equity on a structural level (Flores, 2007; Lewis & Shah, 2015). For example, approaching equity in terms of access allows for measuring data as to the number of schools that offer CS courses, the demographics of those schools and the students who participate in CS, requirements for graduation, and access to qualified teachers (Code.org, 2020; Google & Gallup, 2020). Approaching equity using the access lens is only beneficial if we widen our gaze, lest whole populations of students and their involvement (or lack thereof) in CS education are left out of the picture. The most glaring example of this myopathy is the frequent exclusion of students

with disabilities in conversations and data related to broadening participation and access. For example, the 2019 State of CS report (Code.org) does not mention disability even once and as of 2020 the College Board still does not collect data on the participation of students with disabilities who take part in AP CS courses (Blasser & Ladner, 2020; Code.org, 2020).

Equity is a complex subject, and while access is an integral part of equitable CS education, focusing primarily on access risks over-simplification at the expense of understanding the complex systemic, political, and socio-cultural forces at play (Dawson, 2014; Vakil, 2014). It is therefore imperative that researchers move beyond access to a more nuanced and thorough understanding of other dimensions of equity issues and how they might be addressed (Dawson, 2017; Goode et al., 2014; Margolis et al., 2012). As scholars in CS education continue to prioritize other dimensions of equity beyond access, a growing trend has emerged emphasizing the socio-cultural dimensions of equitable CS education as a way to connect with students who are historically underrepresented in CS and empower them to make a positive change in their communities (e.g., Goode et al., 2012; Goode et al., 2014; Ryoo et al., 2013). These approaches, which center students' racial, cultural, and gender identities, focus on positive CS identity development through meaningful, often locally bound, learning experiences (Nasir & Vakil, 2017; Pinkard et al., 2017; Ryoo, et al., 2013; Vakil, 2014). Though focusing on such approaches may be a powerful tool to increase equity in CS education, students' diverse social-cultural backgrounds may also give rise to further challenges CS teachers must address (Goode et al, 2012; Bandura et al., 2001). These challenges, rooted in socio-cultural stereotypes related to what types of students can be successful in CS, limit students' opportunities and their self-efficacy due to systemic bias and social persuasion (Bandura et al., 2001; Margolis et al., 2017).

Equity in CS education is clearly a complex issue for which there is no one formula for broadening participation, building inclusive communities, or increasing the success of underrepresented populations who do participate in CS education (Lewis et al., 2019; Margolis et al., 2012). Challenges and corresponding solutions can vary across locales and contexts. Teachers and students each bring their own unique attitudes, biases, strengths, challenges, perspectives, relationships, and passions, which are then affected by structural factors often beyond their control (e.g., class size, funding, school or district politics, competing academic priorities). While recognizing that a one size fits all approach is insufficient, we can learn from those in the field who have prioritized equity in CS education.

Purpose

The purpose of this qualitative study was to understand how the 2019-2020 CSTA Equity Fellows worked to enact equitable CS education for the widest variety of learners across differing contexts and locales. Therefore, the research questions that guide this study include:

1. How did the CSTA Equity Fellows, with varying backgrounds and experiences, define and describe equity in K-12 CS education?
    a. How and to what extent did the Equity Fellows consider learner variability in general and students with disabilities specifically in their equity-focused CS education work?
2. How did the CSTA Equity Fellows intentionally use strategies to support equitable access to CS education and promote success in CS education for historically underrepresented students, including students with disabilities?

By studying teachers' approaches to equity focused CS education across a variety of contexts, we can be both responsive and anticipatory in designing learning systems that reach the greatest number of learners and account for the widest learner variability from the beginning.

CHAPTER 2: LITERATURE REVIEW

According to the Computer Science Teachers Association (CSTA) Standards for CS teachers, "Effective CS teachers proactively advocate for equity and inclusion in the CS classroom. They work towards an intentional, equity-focused vision to improve access, engagement, and achievement for all of their students in CS." Given the complexity of equity-related issues in CS education, we need to understand what the field considers equity-related practices, how the field studies equity-related issues, and what gap exists in the literature. Primary to this exploration is understanding barriers to equitable CS education at both a landscape/systemic level and at the interpersonal level.

The Landscape of Equitable CS Education

Despite the significant and enthusiastic push for CSforALL, CS education continues to see the lowest participation for girls and students of color as compared to other STEM areas; these trends continue or worsen as K-12 students enter higher education and the workforce (U.S. Equal Employment Opportunity Commission, 2016; Zweban & Bizot, 2018). Given the paucity of data regarding the participation of students with disabilities in CS education, we have little idea of actual rates of participation for this group although the data available is not promising (Blaser & Ladner, 2020). The good news is that access to CS education in the US is generally growing and that approximately 47% of public high schools offer a minimum of one foundational CS course. Code.org's most recent report (2020) on the state of CS makes it clear however that gross disparities persist as schools in rural communities and those with a higher percentage of economically disadvantaged pupils are less likely to have access to CS education. Furthermore, even in communities where CS courses are offered, students from underrepresented

racial and ethnic groups are less likely to attend a school that offers CS (Code.org, 2020). It is in these "within community" discrepancies of opportunity that pathways to CS education become more racialized and restrictive for BIPOC (Goode, 2008; Nasir & Vakil, 2017). The seminal work of Margolis et al. (2017) is perhaps the best-known example of these disparities. The authors' ethnographic study across three high schools with varying demographics uncovered how CS learning opportunities and access to qualified teachers varied greatly both between and within schools.

The rapid push toward scaling CS education and reaching a broader constituency has sometimes resulted in more highly-resourced schools providing a greater share of CS educational opportunities across districts (Margolis, 2010). This was the case in a localized study of New York City (NYC) public schools (Fancsali et al., 2020) wherein it was found that approximately 75% of high economic-need schools are also lower-performing schools. Lower performing schools tend to be more segregated, often with older, more run-down facilities, have higher teacher turnover rates, and offer fewer honors or AP classes (Orfield, 2013). Teachers from these lower-performing NYC schools with the greatest economic needs also reported receiving less support for CS education learning and more challenges than their peers in schools that were higher performing and with less economic need (Fancsali et al., 2020). School performance on standardized measures has been shown to be representative of race and income (Holme, 2002; Reardon, 2013) and is directly related to resources available to teachers and teacher turnover rates (Buckley et al., 2005). At the elementary level, Salac et al., (2020) examined the performance of 4th-grade students on beginning computational thinking (CT) tasks and found statistically significant differences in performance between high and low performing schools as identified by school report cards. It is notable that the higher-performing schools in the study

were populated by high percentages of students historically well represented in computing (White and Asian), while the lower performing schools were made up of a majority of historically underrepresented populations such as Black, Latinx, and Pacific Islander students. This perfect storm of high economic need, lower performance schools, and scarcity of support mean that even in districts where historically underrepresented populations have access to CS, their in-school experiences with CS and their success in CS education can differ drastically due to structural and other factors.

Advanced Placement courses (AP-CSA and AP Computer Science Principles; CSP) are often used as metrics for reporting participation and achievement in CS education. The most recent Code.org State of CS report (2020) continues to show drastic differences in access with Native American or Alaskan students 2 times less likely to attend a school that teaches AP CS than their White and Asian peers. Black students are 1.2 times less likely to attend a school that teaches AP CS, and Latinx students are 1.1 times less likely to attend schools with AP CS offerings. While the number of young women taking AP CS tests is on the rise, their percentage (versus males) has not grown significantly. AP CSA continues to be the second-highest in terms of the discrepancy between young men and young women test takers with AP CSP coming in at fifth-worst (Ericson, 2020). Sax et al. (2020) used survey data to examine student characteristics (including demographics) of those taking CSA or the (at the time) new CSP course, at the end of 2017, in an effort to determine if the new course was having an effect on broadening participation in CS at the high school level. The authors found that students who took CSP were more diverse than those taking only CSA with the former reporting less confidence in their CS abilities and being less likely to pursue computing beyond high school. Ericson (2020) reports

that Black students had the lowest pass rate of any racial group taking either AP CSA test in 2019.

Many scholars urge caution in interpreting achievement gap data which have historically and wrongly been attributed to genetic differences between underrepresented groups and Whites. Instead, these scholars urge that we query whether there is an achievement gap or an opportunity gap (Ladson-Billings, 2006, 2013; Milner, 2012). These opportunity gaps should be understood within the context in which they originated and in which they persist and they are not analogous with a simple lack of access to a course or instruction (though those might be components). Instead, Ladson-Billings (2013) proposes the idea of education debt that accrues over the course of generations as a result of decisions made and which disempower historically underrepresented groups. Educational debt is a result of political, economic, and historical forces. CSP was developed, at least in part, to broaden participation in CS education, and while CSP may be recruiting more young women and BIPOC into the course, this course alone may not function as a direct pipeline into post-secondary CS for many underrepresented groups. Finally, if AP course statistics are to be used as a metric for measuring participation and success of underrepresented groups then we must recognize that any reporting using those metrics is incomplete given that the College Board does not collect data on the number of students with disabilities taking AP CS exams. Though they do have data about disability-related accommodation requests, the College Board does not publish that information in contrast to their publishing data related to the participation of young women and other underrepresented groups (College Board, 2019). Yet, despite the continuing trends related to participation and achievement, Bishakha and colleagues' recent longitudinal study (2020) found that while the number of CS concepts being researched is growing, demographic data related to student socio-economic status and disability continue to be

underreported, leaving the community with little idea of how these students are fairing within and across communities. What is clear is that inequities persist and not simply as a result of major systemic and structural causes. Instead, they are today, just as in Margolis and colleagues' foundational work (2008), rooted in the confluence of structures and belief systems which continue to create barriers to access, achievement, and longevity within the field.

Belief Systems: Stereotype and Deficit Discourses

Narratives about who does CS and who can do CS abound. These narratives often reside in the nature of computing ability. One example is the clearly outdated belief in the "geek gene" which posits that one is born with computing aptitude (Ensmenger, 2012; Lewis et al., 2012). Even more insidious are stereotypes which suggest that students from certain populations (e.g., students of color, girls and young women, students with disabilities) are not interested in CS or cannot learn CS, the rationale being that if they could do so, they already would be doing so.

At the systemic level, as these beliefs are perpetuated, they function to create an educational system (e.g., administrators, counselors, teachers, parents, and students) that may assume that students who are underrepresented in CS just will not understand CS (Margolis et al., 2012). As a result of the stereotypes, deficit discourses arise perpetuating beliefs about disinterest and inability situated in the minds, bodies, beliefs, and communities of underrepresented students (Dudley-Marling, 2015). For example, a student with learning disabilities may be presumed by the school system to be lacking in requisite cognitive skills required for success in computing. Instead of addressing environmental and systemic factors that might inhibit the student's interest in, participation in, and success in computing, the deficit thinking perpetuates that student's potential disinvolvement or failure.

Clearly, educator beliefs and practices, as they relate to stereotypes and the corresponding deficit thinking, can profoundly impact students' opportunities to learn CS often resulting in tracking students out of CS learning pathways (Goode, 2008; Margolis et al., 2017). The literature is rife with examples of how school personnel and their belief systems impact the educational trajectories of students in CS. For example, Margolis and colleagues' landmark study clearly showed how stereotypical beliefs and corresponding low expectations of school staff inhibited the participation and achievement of BIPOC and young women. For example, one teacher in the study was quoted, "There are some students that just because of their background, they have never been able to—they don't know how to problem solve...they don't have that ability or desire to figure things out or explore" (Margolis, et al., 2008, p. 40). In a more recent study investigating the intersectional experiences of women of color in CS, one teacher is quoted as having overheard colleagues opening stating, "that there's no place for people of color in CS," (Johnson et al., 2020).

If they manage to gain entry to a CS classroom, underrepresented students, who have few role models in CS who look like them, may enter CS classrooms with a lack of supports. It is no wonder that some may feel overwhelmed, unsure of themselves, and unprepared for CS learning as the perpetuated stereotypes become stereotype threats. These stereotype threats may then further influence student behavior in ways that lead students to conform more closely to the stereotype (Steele, 2010; Steele & Aronson, 1995). Microaggressions that occur in the CS classroom can further compound these issues. Microaggressions are defined as, "Brief and commonplace daily verbal, behavioral, and environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative slights and insults to the target population or group," (Sue et al., 2007, p. 271). The power of microaggressions is in their

invisibility to the perpetrator and sometimes, the recipient as well (Sue, 2005). One particularly insidious type of microaggression is termed, microinvalidation, and is characterized by communication that works to exclude, or nullify the thoughts, feelings, and lived experiences of the recipient (Sue et al., 2007). Beliefs that CS curriculum, teaching, and learning are neutral can perpetuate these types of microaggressions. Clearly, even with successful efforts to broaden participation in CS education, putting "butts in seats" is not enough. The intersection of structural and belief system biases results in profound and persistent issues of equitable opportunity gaps in CS education for many BIPOC, girls and young women (Ashcraft et al., 2017; Scott et al., 2019), and students with disabilities (Blasser & Ladner, 2020; Ladner & Israel, 2016).

Prioritizing CS Identity Development

Given the roadblocks to participation and success for underrepresented populations in STEM fields such as CS, it is no wonder that many new initiatives have prioritized helping learners to develop an identity as one who can succeed in these fields, personally and/or professionally (Cheryan et al., 2017). Yet, even with myriad calls for diversity and equity in CS education, identity has been less commonly engaged at an analytic or empirical level due in part to the relative underutilization of theoretical perspectives (e.g., sociocultural, interactional) which prioritize identity development (Vakil, 2018). For years, studies have consistently shown that learning and identity are strongly linked (e.g., Illeris, 2014; Nasir & Cooks, 2009;; Wortham, 2006). Furthermore, individualism and identity are not fixed, but instead, made and remade through participation in social action and discourse within distinct social contexts (Davies & Harre, 1990; Gee, 2000). As a result, how one is positioned within these social actions is highly

formative (Hall, 1996) and identity is often viewed as it relates to organizations, groups, and activities in which individuals take part (Ashforth & Mael, 1989; Brickhouse et al., 2000).

Social Construction of Identity

Identity development is a fundamentally social process, wherein identities are formed through mirroring, modeling, and recognition (Forber-Pratt et al., 2017). For example, gender identity is developed through experiences that youth and adolescents engage in and see in the world around them (Bussey & Bandura, 1999). Racial identities, which also develop as youth age, is at least partially developed based on perceived differences in physical traits and how individuals perceive the social hierarchy in the world around them, leading to the ongoing development of ethnic identities which children achieve greater awareness of as they are immersed in the realities of living in a White, male-dominant society become more apparent (Smedley, 1998). Persons with disabilities engage in social meaning-making as they strive to build identities and navigate internal, interpersonal, and social dynamics. Gill (1997) in writing on the identity development of persons with disabilities, sees a process wherein one continually seeks to negotiate the pulls of opposing forces, seeking a type of integration of individual and group belief systems. He states:

> (The) four types of integration underlying disability identity development are delineated as, (1) 'coming to feel we belong' (integrating into society); (2) 'coming home' (integrating with the disability community); (3) 'coming together' (internally integrating our sameness and differentness); and (4) 'coming out' (integrating how we feel with how we present ourselves) (Gill, 1997).

Teachers and researchers who engage in helping underrepresented students build positive identities can be seen as helping these students to construct a counter-narrative as they navigate

individual, group, and within-group identity development and construct what is known as an academic identity (Ryoo et al., 2013).

Academic Identities

Academic identities can be powerful for students. As students perceive a belonging to a field or group (such as CS) they see themselves as the type of person who could belong in that field (Brickhouse et al., 2000). If students are to continue with this academic identity development long-term, it must be reinforced both at school and at home (Nuamah, 2018). This may be especially important for Black males whose academic identification drops significantly lower than other racial or ethnic groups from 8th to 12th grade (Osborne, 1997). This change in self-identification is possibly due to a sense of declining agency as these students are subjected to disproportionate school discipline, and face greater negativity from teachers as noted by Ryoo and Tsui (2020) in a recent study of underrepresented highschool CS students taking AP CSP. The study examined student levels of engagement, and whether students across racial and ethnic groups, combined with gender, identified as "computer science people." The authors found that a low engagement with CS occurred for Latina, Asian, and White young women and attributed this lack of engagement to the fact that these same groups of young women did not feel as strongly that their race/ethnicity combined with their gender would be accepted in CS environments post-high school. This anticipation of rejection speaks to a perceived lack of belonging and is highly important to academic and STEM identity formation. While there was no statistically significant difference between the responses for Black males and the responses of young Black women to statements about CS belonging, the authors questioned why Black males, on average, agreed less than Black young women about being welcomed in the field of CS, or that they would be accepted in the field if they chose to pursue CS. Moreover, a sizable group of participants

declared that they could not be “CS people” because they had further learning to do related to CS. The authors contrast these participants who did identify positively with CS due to their perceived skills or abilities. This is significant in that substantive overlaps persist between perceived traits associated with men and scientists, but not between women and scientists (Carli et al., 2016). These stereotypes inform identity development in youth as young as age six when girls begin to believe that they are less brilliant than boys, and the stereotypes affect their aspirations and interests (Bian et al., 2017). The perspective or mindset of having more to learn as a barrier is one that should be further explored, especially as it relates to creating a sense of belonging identity formation in CS learning.

Ryoo and colleagues (2020) further explore identity in high school students’ new to CS, building on Calabrese and Tan’s (2019) idea of “rightful presence " as it applied to underrepresented students in CS learning spaces. The authors used classroom observations, interviews, student artifacts, video/photos, and surveys to explore students’ ideas of belonging. In juxtaposition to the study by Ryoo and Tsui (2020) wherein Latina, Asian, and White young women who indicated a sense of non-belonging and therefore showed little inclination to continue with CS, Ryoo et al., (2020) found that identity formation was associated with student agency, specifically as a form of resistance and a means to make space for oneself in a discipline where there had previously been little. In the process, these students enacted a kind of resistance through participation in response to the dehumanizing (and pseudo-neutrality) that can accompany CS in schools.

Coenraad et al., (2019) sought to explore how engaging Black young women in middle school in a participatory design process might instill agency and give context for the students to explore their own emerging identities. The participatory design sessions were conducted as part

of a larger project to create a culturally responsive computer science curriculum to address issues of equity and underrepresentation. The case study showed how participatory design activities served as a space for the young women to probe characteristics of their current identities and project future (including possible STEM) identities while applying aspects of these identities to shape materials for others. Drawing students' attention to their current developing and possible future identities through collaborative design has the potential to be a powerful metacognitive tool. As with other explorations of identity, part of this work was being aware of how individual voices were considered by and reflected the larger, diverse design team. This study confirms previous research as to how identities can emerge when students have access to materials and resources which lend themselves to reflection and iteration (Darling-Hammond et al., 2020; Gutiérrez & Rogoff, 2003; Nasir, 2011) and thereby set in motion possible future learning (Barron, 2006).

Intersectional Identities

Sometimes students may see themselves as having multiple identities. The intersection of identities or intersectionality for underrepresented persons means that the discrimination they face may be greater than the sum of any of their identities alone and scholarship suggests that this is especially true for Black women (Crenshaw, 1989). Therefore, the identity development of girls of color can be incredibly complex as they develop at the center of race, ethnicity, gender, class, sexuality, and (dis)ability (Bonsignore et al., 2013: Scott & Garcia, 2016). In response to these complexities and in an attempt to help girls of color develop rich STEM identities, the COMPUGIRLS program (Ashcraft et al., 2017; Madkins et al.,2019; Madkins et al., 2020; Scott & Garcia, 2016; Scott & Garcia, 2013) as with the program set out by Ryoo et al, 2013, uses a funds of knowledge approach (Moll et al., 1992) to build community, and as a base for nurturing

teen girls' habits of mind toward undertaking a form of political-social-techno activism. While instilling belonging and a sense of agency, the culturally responsive (e.g., Ladson-Billings 1995) program seeks to empower girls of color to wield a critical perspective on how technology can be used for social change while recognizing the affordances and limitations of technology.

Political Identity

Tied closely to social justice approaches of CS education, the development of political identities, as with COMPUGIRLS, is conceptualized at its most basic level as the dawning of one's awareness of and commitment to addressing inequalities in society born out of issues of power and privilege (Nasir & Kirshner, 2003; Yates & Youniss, 1998). The awareness component of developing political identities, both in terms of the affordances of computing and any possible negative consequences, is often accompanied by a sense of the need to act or to become an agent of change (Barton & Tan, 2010). From CS learning perspective, a fully-realized political identity would include an individual leveraging their computational knowledge and awareness to better the lives of those within their community and society at large. Vakil (2020) takes things a step further by having highschools students examine and reflect on inherent values with the field of CS and how those values interact with the students' own emerging political identities, allowing them to generate ideas about how and why they may (or may not) wish to participate in CS for reasons related justice and ethics. Learning experiences for underrepresented youth are greatly enhanced when a clear link is established between STEM learning, a greater social purpose, and the development of personal agency (Goode, 2008; Kafai et al., 2014; Margolis & Fisher, 2003; Margolis et al., 2014; Ryoo et al., 2020). This idea of reorienting CS education toward the pursuit of a more just society has been championed by many scholars in the field (e.g., Bobb, 2016; Ko et al., 2020; Toyama, 2015; Vakil, 2014; Vakil 2018)

and it requires a deep analysis of the socio-political values and the goals researchers, teachers, and society espouse for CS education.

Computational Isolationism

Given the importance of community, belonging, and agency in the cultivation of CS identities, Gretter et al., (2019) sought to explore the idea of student isolation as a barrier. The authors conducted a qualitative study of 8 high school teachers to explore how the teachers encountered a lack of belonging in diverse student groups. One teacher in the study shared how it could often be difficult for students from underrepresented groups to feel welcomed, as they entered an educational space with a classroom atmosphere and culture already defined by a more dominant group. This sense of isolationism is clearly a deterrent to identity development and a detriment to the continuing study of CS by underrepresented groups. It should be noted that all of the studies related to CS identity development with the exception of one at the middle school level, focused on high school-age students. At this time, there is a lack of empirical work exploring the CS identity formation that pertains to equitable CS beginning at the elementary level. Understanding how underrepresented youth CS identity develops longitudinally could go a long way in creating more equitable learning opportunities and outcomes.

The Role of Classroom Teachers

If the goal of CSforALL and broadening participation in CS is for all students to have access to and learn computer science, then teachers must play a crucial role in the equity work necessary to achieve these goals. Studies have highlighted the disparities in access to high-quality teachers across the U.S. educational system (Darling-Hammond and Berry, 2006). The shortage of qualified and certified teachers extends to CS education as well (Ladner & Israel, 2016; Lang et al., 2013) and is cited as a major barrier to providing equitable CS learning

opportunities for students (Margolis & Goode, 2014; Margolis et al., 2015). Further, disparities in who has access to qualified teachers and other resources needed to learn CS has exacerbated pre-existing inequities in the field (Aspray, 2016; Goode, 2008; Google & Gallup Inc., 2020; Margolis et al., 20008). Beyond access to qualified teachers, effective CS teaching for all students is dependent on teachers' deep understanding of the equity issues which exist in CS classrooms (Zhou et al., 2020).

Teacher capacity is clearly lacking in CS education and disparities in access to qualified CS teachers perpetuate existing inequities. Furthermore, the meager professional learning options which are available are generally provided by institutions of higher education with little to no input or involvement from the schools or districts within which CS teachers work. This disconnect between professional development (PD) opportunities and local context limits the extent to which PD is aligned with and relevant to the needs and values of the community, its schools, and its students (Century et al., 2013). Recent scholarship has pointed to the value of community aligned CS education in promoting equitable and sustained CS learning (e.g., Ashcraft et al., 2017; Fancsali et al., 2020; Madkins et al., 2019; Ryoo et al, 2013; Ryoo et al., 2020; Scott & Garcia, 2016). Johnson et al., (2020) highlight the need for a diverse teacher workforce and the importance of living within the community in which one teaches. In their study of underrepresented communities and the intersectional experiences of Black women high school CS teachers, the authors found that commitment to one's community and the exercising of "critical hope" were key components of the teachers' efforts towards equity in CS. When discussing how her identity impacts her students, one teacher stated:

> I think it makes a difference because all of my students are Black students so I can talk to them as a Black mother and I can build a different type of relationship with them, I

> think. The relationship that I have with them is a little different than some of the other teachers. (Johnson, et al., 2020, p.3)

While intersectional identities necessarily come with greater exposure to racism and prejudice, in this study, the teachers also saw their identities as an asset to their students.

Importance of Creating Classroom Communities

The focus on community in the CS equity literature is strong whether it be related to locale, within the classroom, or within a teaching community. This is certainly the case with work related to the Exploring Computer Science (ECS) initiative. Ryoo and colleagues (2015) describe the importance high school CS teachers placed on the creation and sustainment of professional learning communities (PLC) designed around inquiry and equity-oriented CS instruction. As noted in the discussion of the work by Fancsali et al. (2020), teachers in high-need buildings are often under-supported and under-resourced often leading to high teacher turnover rates in those buildings. This is partly due to a sense of isolation felt by these CS teachers who may be the only person in their position at their building. The 81 teachers studied by Ryoo et al., (2015) described the importance of their PLC in breaking their isolation and in supporting them in their own CS learning. PLC's can be especially powerful in supporting those working in high economic need schools where in NYC, teachers reported being less likely to receive support from administrators, specialists, or other teachers at their buildings (Fancsali et al., 2020).

These findings become even more important when examining teacher isolation and lack of support as it relates to conservation of resources theory (COR) that posits that teachers strategically utilize a limited set of resources to meet their goals (Alacon, 2011). Israel et al. (2018) examined how CS instructional coaching might help teachers meet the needs of diverse

learners, including students with disabilities, in a large urban district, as teachers face new challenges and demands such as integrating new subjects like CS. Without sufficient resources, such as involvement in a robust PLC or access to instructional coaching, as teachers face new challenges and instructional demands, their identification with their work may wane (Alacon, 2011). Ongoing, high-quality interaction with experienced colleagues such as instructional coaches can play an important role in helping teachers, especially new teachers or teachers new to CS, succeed (Cornett & Knight, 2009; Johnson, 2004). Given the insufficient teaching capacity that exists, the field cannot stand to lose CS teachers due to a lack of resources and support. This is especially true for teachers in higher economic need, lower resourced schools where attracting new teachers may be difficult, and finding teachers with the content and pedagogical as well as cultural understanding necessary to help underrepresented students succeed is paramount. The work of Margolis et al., (2017) on the importance of instructional coaching, supports the work of Israel et al. (2018) while adding that ongoing coaching conversations directly related to equity were central in helping teachers to successfully engage students who have been historically underrepresented. The authors found that these focused coaching conversations helped teachers to better align instruction and classroom culture to student needs. Teachers also noted that instructional coaching in CS helped them to build their CS content knowledge and their pedagogical content knowledge as was the case in the coaching study by Israel et al. (2018). Furthermore, coaching helped teachers to ease their sense of isolation at school.

Teaching as Political

Critical Education Theory links teaching and learning to broader systems of power and how those systems have been used to oppress (and potentially liberate) populations (e.g., Freire,

2000; Giroux, 2014). Therefore, if education is power, it is then necessarily political (Vakil, 2018). Social justice-centered approaches to CS teaching are based around the idea that without a thorough examination and understanding of the political aspects of teaching, we risk further marginalizing and even oppressing students as they engage in their pursuits of disciplinary learning (Philip & Azevedo, 2017; Vakil, 2018). For example, Zhou and colleagues (2020) in examining high school teachers' perceptions of equity during a two-year CS certification program found that equity was often expressed as equality in terms of access to resources and equal participation in CS programs. The authors found that the teachers engaged in little discussion of how student participation and success in CS may be influenced by systemic factors and nearly all of the teachers interviewed stated that they could not see how teaching CS was in any way political. These findings speak to the importance of more explicitly focused PD to assist teachers in understanding the myriad forces that entwine to create inequitable CS learning. The study does highlight that teachers identified the need for empathy in their teaching which could only be achieved by learning about honoring their students' backgrounds, lived experiences, and emotions.

Two studies related to STEM learning (Nasir & Vakil, 2017; Van Horne & Bell, 2017) further highlight the tensions between belief systems related to disparities in student STEM achievement and how those beliefs may perpetuate inequity. Here too, teachers did not see the political elements of education or how systemic issues contribute to disparities in learning. Instead, the faculty blamed historically underrepresented students' struggle on student or cultural deficits. In an ethnographic study of a week-long teacher PD, Goode et al. (2020) draws on the dialogue of a diverse group of teachers and explores how they engaged in verbally evaded, deflected, and then reflected on explicitly racial discourse related to CS teaching. The study

shows how long-term PD has the potential to unveil colorblind thinking and belief systems as teachers move toward more culturally responsive pedagogical approaches. While teachers may or may not engage students in discussions about race on their own outside PD opportunities, talk about race or "racial talk" has been well documented among STEM students (Nasir et al., 2009; Schaffer & Skinner, 2009; Shah, 2013). Vakil (2020) studied this racial talk or "political-racial contestation" among high school students in a CS class noting that willingness to engage in dialogue that may be uncomfortable for students and teachers is necessary if we are to prioritize equity. Due to the pervasive nature of racism around the world, teachers can assume that racial talk is happening amongst their CS students, even if teachers are not witnessing it directly (Lewis et al., 2019). In order to validate these dialogues and use them to advance equity in their classrooms, teachers must themselves first commit to engaging in exploration at the intersection of politics, power, and education.

Curriculum and Equity

As mentioned previously the ECS high school curriculum is one of few examples of a curriculum that includes equity-based components as well as deep investment in ongoing PD for teachers. The inquiry-based nature of ECS is another of its most prominent features and one that researchers have established as central to promoting student agency and equity (e.g., Goode et al., 2014; Ryoo et al, 2013). Although equity-based instruction is an integral part of the ECS curriculum, it seems to be an outlier in CS education. This is problematic as the underrepresentation of women and BIPOC in STEM can in part be linked to instructional issues and a lack of culturally-relevant curricula in formal educational contexts (Ladson-Billings, 1998). Furthermore, teachers' approaches and enactment of equity focused curricula is strengthened by PD that is synergized with that curricula (Goode et al., 2014; Goode, Ivey et al.,

2020). The synergistic effects of curricula and ongoing PD that both prioritize equity leads to more scalable efforts especially if key personnel beyond teachers are included, such as counselors, and administrators (Flapan & Ryoo, 2020).

While high-quality CS curricula have been created and iterated upon to engage high school students from diverse backgrounds and facilitate their understanding of essential CS concepts (Brown & Briggs, 2015; Margolis et al., 2017) few examples of formalized curricula exist at the K-8 level meaning that often under-resourced, under-supported teachers have to create their own curricular materials. While there is a paucity of formal curricula prioritizing equity available to K-8 CS teachers, researchers have recently begun to study some promising approaches. For example, Pinkard et al. (2017) used a design-based research approach to study how an out-of-school program named, Digital Youth Divas, could support young women, Latinx, Black and low-income, middle school students in exploring their STEM interests and identities through virtual and real-world communities. Researchers facilitated the use of narrative story creation as part of a project-based learning design challenge to engage the participants. The results suggest that this approach increased the participants' identification as STEM learners and increased their sense of agency. As with ECS, the co-occurrence of building student interest, engagement and identity building were major features of the work.

Jacob et al., 2020 also used a design-based research approach to iteratively develop, test, and refine a culturally responsive inquiry-based curriculum for upper-elementary-aged students. The program aligned with CS and literacy standards and provided linguistic scaffolding supports for multilingual students. The authors sought to explore how such a program may support or constrain the identity development of diverse learners. In analyzing teachers' instructional choices during the implementation of the program, the researchers learned that teachers adopted

differing approaches to inquiry along a continuum (open-closed) to support their students. Furthermore, student-level data showed that those who were given more structured approaches to inquiry lessons created more sophisticated computational projects and also expressed a greater affinity for CS. The findings around the efficacy of teacher support and scaffolded inquiry are echoed by previous work related to supporting students with disabilities in CS education (e.g., Israel, Pearson, et al., 2015, Israel, Wherfel, et al., 2015; Snodgrass et al., 2016).

Classroom and Learning Environments

High-quality, positive learning environments have been repeatedly shown to help successfully support engagement, learning, and overall development (Hewes, 2006; Makin, 2003; Shipley, 2008; Sylva et al., 2006) and Regio Emilia often referred to the classroom environment as the "third teacher" assigning tremendous importance to explicit and implicit messages students receive from their learning environments and how those environments shape students' sense of belonging and engagement (Strong-Wilson & Ellis, 2007). Elements such as classroom aesthetics, transparency, active learning, flexibility, collaboration, reciprocity, and relationships are examples of components in the learning environment that should be considered and can be consequential for learners (Fraser, 2006). For example, researchers have found that the physical artifacts and layout of a CS classroom can diminish women's sense of belonging in the field (Cheryan et al., 2009). Barker et al. (2002) found that the computing learning environments they studied were often impersonal, resulting in feelings of isolation for some students, and lending themselves to compete in ways that fostered defensiveness as opposed to shared learning and collaboration. This was true in the work of Gretter et al. (2019) wherein underrepresented students felt isolated and without agency to shape classroom culture already defined by the more traditional White, male students. Student relationships within classrooms

can be a powerful factor in determining students' sense of belonging and how they do or not engage as shown by Vakil and DeRoyston (2019) whose qualitative study, using classroom video data and interviews, explored how a lack of solidarity and trust in a high school CS classroom can influence student learning. The authors caution that classroom norms which often focus on developing student relationships for the purpose of enhancing learning, ignore the deeper more generative possibilities inherent in authentic and reciprocal relationships. The findings further show that the cultivation of political-racial awareness and solidarity (and therefore trust) allows students to interact in new and formative ways.

Computational Tools for Learning

To date, little scholarship has gone toward understanding the structural design of technologies used to teach CS with regard to how these technologies may mirror the biases of those who create or use them (Caliskan et al., 2017). One outlier is a recent study by Kits et al. (2020) in which the authors explore how moving beyond surface-level feature changes in tool design or usage may elucidate how the underlying structure of a tool privileges particular ways of knowing. In working with 38 Native American participants, researchers examined how the cultural practice of storytelling was supported and/or inhibited within novice programming tools. ARIS, or Augmented Reality and Interactive Storytelling, was used to support location-based narrative construction. The authors found that while other more established tools lend themselves to the more linear approaches typical of white, dominant culture, the ARIS tool structure allowed for non-linear computational storytelling more closely aligned with the participants' cultural practices and ways of understanding the world. These findings highlight the need to interrogate who designs computational learning tools and how their epistemologies may shape those tools.

Other scholars have devoted considerable effort to create computational tools for students with vision-related impairments. These include the Quorum programming language (Stefik & Ladner, 2017) which is a text-based language whose syntax and semantics have been rigorously tested for learnability and usability with screen readers. The authors of Quorum targeted the language syntax and purposefully created a programming language that was less intimidating for novice users. Block-based programming languages are often used with younger programmers as they remove issues related to visual language complexities. For example, users of block-based languages need not remember code choices, how they should look, and their syntax (Weintrop & Wilensky, 2018). Therefore, these tools are used heavily in curricular materials and outreach efforts for K-12 education. However, these tools rely heavily on visual elements, leaving them inaccessible for students with visual impairments. The Blocks4ALL project (Milne & Ladner, 2018) addressed these issues by creating and testing a blocks-based programming tool that is accessible to students with vision-related impairments. The authors admonish future developers to consider how to incorporate more physical and auditory output for programming tasks in tools, thereby making their applications more broadly appealing and usable. Developing accessible tools for the youngest CS learners should be prioritized because interest in CS tends to decline for underrepresented groups (e.g., girls and young women, minority students, and students with disabilities) as students move through their school progression (Carter, 2006).

Pedagogical Approaches to Equity

Beyond but directly related to the importance of a curriculum that is equity-driven and tools that are designed to be useful for the broadest range of learners, understanding what pedagogical equity practices “work” in CS is paramount. This is especially true for learners who are historically underrepresented in the field (including girls and young women, students of

color, low-income students, language learners, and students with disabilities) as pedagogical choices teachers make may enable or constrain the equitable distribution of learning opportunities within classrooms. Ryoo (2019) investigated what pedagogical practices ECS teachers found most effective for engaging students. She found that key practices which impacted student interest were showing how CS connected to students' everyday lives, valuing students' voices and perspectives, and promoting student discovery of the potential social impacts of computing on students' communities. Fields et al., (2017) explored ways in which teaching practices such as modeling in-progress artifacts, valuing student expertise, and promoting personalized connections in student work could broaden access to making while deepening participation in computing. Classroom design, it was found, worked in conjunction with the aforementioned teacher moves to help promote sharing of ideas and support the development of friendships as part of this new ECS module. As a result, students took on new roles in teaching and supporting each other's learning, allowing the teacher to work more closely with students in need of extra attention.

Equitable outcomes of cooperative learning were the focus in two earlier studies looking at pair programming. Fields and Enyedy (2013), using an identity lens, investigated learner participation levels and how roles shifted among two upper-elementary-aged students as they took on the role of "expert" programmers. As with the previous study, students' willingness to take on new roles in the classroom helped in facilitating student identity development. Interestingly, while the authors do concede that one of the participant's actions could have been driven, at least in part, by a perceived stereotype of computing as a male activity, they do not focus on the role of gender, race, class, or (dis)ability in identity formation. Lewis and Shah (2015) studied sixth-grade students engaged in pair programming at a summer camp to uncover

how student content knowledge, beliefs about, and preferences related to collaboration might affect equitable learning. Findings showed that students who were more equitably paired in terms of content knowledge had less of a focus on speed in task completion than inequitable pairs. The authors warn that such inequitable pairings may lead to the marginalization of students with less content knowledge. Another interesting finding of the study was that the use of a self-paced curriculum may have further contributed to the student's focus on speed. Given that one of the most widely used K-8 curriculums (Code.org) is self-paced, further study related to these findings is warranted. Other studies have shown that both teacher facilitated collaboration (e.g. pair programming) and student-initiated collaboration can be effective strategies in supporting diverse learners, including students with disabilities, across a range of computing tasks (e.g., Israel, Pearson, et al., 2015, Israel, Wherfel, et al., 2015; Snodgrass et al., 2016). The authors of these studies do caution that student-initiated collaborations often require instruction and scaffolding in order for them to be productive. Understanding when and how to seek collaboration or to engage in collaborative behaviors in a manner that promotes learning is not innate (Israel, Wherfel, et al., 2015) and in order not to create further learning disparities, explicit instruction in productive collaboration behaviors is recommended.

Guiding Frameworks

There is clearly overlap in the literature related to instruction, tools, learning environments, and curriculum. Dependencies between and amongst these areas often exist. It can therefore be helpful to use frameworks that consider how best to leverage these overlaps more holistically, in thinking about creating equitable outcomes for students. Evidence continues to accrue that suggests using frameworks that prioritize equity can support learning outcomes (i.e., conceptual knowledge development, student achievement, and positive identity development)

and address a wide variety of learner needs for underrepresented students across content areas (e.g., Allen-Handy et al., 2020; Allen et al., 2012; Boaler & Sengupta-Irving, 2016). Such a framework is culturally relevant computing (CRC) introduced by Kimberly Scott and colleagues (2013, 2015). CRC is grounded in the ideas of culturally relevant teaching (Gay, 2000; Ladson-Billings, 1995, 2006), culturally relevant pedagogy (CRP) (T. Howard, 2001; Ladson-Billings, 2012), and culturally sustaining pedagogy (Paris & Alim (2012, 2014, 2017). CRC builds on previous scholarship that prioritized the use of equity pedagogies in CS learning to positively affect student outcomes (e.g., Ryoo et al., 2013; Scott & White, 2013; Vakil, 2014) including many of the studies highlighted herein that are related to ECS (Goode & Margolis, 2011; Margolis et al., 2012; Ryoo, 2019; Ryoo et al., 2013). Throughout the CRC learning process, students are to be supported in creating personally meaningful computational artifacts and are taught to explore how their (often intersectional) identities intersect with their computing experiences. CRC emphasizes that sociocultural relevance be embedded at all levels of student learning experiences including instruction, tools used, classroom environment, and how learning is applied outside of classroom contexts.

The second guiding framework for this study is Universal Design for Learning (UDL). UDL is an instructional framework that seeks to proactively address barriers to learning to meaningfully engage a wide range of learners (Center for Applied Special Technology [CAST], 2018). The UDL framework comprises three principles that may be readily applied to CS education focused on equity:

1. *Multiple means of representation.* The first principle of UDL stresses that teachers should deliver instruction in multiple ways, giving students different ways of encountering the same content. In computing instruction, teachers may model a specific idea and its

application, provide students with instructional videos explaining the concept, and/or introduce an idea through the Use-Modify-Create framework. Within Use-Modify-Create oriented instruction, students first encounter an idea through using it as part of a pre-made program, then modify a similar program, and then finally create a program using the target concept (Lee et. al., 2011). Instructors might also provide worked examples, Parson's problems, or ask students to engage in a computing activity that does not use computers at all, commonly referred to as CS unplugged activities. Different combinations of these techniques, in varying scope and sequence, can be tailored for students based upon their needs.

2. *Multiple Means of action and expression.* UDL emphasizes the use of multiple methods of allowing students to express their learning. Here, for example, students may create a program on their own, modify an existing program based on a certain set of criteria, debug a program to allow it to produce an expected output or comment on one's code to explain programming choices. It should be noted that programming is inherently flexible in that there is a multitude of ways in which students can express their mastery of a concept within a programming environment. Teachers can scaffold this expression with the use of project planning support and by breaking down assignments into base-level assignments and assignment extensions, thereby allowing all students to meet a target learning level as well as providing some controlled choice to those who want to go beyond.
3. *Multiple ways to engage students.* Learners can differ remarkably in the ways in which they are motivated and engaged to learn. The third principle of UDL emphasizes the importance of including multiple options with which to cultivate student engagement. In

computing education, some students may prefer to work in a more sequential, puzzle-based environment, such as Code.org or Kodable.com. Others may be more engaged in open-ended or sandbox environments such as Scratch wherein students have access to all the platform's tools and there are few constraints placed on students' exploration. Some students may prefer to move away from block-based programming and work with text-based languages such as Python which can be seen as more "real" by some older students. Other students may hold a deep preference for CS unplugged activities requiring no computing device at all, and still, some may go the opposite route and prefer to work with physical computing devices such as the MicroBit or robotics. While allowing student choice in the type of activity and the platform is important, it is equally important to give students access to learning opportunities that are both culturally and personally relevant.

There are currently relatively few computing studies exploring cognitive accessibility features or frameworks, such as UDL, which are shown to be effective in other content areas. However, those that do exist, at the high school level (e.g., Wille et al., 2017) and at the elementary level (e.g., Hansen et al., 2016; Israel et al., 2015; Israel et. al., 2015; Israel, et al., 2020) show how using flexible approaches that move beyond mere engagement and value learner differences can be fruitful in creating equitable access and outcomes for all students, including students with disabilities.

In summary, both CRC and UDL are flexible, learner-centered frameworks based on the idea that learner variability should be valued as an asset. They further explore that learner differences in terms of access and outcomes are socially constructed and not innate. At the heart of all equity work is the idea of learner variability; that we cannot treat all students as if they are

the same or that there is such a thing as an average student. Both culturally centered approaches to computing and UDL are aligned with this idea. Accordingly, both approaches are featured in the Equity section of the CSTA Standards for teachers. The standard indicators include that teachers (a) examine issues of equity in CS, (b) minimize threats to inclusion, (c) represent diverse perspectives, (d) use data for decision making to improve equity, and (e) use accessible instructional materials. Combined, these two frameworks provide a comprehensive lens for the equity-related study of CS education. Finally, it should be noted that while there is great breadth in the literature highlighted here, there are some clear gaps. For example, an overwhelming majority of the equity-focused work in CS education is geared towards the study of high school level CS with few studies at the middle school level and fewer still at the elementary level. As noted above, data on the socio-economic level of student participants is generally underreported throughout the body of CS education research (Bishakha et al., 2020) and many of the studies fail to investigate underrepresented student populations such as students with disabilities, Native or Indigenous students, rural students, and English language learners. Further, many of the equity-focused studies noted here are based on one curriculum (i.e., ECS) and while much can be learned from these efforts, investigating the approaches of teachers without formalized curriculums that prioritize equity is warranted. The proposed study seeks to explore the equity practices and beliefs of a varied group of teachers across all grade levels, K-12, from diverse locations (e.g., urban and rural, various cities and states) who teach diverse students and do so with and without formalized curriculums focused on equity. It, therefore, has great potential to address some of the gaps in the existing literature and in doing so move the needle on equitable CS education.

CHAPTER 3: METHODS

Purpose

The purpose of this qualitative study was to understand how the 2019-2020 CSTA Equity Fellows work to enact equitable CS education for the widest variety of learners across differing contexts and locales. The data for this study were collected as part of my participation in the fellowship program. In addition, much of the data, including demographic information, the structured interviews, and some meeting artifacts such as blog posts are publicly available. Approval to conduct this study has been granted by the Institutional Review Board, found in Appendix A.

The research questions that guided this study include:

1. How do the CSTA Equity Fellows, with varying backgrounds and experiences, define and describe equity in K-12 CS education?
    b. How and to what extent do the Equity Fellows consider learner variability in general and students with disabilities specifically in their equity-focused CS education work?
2. How do the CSTA Equity Fellows intentionally use strategies to support equitable access to CS education and promote success in CS education for historically underrepresented students, including students with disabilities?

Methodology and Research Design

While equitable access to and success in CS education has been explored within certain populations and mainly at the high school level (e.g., Goode, 2008; Goode et al., 2020; Margolis et al., 2017), the experiences of and the strategies used by teachers who span major demographic

categories and varied locales has not been well explored. Given the exploratory and descriptive nature of this investigation, qualitative inquiry is best suited to answer the research questions (Cresswell, 2014). A basic qualitative approach was used as this study's overarching design because it is a good fit for the practical and straightforward goals of this investigation (Merriam, 2009; Patton, 2015). Basic qualitative research design, as described by Merriam (2009), is a widely used inquiry framework in social science research that is grounded in the philosophy of constructivism and is particularly well suited to examine practical topics in education research. The utilization of a basic qualitative research design is utilitarian, allowing for flexibility in the research procedures.

Reflexivity Statement

While this study used basic qualitative inquiry for its overall design, my positionality within the study as one of the participants was of importance. To begin, my work as a researcher at the intersection of special education and CS education is informed by my 17 years as a K-5 educator working in high-poverty public schools. Due to these experiences, I predominately operate from a pragmatic paradigm and focus on work that is less theoretical and more practical and applicable. My deep experience in the K-12 CS education community as a member of the CSTA K-8 task force and a writer for the K-12 CS Framework and the CSTA Standards informs my work as well, specifically as it pertains to inclusive and ethical practices in CS. As someone with a rare degenerative eye disease (Ocular Histoplasmosis) my perspective is at least partially informed by my daily experiences with that disease and how I interact with a world flush with computational tools to which little attention to accessibility has been given.

When I started my term as an Equity Fellow, I did so solely as a participant in the program and with no intention of conducting a research study based on the fellowship. However,

being that I was the only fellow not actively teaching CS in K-12 schools and had transitioned to a research role, I could not help but see myself in a different light. As a participant-observer (Pole & Morrison, 2003; Woods, 2005) within the fellowship over the course of the year, I was able to observe, interrogate and better understand the fellows' equity practices over an extended period of time. Participant observation is ideal for understanding the experiences of others through their own perspectives, and elucidating practices and beliefs that may not be explicitly discussed during interviews or surveys (Woods, 2005). Additionally, my role as a participant-observer was an active one, where I was both a contributor to the group's efforts and a learner alongside the participants (LeCompte & Preissle, 1993).

CSTA Equity Fellowship Recruitment and Selection

The participants involved in this study constitute the ten individuals who were selected as the inaugural cohort of the CSTA Equity Fellows during the 2019-2020 school year. The Equity Fellowship was first announced during the first quarter of 2019 through social media and direct emails sent to CSTA members. It was described as:

> ... a selective, year-long program designed to develop leadership in equitable teaching practices and advocacy. The program will both provide leadership development opportunities to the fellows and identify opportunities for the group to develop ongoing, peer-to-peer professional learning experiences focused on addressing issues of equity in the computer science classrooms for all CSTA members. (CSTA, 2019)

Eligibility criteria included that individuals applying be a CSTA member, a current K-12 educator and that they submit their application by the stated deadline. Applicants were asked to submit a 1-2 minute video introduction explaining their interest in the fellowship. In these videos, participants were asked to respond to five short questions:

1. How would you like to learn or develop through this fellowship?
2. How do you define equity within your practice of teaching?
3. How have you disrupted the disparities impacting females, underrepresented students of color, English language learners, and/or students with special needs in computer science education? Please include specific strategies to improve access, engagement, and achievement and how you measure success.
4. Discuss ways you have leveraged partnerships and collaboration to tackle inequities in computer science education.
5. A primary objective of the Equity Fellowship is that Fellows develop solutions to improve equitable access and achievement at scale. What are specific ideas for potential activities or projects that Equity Fellows could pursue?

Applicants were also asked to provide demographic information such as (a) their gender, race, and age, (b) the locale in which they taught, (c) whether it was a small or large urban, suburban or rural school district, (d) whether the school received federal Title One funding, (e) their teaching role, and a description of that role, (f) what grades they served, (g) what subjects they taught, (h) whether they were a classroom teacher or an itinerant teacher, and (i) how long they had taught computer science.

In total, 112 applicants completed applications for the Equity Fellows program. Those applicants were initially screened by CSTA staff based on the completeness of the application and were then scored based on criteria set out by the planning committee. Of the original group, 53 applicants were selected for a full review by no less than three reviewers. The pool of reviewers included CSTA staff, CSTA board members, program advisers, and researchers who work in equitable CS education. From this group, 22 unique applicants were chosen to be

considered for the 10 fellowships. The final group of 10 Equity Fellows was selected based on reviewer comments, criteria-based scores, and input from program advisors.

Participants

The participants in this study included the 10 CSTA Equity Fellows for the 2019-2020 school year. The fellows were a diverse group, working in both public and private education at schools of varying sizes and with diverse student bodies. These fellows represent eight different states: Alaska, Arkansas, California (2), Connecticut, Georgia, Illinois (2), New York, and Ohio and work in locales ranging from remote or rural to large urban centers. Besides myself, all of the fellows were practicing CS teachers or instructional coaches who regularly worked with students learning CS. They had a wide range of grade-level expertise (K-12). While not a practicing teacher, my selection as one of the fellows was in-line with selection guidelines as I had previously taught CS and served as a CS instructional coach before leaving the classroom to pursue research interests and a doctoral degree full-time.

Prior to data analysis, informed consent was distributed and obtained from the participants through email. Participants were anonymized and given pseudonyms, though given the uniqueness of the Equity Fellows program, a degree of discoverability does exist. However, multiple participants asked to be named for their unique contributions. In light of this request, these participants are referred to by their first names within the text. A table with participants' full names is included in appendix G. All participants were reminded that the researcher was readily available via telephone, email or Slack to answer any questions related to the study. The demographic details for all participants may be found in Table 1 below.

Table 1
Participant Demographic Data

Pseudonyms	Type of School	Locale	State	Grade Levels Taught	Years of CS Teaching	Race/Ethnicity	Age
Rose	Public	Small City	Northeast	9-12	7	White	40-49
Lucia	Public	Small City	South/South East	6-8/9-12	3	White, Native American	30-39
Shana*	Public	Suburban/Large	South	6-8	2	Black, Latinx	40-49
Abigail*	Private	Large City	West Coast	6-8	17	Black	40-49
Yusra	Public	Suburban/Large	Midwest	9-12	2	Black	40-49
Todd*	Post-secondary	Small Urban	Midwest	K-5	7	White	40-49
Jett	Public	Large City	Northeast	K-5	3	Asian or Asian-American	30-39
Charlize	Public	Large City	Midwest	6-8 9-12	2	Black	30-39
Michelle*	Public	Large City	West Coast	Pre-K K-2 3-5	2	Asian or Asian-American	30-39

Table 1 (continued)

Avery	Public	Rural	Alaska	6-8 9-12	5	White

Note. Names with an asterisk have been de-anonymized at the participants request.

Settings

The Equity Fellows initiative was originally designed to include a mixture of in-person and remote meetings with asynchronous communication occurring as needed. One in-person initial gathering of the fellows took place at the offices of the CSTA in downtown Chicago, IL over the weekend of October 17-19. While other in-person convenings were planned, the emergence of COVID-19 made travel dangerous. All other CSTA Equity Fellow meetings took place virtually through Zoom meetings. These online, whole-group meetings occurred at least once a month (through August 2020) and usually lasted two hours. Longer, virtual convenings took place in both March, 2020 and May, 2020. These events lasted approximately four-five hours each.

Data Collection and Data Types

Multiple sources of data were used to answer the research questions. All data used are secondary data and were not initially created or collected for the purpose of research. Instead, the data used in the current study evolved naturally out of the work of the fellowship and its participants for the purposes of growing the fellows and their equity-focused work and for sharing their learning with the wider practitioner audience which makes up the CSTA. Sources of data include: (a) demographic information, (b) two sets of interviews, (c) Zoom video recordings of fellowship meetings and their associated transcripts, (d) documents which include meeting notes and agendas, (e) meeting notes, agendas and artifacts from a two-day in person meeting which took place in October of 2019, (f) blog posts written by the fellows and published on the CSTA website, and (g) a post-fellowship questionnaire sent by CSTA leadership to the fellows which serves as the final data source for this proposed study. Demographic information, one set of interviews and the blog posts are all publicly available on the CSTA website.

Interviews

Two types of interviews were conducted. The first set of interviews (n=10) were structured and conducted by the CSTA staff during the only in-person meeting of the Equity Fellows. This meeting occurred in October of 2019 and was held at a hotel in downtown Chicago, IL. These publicly available interviews, which were video recorded and transcribed, were brief, ranging from 3-10 minutes and were held in a private room at the CSTA offices in Chicago. Given that these interviews were structured, the same questions (see appendix C) were asked of the fellows in the same order without the use of probing questions, resulting in the expediency of the interviews and allowing for interviewees to elaborate to a greater or lesser degree as they saw fit. The interviews were then posted for public viewing on the CSTA website as part of the organization's efforts to spotlight the work of the Equity Fellows. The second set of interviews (n=8) were initially conducted as part of a joint fellowship project between myself and a co-fellow, "Jett." These interviews (see appendix E) were conducted over Zoom using a semi-structured interview protocol. The interviews took place during the months of January and February of 2020 and were conducted by either Jett, myself, or both of us as schedules allowed. Although a semi-structured interview protocol was developed containing nine questions and three probes, these interviews were not conducted for research purposes but for use in an internal fellowship project and for the purpose of building relationships between the fellows. As a result, these interviews tended to be more informal, with the interviewees being given leeway to elaborate on topics that were of importance to them at that time.

Equity Fellow Group Zoom Video Meetings

Approximately 18 hours of video meetings (n=9) and their transcripts provided an important source of naturalistic data, offering access to how the fellows expressed themselves

and formulated their thinking in real time while engaging in conversation and debate with each other and guest speakers. Recordings of all Zoom video meetings were uploaded to trint.com for transcription. Monthly fellowship meetings typically lasted approximately two hours and the online convening was approximately five hours over two sessions.

Meeting Notes, Agendas and Artifacts

Documents created by CSTA staff to guide the work of the fellows, such as meeting notes and meeting agendas provided a context and perspective for the conversations that occurred in fellowship meetings. Artifacts created as a result of monthly meetings provided further data into the collective learning of the group or the work of individual fellows who shared project progress. Artifacts included publicly available blog posts written by fellows, and outcomes of fellowship including projects and presentations. Only artifacts created by the fellows as part of the fellowship practice and which were directly applicable to answering the research questions were included. An accounting of all data sources including interviews, meeting notes, agendas and the artifacts may be found in appendix E.

Data Analysis

Data analysis comprised three major phases. These phases were data management, implementation of analysis procedures, and steps to promote trustworthiness. Analysis was conducted with the assistance of a sixth-year doctoral student in special education with experience working on multiple qualitative studies related to the participation of students with disabilities in computer science education.

Data Management

The primary step in data analysis was preparing and organizing the data. Qualitative data analysis software (QDAS), Dedoose was used to facilitate organization and analysis of the data.

Data were imported into Dedoose and organized by data type. All data was stored securely on my password protected computer and backed up on a secure server (Box) which I used to share data as necessary with a second rater for analysis. Any data in need of transcription was securely uploaded to trint.com for processing. Once transcriptions were checked for accuracy and amended as necessary, I downloaded them and stored them in Box. A key linking participant information to raw data was stored on a password protected external hard drive separate from the data itself in my personal home office. All investigators (i.e., myself and another graduate student) were trained on Institutional Review Board (IRB) guidelines for protecting the confidentiality of the data.

Data Analysis Procedures

Data Preparing and Precoding. Once all materials had undergone automated transcription, I engaged in a data preparation and precoding process. This process included rewatching meetings and interviews to confirm the accuracy of the transcriptions and with an ear towards emphasis and importance (Layder, 1998). While engaging in this precoding, I created memos of things that struck me as important and questions to explore later. This "live coding" (Parameswaran et al., 2019) served as initial documentation of potential "codable moments" which warranted further attention (Boyatzis, 1998) and served as a transitional stage between data collection and more extensive data analysis (Saldaña, 2021). During this precoding phase, it became evident that some of the available data were not relevant to answering the research questions. This was mainly true in regards to the meeting notes. Wherein considerable data were attributable to non-participant individuals (e.g., the facilitator or guest speakers). Moreover, these meeting transcripts also included long stretches of conversation that were meant as ice-breakers, to build community amongst the fellows or just banter and which had nothing to do with the

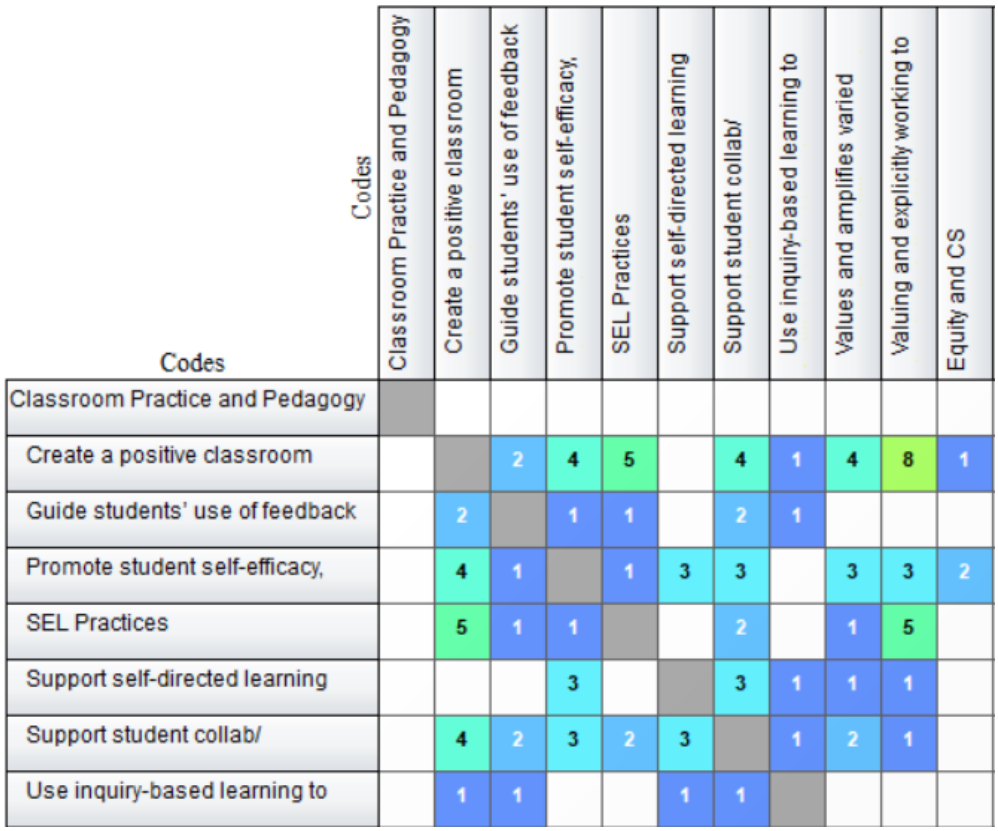
research questions. If a participant's response to a guest speaker was applicable to the research questions, then that data was coded and included as part of the study. As I engaged in the precoding process, I made notes throughout the data as to what sections of the meeting notes were relevant to the study and which were not. These notes were available to the second coder during co-coding and were discussed as part of the agreement process. Therefore, the data preparation and precoding phase of analysis included periods of what Creswell refers to as, "winnowing" (2015. p. 160).

Coding the Data. A cyclical process of memo writing and coding was performed throughout the analysis phase of this basic qualitative interpretive study (Merriam, 2002). In keeping with the recommendations of Glasser and Strauss (1967, p. 43) I approached the coding process in a nonlinear fashion wherein coding and memoing were intertwined throughout the study. This heuristic fluidity served to emphasize qualitative discovery (Locke et al., 2015). Two types of qualitative coding were used for this study: A priori codes and in vivo codes. A priori or "provisional" codes were developed based on the CSTA teacher standards (2020) and in response to the review of the literature. Therefore, first cycle coding was a deductive process reflective of the larger CS education community and its values as well as the teacher-participants who are a part of that community. This process resulted in an initial, provisional coding scheme that was iteratively refined as the analysis revealed new, or evolving codes and codes were either subsumed or abandoned based on use (Silver & Lewins, 2014, p. 227). Due to the often overlapping or "fuzzy" nature of equity related work, simultaneous coding sometimes occurred. Indexing the same piece of data with multiple codes can help in uncovering patterns and assist in categorization and theme building (Ritchie & Spencer, 1994, p. 182). A visual data representation tool in the Dedoose software allowed for examination of code co-occurrence. This

display helped to highlight expected and unexpected patterns in the data and how such patterns were related to the research questions. Individual co-occurrences (e.g., the number of co-occurrences between two codes) and the total number of co-occurrences for each code were displayed. A partial representation of the code co-occurrence display may be found below in Figure 1 below.

Figure 1

Code Co-occurrence



Codes	Classroom Practice and Pedagogy	Create a positive classroom	Guide students' use of feedback	Promote student self-efficacy,	SEL Practices	Support self-directed learning	Support student collab/	Use inquiry-based learning to	Values and amplifies varied	Valuing and explicitly working to	Equity and CS
Classroom Practice and Pedagogy											
Create a positive classroom			2	4	5		4	1	4	8	1
Guide students' use of feedback		2		1	1		2	1			
Promote student self-efficacy,		4	1		1	3	3		3	3	2
SEL Practices		5	1	1			2		1	5	
Support self-directed learning				3			3	1	1	1	
Support student collab/		4	2	3	2	3		1	2	1	
Use inquiry-based learning to		1	1			1	1				

Codes were continuously compared to discern their relations and possible outcomes based upon their alignment or union. Therefore, further interaction with the data often meant that previously established codes were renewed or modified.

Moving from Codes to Categories. Once the initial coding of the corpus of data concluded, the code book was updated. Any codes (and corresponding data) that were not directly relevant to the research questions were put aside during the process of categorization. This process was conducted collaboratively with the second rater who was a sixth-year doctoral student with experience working on multiple qualitative studies related to the participation of students with disabilities in computer science education. I had worked with this person for several years allowing for a collaborative relationship built on trust and respect. Our work together included both in-person and online meetings. The evolution of the code scheme (and code book) was documented through code mapping (Anfara, 2008, p. 932). This visual organizational technique served as a way to provide order and structure to the evolving scheme and aided in meaning making. A detailed code map can be found in appendix G. Saldaña (2021) recommends code mapping as one approach to assist in data synthesis between first cycle coding and further sense-making techniques. Furthermore, providing access to decisions made as part of the analysis process, as with code mapping, can enhance trustworthiness and credibility (Borman 1985). As the coding scheme evolved, codes were grouped into categories, based on their relevance to the research questions.

In Vivo Coding and Themes. Once categories were established and initially mapped to research questions, in vivo coding was applied. In vivo coding was chosen as a second or eclectic coding method (Saldaña, 2021, p. 299) because of its potential to honor and elevate participant voices and capture the meanings directly related to participants' experiences (Stringer, 2014, p.140). Applying in vivo coding to datum previously coded with a priori/provisional methods provided a heuristic by which analysis could move from confirmation and discovery based on the known to a condensation of meaning based on significance to the participants. Similarities and

differences in these in vivo codes across participants and categories were examined. This inductive approach ultimately led from a more specific participant-level data to a set of broader themes across all data and participants which aligned with the research questions.

Trustworthiness

Multiple measures were used to promote the trustworthiness and credibility of the findings of this study. These measures included triangulation (data sources and investigators), active searching for disconfirming evidence, the use of member checks, researcher reflexivity, and transferability (Brantlinger et al., 2005; Patton, 2015). Triangulation was used to confirm that claims made based on the data were consistent across the various data types (e.g., interviews, meeting notes), participants, and investigators (i.e., the same patterns within the data were discerned by different investigators) (Patton, 2015). Discrepancies in the evidence and disagreements between myself and another doctoral student serving as a second coder were taken as opportunities to challenge primary assumptions and build a more robust understanding of any inconsistencies within the data. Therefore, triangulation was used to confirm or disconfirm alternate interpretations of the data when disagreements and new claims that may arise as a result of discrepancies and disagreements (Stake, 2005).

Member checks were used to gather participant feedback on the researchers initial interpretations of the data and confirm the credibility of the data drawn from interviews, artifacts and meeting notes (Brantlinger et al., 2005; Doyle, 2007). Member check was conducted through email after initial theme development. These emails consisted of a description of the data sources used for the study and an overview of the themes which emerged from the data. Participants were asked to respond to the themes. In cases where I sought clarity on specific quotes, participants were invited to respond with further explanation. In this way, a specific focus was

applied to member checks related to in vivo coding to ensure researcher understanding of specific words or phrases used by participants (Saldaña, 2021). Of the nine fellows contacted for member check, six responded. Feedback from the member check showed the fellows were largely supportive of the themes shared. Member check data, including disagreement, was incorporated in the findings. The text of the member check email, responses and feedback may be found in appendix I and J. Member check data was the only additional data collected. Researcher reflexivity and the use of detailed, rich description was used to advance transferability and promote trustworthiness of the findings. I reflexively engaged in each stage of the research process and in doing so, put forward authentic descriptions and understandings grounded in the data. Furthermore, I include a self-disclosure in the researcher identity statement, wherein I describe my personal experiences as they relate to the phenomenon to be studied and will clearly describe in the findings how my personal experiences informed the interpretations made (Patton, 2015).

As noted above, another doctoral student experienced with basic qualitative research assisted in conducting iterative rounds of coding wherein each rater independently codes the same data, the codes are compared, discussed and grouped until agreement is reached. This occurred for the a priori coding for 20% of the data across all data types. Both raters initially coded a random sample of 5% of the data individually, came together and assessed the scheme. Once agreement was reached, we then coded together for the remaining 15% of the data using an iterative approach. Descriptions of co-coded data may be found in Figure 2 below.

Figure 2

Co-Coded Data Sources and Descriptions

Initial 5%

Structured interview (SI) Charlize
Published artifact (No Longer Hidden Figures)
Meeting transcripts (MT) 12/16/19
Semi-structured interview (SSI) Shana

Remaining 15%

Meeting Agenda (MA) 04-27-20
Structured Interview (SI) Rose
Published artifact (What Could it Be?)

Note. In-text abbreviations used are provided next to each example. Published artifacts are listed by name.

Once a final agreement was made, I continued to code the remaining 80% of the data. As the coding scheme evolved, changes were discussed with the other rater as were in vivo codes that arose during second round coding. Insights gained through the discussions of agreements and disagreements were used as an aid to understanding the patterns and outliers emerging from the data (Curry et al., 2009). As part of this process, the raters engaged in the joint development of a code book, discussing codes, categories, and later, themes.

CHAPTER 4: FINDINGS

The findings presented in this chapter are organized by research questions and corresponding themes. Although there is overlap in the data between both questions, presenting the data separately allowed for a more representative presentation of the themes that emerged for each question. A table with data types and the associated abbreviations used for each when citing data is found below.

Table 2

Abbreviations for Data Sources

Abbreviation	Data Source
MT	Meeting transcript
PA	Published artifact (blog)
SI	Structured interview
SSI	Semi-structured interview
QU	Questionnaire

Note. When data is cited, it is done so by listing the participant's name, data type, the date (if a meeting transcript) and the time stamp (if available).

Research Q1: Defining and Describing Equity in K-12 CS

Findings that pertained to the participants' conceptualization and description of equity in CS education are included under this research question. This includes perceptions related to how equity is defined and described. This research question also focused on how learner variability in general and specifically for students with disabilities was integrated into definitions and descriptions of equitable CS. Overall, there were seven major themes related to the first research question. Each theme is discussed with relevant quotes provided. Table 3 below lists the major themes and associated sub-themes.

Table 3

Themes and Sub-themes for RQ 1

Major Themes	Sub-themes
Understanding and addressing the historical underpinnings of inequity	Relationship between psycho-social factors and systemic causes of inequity
	The Perpetuation of inequities is an active, not passive process
It is a teachers' responsibility to address inequity	The System within which teachers work is built to the advantage of some and the disadvantage of others
Fellows experience and identity: Past, Present and Future	Backgrounds and experiences help shape fellows' identity development, career path and beliefs
	Importance of family and community
	Professional development
Access as low bar metric	Issues with access to CS mirror other subjects Representation in CS classes should mirror the population
Fellows definitions of equity evolve	Independent or personal equity work and collaborative equity work are important for growth
	Teachers must understand and attend to personal bias and knowledge gaps
	Desire to help grow other teachers in addressing issues of equity
Learner variability is conceptualized broadly	Give students what they need to succeed
	Shifts in power are needed to address issues related to learner variability and equity
Help students make informed decisions	Provide access, understanding, tools and support
	Honor student choice about continuing CS

Understanding and Addressing the Historical Underpinnings of Inequity

Overall, there was a general sense that the participants rooted their views of equity in CS education in their understanding of the history of underrepresented populations. Central to this framing was the idea that equity in CS was not something that could be covered in a lesson or a unit, but instead something that permeated the discipline as a whole. This view was summed up by one fellow as she described her approach to planning for a professional development session saying, "Equity is not a feature of computer science. Computer science is an equity issue" (Rose, MT 02-24-20). This idea of treating equity in CS holistically was one that reverberated throughout the data.

During the entirety of the fellowship, the teachers explored the relationship between psycho-social factors (e.g., bias, stereotype threat, deficit thinking) and systemic causes of inequity. For example, one teacher expressed her view that, "the emphasis is less about individuals and how the systems and the structures and the institutional barriers are designed to keep certain students out and to invite other students in" (Yusra, MT 07-27-20). Similarly, in a blog post, two other fellows asked the CS education community to consider, "What could be? If we, in addition to the difficult work of understanding our personal biases and prejudices, we work toward understanding and highlighting how institutions serve to uphold the culture and mentality that actively disenfranchises our most vulnerable students?" (Jett & Todd, PA, What Could It Be, 2020). In exploring the relationship between psycho-social factors and systemic roots of inequity in CS, the fellows expressed the belief that these inequities were not only historical but being actively perpetuated. For example, during one interview, Michelle expressed the following:

> To me, equity is addressing head on a long history of systemic and internal oppression that has been not only in the computer science space but in other facets of our society. So I think, for me, what equity in computer science is doing is deep restorative justice work to write a path that is part of a larger goal for many of us (Michelle, SI).

The idea of teachers engaging in restorative justice work was evident throughout the fellowship and was perhaps most apparent in the fellows' discussions regarding their views on teacher responsibility.

Teacher Role in Addressing Inequity

Teacher responsibility and agency to address these historical inequities was an important component of the fellows' framing of equity in CS. For example, during one monthly meeting, Shana's comments related to the societal underpinnings of inequity and teachers' power to confront these challenges builds on Michelle's comment above:

> So there's somebody always at the top and there's always going to be people at the bottom. And capitalism operates that way. And so does racism. So what I wanted to talk about, more or less, is what we can do as educators and also what we can do as colleagues, with our colleagues, in taking culture and taking critical race theory and attaching it to whiteness. (Shana, MT 5-18-20)

Time and again, the fellows made clear that they viewed all teachers as having a responsibility to take action when confronted with inequity. During one meeting Alecia shared her view that, "We disrupted disparities impacting these marginalized communities, that is like at our core is shaking things up and making sure that those disparities are closed, the gaps are closed." (Alecia, MT 05-09-20). In a blog post, another fellow echoed these sentiments saying, "We, as computer science

teachers, are positioned to either fix this inequity or continue to foster it." (Rose, SCRIPTing Change) In even stronger language, yet another fellow provided this admonition:

> Your intentional silence actively perpetuates inequalities. Underrepresented groups will continue to be barred access to equitable computer science opportunities because your silence isn't actively subverting the existing current systems and structures that are rooted in inequality. (Yusra, Intersectionality of Systemic Racism)

This belief in teacher responsibility was coupled with the idea that the system within which teachers work is itself broken for many students. Here, Shana expanded on her views of how schooling, power, and privilege actively disenfranchise those with intersectional identities to a greater degree:

> Now there' s intersections with that, where there are people that have multiple identities that are prejudiced or racist or sexist or ablest against, but understand that whiteness just basically means that that is what is considered the norm. And anything that's different from that is not normal. It's not neutral. It's different. And that's the thing that's very, very key, because whiteness is how our school system is structured. (Shana, MT 5-18-20)

The idea of marginalization of populations with certain identity markers is also apparent in many of the fellows' characterizations of their own journey to becoming CS teachers. While every fellow travelled a different path to their position, some clear themes arise out of their personal experiences and identity formation.

Experience and Identity: Past, Present and Future

The personal experiences of the fellows figured greatly in how they conceived of and spoke about their ideas of equity in CS. Two of the fellows had backgrounds related to CS while the remainder of the fellow became CS teachers in a variety of other ways. Regardless of how

they came to their current profession, their personal history as it related to CS education was clearly formative. For example, both fellows with backgrounds in computing discussed their early experiences with computing education as students and how those experiences figure in to their motivation to work towards equitable CS:

> When I think back to what was missing in computer science when I was in high school and college, the space did not seem safe to me. I felt like I couldn't join in on the conversations that were happening — they were really connected to a lot of terminology. As a high school student, not having a lot of connection to technology, that frightened me and made it seem a little off-putting. [Rose, SI]

Reflecting on past experiences to inform present practice was clearly a motivator for both fellows with previous education in computing. Alecia, for example, spoke of her lack of connection and feelings of isolation while in college:

> And so my "why" is so that no other student has to have an isolating experience being a computer science major, if that's what they choose to be or an isolated experience in general and spaces where they're not the majority. (Alecia, SI)

Family considerations past, present and future figured prominently in many of the fellows' efforts to champion equity in their teaching. Family history was a motivating factor for Shana, a third-generation educator, who heard, "...first hand stories of my mom and my dad attending segregated schools, my grandmother teaching in segregated schools and then seeing the barriers that they broke...so my why is just kind of like I want things to be better for my own kids selfishly and the kids in my children's generation" (MT 07-27-20). Lucia also spoke of attending to equity in CS partially as a result of her desire to help her daughter and her newfound love of

Minecraft and computing (Lucia, Complimentary Origins). While Jet spoke of her children as well, she was clearly looking toward the future in her prioritizing equity in CS:

> I'm scared about raising my children and what their future is going to be like. So my "why" is making things brighter and hopefully they won't be marginalized like I was growing up in the communities that I was in. And I want to be the educator that will fight and bring hope into the classroom for all my students so that they don't ever feel sad and uncomfortable where they are and that they will be brave and bring hope for future generations to come. (Jet, MT 07-27-20)

Professional development experiences also influenced fellows' pivoting towards their equity focus in their teaching. Speaking about her experiences with her Exploring Computer Science professional development program, Yusra noted, "...inquiry, equity and CS content, we're woven throughout. And I'm like, oh my goodness, this is amazing. This is the best thing ever. I've literally been hooked ever since" (Yusra, MT 04-18-18). Another fellow spoke of a professional development experience that made her reflect on her teaching practice and her own history, giving her a sense of urgency to imbue her teaching with a greater focus on equity:

> I went to Las Vegas and learned from Hadi Partovi about issues in terms of equity. I felt that I was one of the statistics we were looking to pull in the classroom and I had this sudden realization that I had missed that boat and I wanted to make that right for my students so that they would have experiences in high school that I didn't have the opportunity to have. (Rose, SI)

Overall, considerations of past, present and future identities surfaced as the fellows discussed their approaches and beliefs as well as their desires for their own children and those whom they taught.

Access to CS Learning

Access to CS learning opportunities is perhaps one of the most basic and long-standing metrics for gauging how well CS education programs include learners widely. It is no surprise then that the fellow widely discussed access as part of their understanding of equitable CS. For example, one fellow defined equity in CS as, "To me, [it] means taking away the barriers that stop the kids from taking the class and also providing more opportunities to reach kids who wouldn't necessarily sign up for those classes" (Avery, SI). Another fellow noted that, "...if they don't have the tools, the accommodations to get access, because access creates opportunity and opportunity pretty much creates that pathway" (Lucia, SSI). Other fellows noted that disparities in access to CS mirrored similar disparities in other areas of school. For instance, Jet brought up the skewed populations of gifted and talented classes and the over-identification of certain populations in special education (Jet, MT 5-18-20). Overall, the fellows discussed that access to CS meant that representation in CS classes would mirror their local population as whole. This sentiment was captured during one interview with a fellow who taught at the high school level:

> It means that when I look in the classroom, my population of students in the classroom is representative of the population of our country and our world and specifically in my school district. It's really important, because computer science is the tool of the future, that the people who are using that tool represent that tool so more problems can be solved. We can work together to make our world a better place. (Rose, SI).

While the fellows espoused their certainty in these deeply held beliefs around teacher responsibility and agency, their conceptualizations of equity in CS education were nonetheless evolving.

Evolving Definitions of Equity and CS

Through both personal work and through collaboration with other teachers, the fellows found that their conceptualization of equity in CS was evolving. For many of the fellows this evolution included expanding their equity focus to populations or problems of equity that they had previously not considered:

> At first, I was really interested in solving the gender inequalities or gender inequities in our STEM classes here at the school. And now that that's kind of rolling, I am seeing the kids who my class are missing... I don't have a lot of Alaska native students in my courses. And that's something I'm trying to kind of rectify at the moment. (Avery, SSI)

The idea of attending to personal bias or deficits in approaching CS equity work was one that other fellows spoke to as well. This was the case for both Shana in relation to her work with students with disabilities:

> I think for me, it's been really positive to work on myself, because for me, a lot of times...I didn't think about students with disabilities in computer science. And Maya Israel at Florida, who I worked with on the standard writing committee, really kind of opened my eyes to realizing how much we're missing the boat equity-wise with our students with disabilities and computer science. And so, I've been a lot more vocal about getting a lot of our students with disabilities into computer science classes and getting rid of that old adage that they can't do it. (Shana, SSI, 4:09)

While all of the fellows clearly prioritized student-centered approaches, for some, like Yusra, that also meant an expanded focus on working with teachers:

> My “why” has shifted and my why was once, was completely all about students because where I was, there weren't many other teachers doing the active work of making CS for

> ALL. And then I was able to transition to a very calming and nontoxic space. And my why has now come to include other teachers who want to do CS the right way, who want to do education the right way. (Yusra, MT 07-27-20)

Similarly, Charlize spoke of collaborating with others as a means to more equitable CS experiences. “We are actually learning in the work we do together, even though we each have our own equity journey, we grow ourselves in order to empower our environment and give access to CS” (Charlize, MT 05-09-20). Though Michelle voiced an affinity for using collaboration as a tool to create change, she also recognized the effect of the personal, reflective work she had done in helping to shape her understanding of equity:

> I think a lot of what brought me to where I am right now is a lot of personal work that I've done, a lot of reading about...It's just...talking about how education can be dehumanizing, but it can also be humanizing. (Michelle, SSI)

Whether it be through individual work or through collaboration with other educators, the fellows' conceptualizations of equity seemed to be constantly evolving. Part of this evolution was in how the idea of learner variability fit into their approaches to addressing inequities in their schools and communities.

Learner Variability

The idea of learner variability was conceptualized broadly by the fellows to include variability that was based on such constructs as race, gender, dis/ability, and socio-economic status.

Provide All CS Students What They Need to Succeed. In addition to their discussions about teacher responsibility and the culpability of the school system in perpetuating inequities, the fellows described approaches to schooling which, “...was built for White able-bodied, cis,

heterosexual Christian males. And so, anybody who doesn't meet those identity markers is automatically going to be marginalized in our schools" (Shana, MT 5-18-20). Fellows indicated that the first step in addressing this marginalization is in understanding that educating diverse students means recognizing that those students have different strengths, preferences and needs. Amongst the fellows, there was near complete agreement that addressing these issues meant, "Equity is when everyone gets what they need in order to succeed." (Jet, SI) Shana expanded on this sentiment, noting the role of power and like many of the other fellows, including students with disabilities in her description of students who have historically been underserved and whose learner variability has been ignored:

> I think equity has kind of become a buzzword in it. People don't understand. It's actually like a shift in power in that people are getting what they need to be successful. And there's been years and years and years of people not getting what they need...And I'm talking about students with special needs. Black students, Latinx students, ELL students. (Shana, SSI)

What then does this shift in power look like? Michelle explained her thinking on the subject as:

> So for me, what that looks like is disproportionate, absolutely disproportionate, discriminatory. All the things like money, resources, opportunities to those who have not historically received them. So, if we talk about what that looks like, it could be writing curriculum that disproportionately shows the strategies and resilience and contributions of their communities. It can look like providing spaces of affinity. It can look like giving disproportionate training, but also not only training, but platforms to share what they already know...there's so many things that are already happening. (Michelle, SSI)

The word “disproportionately” figures prominently in this description. The fellows noted that this magnitude of response was necessary given the long history of inequity to which many of their students had been subjected to. Only with such a response could change be made, beyond access and even what is deemed as success in CS education, “...which is often categorized by whiteness in terms of financial security.” (Alecia, MT 5-18-20)

An Informed Decision

Generally, the fellows defined successful outcomes of equitable CS education from a student-centered perspective. While access and opportunity were important, they were not the end goal. Many of the fellows clearly felt that the end goal of their CS education efforts was to give students what they needed to make an informed decision as to whether CS would play a prominent role in their lives beyond the classroom. For example, Charlize noted, “If our students are given an opportunity to experience computer science, and they’re given that exposure to computer science, then they’re allowed to make that decision, is that something they want to do” (Charlize, SI). Another fellow added that it was important that students understood the power of CS to impact the world, before making decisions about further study or career. Ultimately, the idea of informed choice, seemed to be directed at honoring the students with whom the teachers worked. Yusra explained that:

> I believe that equity from the standpoint of computer science education is about making sure that if students decide computer science, either as a course of study or as a career, if they decided that is not for them, it won't be because they didn't think they could do it. It won't be because they didn't know what computer science was. It won't be because they didn't know that that was an option for them. It wasn't because they couldn't see themselves in that particular space. It would just be because they know that you're not

> interested in it. And that's perfectly fine. That's perfectly fine. That's not to make sure that every single student becomes a data scientist or a programmer. But my thinking is always you can see yourself in that role if you decide that doesn't stick for you. Awesome, because that means you're self-aware enough to know that that's not where your interest lies. But also you understand enough about the field that you can say that's not a good fit for me. And here's why versus I don't belong there because I don't see people who look like me or I don't belong there because that's for smart people. And I don't know this. I don't see myself as being able to keep up with the requirements or the reader that is expected of that. (Yusra, SSI)

Consequently, making an informed decision about how, when and why one's life includes CS is a form of empowerment of CS education beyond the popular CSforALL mantra. Defining success for CS learners of all types in terms of informed choice is a further democratization that honors students as individuals.

RQ2: How do the Equity Fellows intentionally use strategies to support equitable access to CS education and promote success in CS education for historically underrepresented students, including students with disabilities?

Across all fellows, three major themes emerged related to strategies for providing access and successful CS learning opportunities: Taking a whole-child approach, teaching as a humanizing act and teacher agency. These themes and accompanying sub-themes can be found in Table 4 below.

Table 4

Themes and Sub-themes for RQ 2

Major Themes	Sub-themes
Taking a whole-child approach	Classroom practices: Building relationships Creating positive classroom environments Addressing social and emotional learning (SEL) needs Planning Frameworks and approaches: Connecting CS to other disciplines Culturally Responsive and Relevant Computing Universal Design for Learning in CS
Teaching and learning as humanizing	Rooted in family and community Turning up the mike on student voices Treating students as fully human Classroom management that is respect of the individual, their identity and fully affirming
Teacher agency and activism	Strong sense of agency within the classroom Desire for greater agency and power to make change outside the classroom

The Whole Child Approach

The fellows frequently described practices and approaches to equity-based CS education that can be described as a whole child approach. They emphasized an understanding that learner variability is the norm, that adversity and inequity affects learning and that learning is social, emotional and academic. As Yusra put it, “We as educators can’t expect to continue with content-based instruction as usual, and that means we need to actively switch to the priorities of our students”. (Yusra, PA, Intersectionality of Systemic Racism)

Classroom Practices. The fellows' descriptions of a whole-child approach to teaching sought to support and nurture all areas of students' development and learning using a combination of classroom practices and planning frameworks and approaches. CS classroom practices highlighted by fellows included a focus on building and maintaining a positive classroom environment, prioritizing student relationships and addressing students' social and emotional learning (SEL) needs. At the core of this whole-child approach was a responsiveness to children's understandings, interests, abilities and needs.

***Creating a Positive CS Classroom Environment*.** A warm, caring and safe classroom environment has been linked to better school performance, engagement and willingness to take on challenges. The importance of such an environment in CS education is perhaps heightened by the historical underrepresentation of students with certain identity markers and the resulting issues related to student retention and achievement in what has been a historically white, male discipline. Throughout the fellowship, Yusra often spoke of putting, "Maslow before Bloom". One of students' most basic needs is that of safety and of all the fellows, perhaps Shana spoke most passionately about schools being potentially harmful places for some students and this included CS classrooms. This idea of first and foremost, "doing no harm" is one that appeared in multiple places across the data. Given the context of this study, both COVID 19 and recent politics figure greatly in her views:

> ...at least for the student population that I work with, this has been a priority for them because there's a lot of schools that are unsafe for Black and Brown kids...And there's a lot of trauma that schools have inflicted on me as a Black female that I know that I see being inflicted on kids that I work with watching teachers and their pedagogy and practices daily in my school building, knowing that I have like blatantly obvious and

> proud Trump supporters that work in my building with Black and Brown kids. That deficit mindset they come to the building with for the students they're supposed to be serving is traumatic and it wears on you... But a lot of times I think of it (schools closing due to COVID-19) as it could be a blessing in disguise because they're given time to heal because there's a lot of trauma that Black and Brown kids are dealing with in schools. And not to say that it has made it better, but they are still allowed to be themselves at home and be who they are, whereas in schools, they're not necessarily allowed to do that. (Shana, MT 05-09-20, 3:53)

This idea of allowing students to "be themselves" in their CS classroom is especially prescient given the stereotype that surrounds what CS students should look like and act like. Schools function as a part of society and as such they contain elements of society's polarization, which can adversely impact students, and especially students with certain identity markers. Schools are also places of conflict and disagreement, but teachers have power over how they structure learning spaces and their responses to these conflicts. One high school teacher professed to having never dealt with a discipline issue by sending students out of the room. Preferring to use conflict resolution techniques that attended to the students' understanding of their emotional state while validating and honoring their feelings, she described her stance on the issue as follows:

> I don't care if you wear a hoodie in my classroom. I don't care what the school policy is on, if that's what makes you feel comfortable, if that's what you want to wear, that's how you feel. But I'm fine with that. Are you learning? Then let's go. (Yusra, MT 05-18-20)

In this example the teacher chooses to exercise her CS classroom agency over school policy in prioritizing student learning. Inequitable school policies that adversely and disproportionately

affected certain student groups in CS were one of the major systemic barriers mentioned by the fellows.

For Charlize, creating a positive classroom environment meant thinking about her physical classroom and how she established a CS classroom structure so that students felt ownership and welcomed each time they entered what she referred to as a, “safe space, brave space” (Charlize, MT 03-19-20). “Brave space” refers to one wherein a student is empowered to take risks and learn how to persevere in their CS learning. This topic will be addressed later when discussing SEL. While Charlize worked tirelessly to create deep, meaningful relationships with her students, it was this early attention to setting and structure that helped to create a space for those relationships to grow. Similarly, Yusra prioritized her initial interactions with her CS students each day, greeting them at the door with a smile to welcome them while paying close attention to their emotional state:

> If I have a student that looks like they've been crying or have a student that is visibly upset, or I have a student that might have just had an argument with a friend like I'm able to kind of check those things as they're coming in. Note to self-check in with her. Notice that she wasn't here yesterday. (Yusra, SSI, 17:24)

In an environment that is not only inequitable, but possibly harmful, investing in creating positive learning spaces that are affirming and welcoming is a first step setting historically underrepresented CS students up to learn. Investing in the environment also proved to be essential for the fellows in creating and growing the trust that leads to productive relationships with students.

Prioritizing Student Relationships. Establishing close relationships with students can lead to higher levels of student achievement and engagement. Overall, the fellows reported that

being attentive, treating students as individuals, granting students autonomy in classroom work and including students in decision making were all key approaches in developing and maintaining strong relationships with their CS students. As one fellow summarized, “We focus on building relationships through empathy to empower students by giving students a voice and allowing them space to provide feedback in the learning process” (Alecia, MT 05-09-20). For many of the fellows, engaging in asset-based approaches to relationship building was a way to build trust and often resulted in better learning outcomes for the students. Genuinely knowing and valuing one’s students, their experiences that the communities in which they reside were important components of the relationship building process. Michelle elaborates on such an approach here:

> I would say that the students that I work with are really creative and resilient. They come from all kinds of life backgrounds and with time and trust and relationship building, they reveal themselves to me and to their classmates in ways that are very inspiring... things that kids care about. They'll come out in conversations and they'll come out in their artifacts. So I first and foremost want to say that my students come with so many assets, with loving families and communities that support them and love them. (Michelle, SSI, 6:21)

This approach that extends on personal relationships between student and teacher, bringing in family and community is one that was echoed by other fellows as well and reflects the fellows’ understanding of identity formation being grounded in the social lives of their students.

Fellows also spoke to identity formation and relationship building as it related to representation in their CS classrooms. When asked to assist other teachers working with

students new to CS and taking AP CS Principles, Shana described the importance of representation to student learning:

> I think the first thing is the relationships I built with students make them more comfortable with the subject. Even last year, when I helped assist teachers teach in AP Computer Science Principles to kids who had never seen computer science before. I think the relationships with the kids was the key ingredient to getting kids to thinking they can do computer science. I think it helps for them to see a black female leading computer science rather than what they stereotypically think is a computer scientist, which is a white man. (Shana, SSI, 4:09)

As someone who spoke often about the importance of relationships in combating inequity in CS education, Shana was asked whether there were any facets to her relationship building that were grade dependent. She responded:

> So I don't think it's grade dependent. I think it's actually personality dependent. And I think that we don't have a lot of teachers who... everyone screams about relationships online, like in class and whatever. But relationships are hard with kids. And I don't think people really are doing that hard work. (Shana, SSI, 5:59)

Relationships can be hard to establish and maintain, but other fellows had ideas as to what approaches were worthwhile to securing trust and connecting with students.

The “warm demander” approach, which shares many similar components of culturally responsive teaching (CRT), was one research-based way to establish strong relationships with CS students for Charlize. Warm demander is a teaching style that was coined in the 1970s and is a strategy that sets a foundation in building relationships with students while using positive discipline, embracing failure, and setting high expectations. Charlize described how daily

interactions were the focus of her work and included getting to know her students anecdotally, through class activities and incidental conversation. These conversations went beyond academics with students often expressing their feelings about life at home, their social life and in the age of COVID, online schooling. This approach to relationship building led to some students taking multiple classes with Charlize, including one young woman who arranged her schedule to take every class Charlize taught. (Charlize, SSI, 32:06)

SEL: "Your Emotions Are Not the Boss of You!" As noted earlier, students, families, schools, and communities are all part of broader systems that contribute to the learning, development, and formative experiences of youth. Deeply ingrained inequities in many of these systems can impact young people's social, emotional, and academic learning. The fellows indicated that while SEL alone will not solve longstanding and deep-seated inequities in the education system, it can play an important role in creating the conditions needed to create more inclusive learning environments, and nurture the interests and assets of all individuals. Jet described her belief in the efficacy of SEL practices as thus:

> When a student feels safe, cared for, trusted then they're capable of caring for others. They will have a sense of confidence and an eagerness to reach out and lend a helping hand. They learn to empathize and be mindful with their peers. If we get them to feel comfortable or successful, and help them recognize the feelings of others, then they can design and build programs, collaborate in teams, and empathize with their users. (Jet, MT 02-03-20, 1:23:17)

Assisting students in feeling safe and cared for began, according to Yusra, by addressing students' basic needs first. It was her belief that only then, could students find success in their computing activities. She stated that, "...before you can engage students in higher level critical

thinking and computational practices and all that wonderful stuff, you need to meet students where they are and first make sure that you know who your students are". (Yusra, MT 05-09-20, 26:43) From this statement, we can see how building student relationships and attending SEL needs of students are closely linked in integral ways for addressing inequities CS.

A prominent sub-theme related to SEL practices was in helping students to persevere through difficulties. The fellows widely indicated that cultivation of persistence was a main facet of SEL in CS. Some fellows stated that they sought to develop these characteristics in their students through helping them effectively identify and use resources, and encouraging them to be self-driven. Related to this drive toward persistence was the idea that CS offers a unique opportunity for its development, for students to cultivate a growth mindset or grit due to the focus in CS on open or semi-open ended problem solving, collaboration the immediate feedback students receive when testing their programs. Michelle noted:

> A lot of a lot of life experiences and a lot of opinions and thoughts that they want to process with one another. So, I really appreciate that computer science gives them a space to do that in a way that they might not be able to do during other parts of their day. (Michelle, SSI, 7:09)

Nevertheless, the fellows were mindful of some of the critiques of growth mindset and grit-based approaches so as not to apply them from a deficit perspective.

Aligned with the fellows prioritizing the development of persistence as a habit, several fellows expressed that they believed teachers should model cycles of making mistakes and persisting through difficulties. Many of the fellows further tied the process to their own learning of CS, seeing it as a natural extension of the learning process for those fellows who did not have formal education in CS before entering the teaching field. For example, one fellow described the

process as, "...huge for me because I came in knowing nothing and I didn't do this together. Like I'm learning this scratch extension with you. I'm learning python with you. (Avery, SSI, 12:38). Another fellow with a background in computing approached the development of student persistence through her planning of activities, purposefully designing CS problem solving projects that would provide opportunities for students to engage in productive failure. In reference to the project, she shared:

> ...it's just a really authentic application of all the class design stuff, all the structures, a lot of the object stuff. And it's challenging and it forces students to often talk to each other and also [pushes] me to get their way out of it...because they do it all from scratch there are a lot of ways it can go wrong, which I think is really, really good for them. (Rose, SSI, 6:44)

It is notable that this notion of persistence often involves collaboration, resource utilization and significant teacher modeling. In this way, the fellows often saw the development of persistence as a counter-story to the idea of CS being about innate ability or due to a "geek gene". It is something that can be developed given the right circumstances, including through planning of lessons that help students experience success where they might have previously believed they could not.

Planning Frameworks and Approaches. The Equity Fellows described their use of three different planning frameworks or approaches in helping provide equitable CS learning opportunities for their students. These approaches were: Connecting CS to other disciplines, Culturally Relevant Computing and Universal Design for Learning and CS.

***Connecting CS to Other Disciplines*.** While several of the fellows spoke about their work in connecting or integrating CS with other disciplines as a tool for creating equity in CS

education, two fellows (Alecia and Lucia) seemed to gravitate towards this approach to a greater degree than the other fellows. Alecia described the rationale for their cooperative work in a blog post:

> If we can demystify the stereotype that computer science is only programming, accessible to White men, and hard to learn through the lens of teachers, then our students will more likely be exposed to the discipline starting in the early years. It is an exciting time to be a computer science educator leader and doing this work as a collective will mean we can advance our ability to disrupt the disparities on a larger scale (Alecia, Complimentary Origins).

By showing the possible uses of CS outside of standalone classes, teachers may be empowered to and comfortable bringing it into their classrooms and thus reach a greater number of students. Another aspect of this approach was the idea that by integrating CS across other subjects, teachers could create pathways for students to understand that CS is about more than just coding (Lucia, Complimentary Origins). Another fellow provided an example related to uses of computing in society:

> Think about the process of developing facial recognition software. If the majority of the faces used to develop this technology belong to White males, then it won't be able to correctly identify the faces of women or people of color. When could this become really problematic? Introduce this underdeveloped tech into law enforcement, and now your facial recognition databases are a lot more likely to implicate a person of color in a crime. (Yusra, Intersectionality of Systemic Racism)

Taking CS beyond the CS classroom has the potential to expand student and teacher understanding of what CS is and how it might be applied to their lives, thus demystifying CS and making it more widely accessible.

***Culturally Relevant (and/or Responsive) Computing*.** Several of the fellows stated that the idea of decentering whiteness in computing education coupled with elevating and illuminating the achievements of BIPOC in computing as an essential component of creating equitable and accessible computing opportunities for all students. As a fellowship project, Shana and Michelle worked on creating an open-source, culturally relevant curriculum. Their stated goal was for, "...teachers to have access to lessons that are culturally relevant that kids will want to take, that also pushes CS into their classrooms and gives them an opportunity to engage in computational thinking. (Shana, SI) Shana often spoke of the need for such a curriculum to replace others which were, "white-washed" which many teachers failed to realize or understand. This curricular representation of BIPOC and responsiveness to the interests and needs of students were features of this approach. For example, Charlize provided an example based on an idea for an app envisioned by her students to meet the needs of their community:

> One of the ideas was called Saving Fellon's. And basically, the app concept was to create an app that focused on jobs and job readiness for people that were out of jail, that just came out of jail, that had felonies. And they said it was important to them to allow their family members can't find jobs because they have a felony now and go back to doing what they were doing before. And they said this will be an awesome app because it would help their own family members. So they pulled it from their own experiences. (Charlize, MT 04-18-19)

Culturally relevant and responsive approaches did not always have to do with computing. This idea of embracing non-computing subjects was not only acceptable but sometimes necessary according to the fellows. For example, in one classroom, students carved out a space where they could talk about issues that were timely and important to them. They called these, Classroom Culture Days. These events might include, "...having conversations about Laquan McDonald and the Jason Van Dyke trial. For my students at Morrowind, as their teachers prepared to go on strike last fall, it meant having conversations about civic engagement and global citizenship. (Yusra, Intersectionality of Systemic Racism)

Other fellows spoke of creating culturally relevant and responsive CS experiences for their Native American students. For example, Lucia spoke of wishing to create more opportunities for other Native American students in her locale (Lucia, SI) while Avery described how she came to make pedagogical changes based on her understanding of how local children traditionally learned within their cultural settings:

> What's difficult for me is that I have a really energetic teaching style where it's like I'm moving around at the board...I'm pretty nonstop during my class hour. And so that is not a teaching style that Alaska native students culturally respond to... I don't want to generalize, but especially for Alaska native students who have been raised in a village setting at a village school that you kind of have to be receptive to how their elders and how their parents teach them, right? That's their learning style. So a lot of it is, they watch. They watch until they know how to fish.... It's because their parents and their elders take them with them and they watch and they watch until they can do it themselves.

In this case, Avery, adapted her teaching approach from one that might have been better received by some students to be responsive to the needs of other, non-White students. In doing so, she not only showed knowledge of her students' culture and traditions, but sought to validate those cultural practices as well.

While Avery adjusted her teaching based on her students' cultural norms, Yusra spoke of making adjustments based on changing jobs and schools in which she taught. Speaking of her transition from a school whose students were primarily BIPOC, to a more highly resources school with far few BIPOC students, she stated:

> In this new space, I'm much more aware of my own Blackness. This has challenged me to embrace what it truly means to be culturally responsive as an educator: to include the voices and perspectives of folks whose faces aren't represented in our classroom. Also, at Lane Tech, students have a great deal of access to resources. For example, our school psychologist hosts monthly support groups for students dealing with trauma, such as homelessness, divorce, and personal loss due to violence. That was particularly hard to adjust to, as I've worked with students in other schools where they didn't have access to these resources, but not because they were any less deserving. (Yusra, PA, Intersectionality of Systemic Racism)

It is notable that while the fellows referred to using culturally responsive and culturally relevant practices, they often described using components of these practices without naming them as such. For example, Charlize often spoke of the importance of having high expectations for her students, a component of culturally relevant pedagogy, without naming it directly. In one case she relays telling a student who wanted to drop her class due to his perception that he was not smart enough to succeed in CS, that he was, "not leaving' relaying that the student went one to

be highly successful despite his initial trepidation. (Charlize, SSI, 11:22) Finally, there were many examples where fellows spoke to teaching students about moving between dominant and non-dominant cultures or building socio-political consciousness in their students so that they were both aware of inequities, and could critique them. Other teachers frequently noted the need to critique curriculum and develop culturally relevant curricula and pedagogies. While these instances were not always overtly named as culturally responsive practices, they nonetheless fall in line with priorities central to that approach.

***Universal Design for Learning*.** Of the three planning approaches and frameworks referenced by the fellows, UDL was perhaps the least mentioned by name. While Charlize, being a former special education teacher, had some knowledge of UDL and Shana had begun learning about UDL through her work on the CSTA teacher standards, most of the fellows other than myself had no knowledge of its basic tenets. After giving a lightning talk at the only in-person meeting of the fellows and a 30-minute overview of UDL during a fellowship meeting, several of the fellows began to explore their understanding of UDL and how it might relate to some of the other equity centered frameworks we had been discussing. For example, Michelle discussed her evolving understanding UDL implementation saying:

> I think that's really important, like in the beginning and then I sometimes think it is not so many strategies, but... a mindset of how you approach teaching. So I just sometimes think, like for curriculum writing, it's not like, check the boxes off, like, oh, if I include this in my lesson, it's automatically UDL. (Michelle, MT 03-19-20, 1:26:53)

Another fellow offered her insight that she had been exposed to UDL in her work for online course development, which helped her understand addressing learner variability from the beginning versus after the fact (Avery, MT 03-19-20, 01:04:21). Other fellows offered examples

that they had seen in their schools using components of UDL, such as providing multiple means of representation, while still others sought clarification about the difference between UDL and differentiation and how to shift teacher mindsets:

> I taught just health like the large class sizes, it was differentiated because it was like I'm just trying to put a Band-Aid on the fact that I have 40 kids in a classroom and I'm trying to get them all the content. So, I'm curious, like, what steps or procedures are you guys going through to get teachers to think less about differentiation and more about UDL? (Shana, MT 03-19-20,1:42:08)

Over the course of the fellowship these conversations about planning for learner variability were weaved throughout group events with some of the fellows expressing that they were beginning to come to a basic understanding of UDL and how they might begin using it within their own efforts prioritizing equity in CS, with one fellow stating, "...it's really student centered. Just like what we were talking about at the beginning and a true UDL model should really be different each year, right? Depending on what our students need. (Rose, MT 03-19-20, 1:27:59) This focus on attending to students' needs is one that runs through all the various aspects of the whole-child approach the fellows described in trying to create equitable CS opportunities and outcomes for their students. To that end, one fellow noted during member check that, "UDL really changed the way I approach the classroom and discussions with fellow teachers". (Lucia, MC, 07-25-21)

Teaching as Humanizing

The second of the three major themes relating to research question two is based on a shared vision of the teaching of CS as a humanizing process that went beyond cognitively oriented practices. Providing humanizing educational experiences was perhaps the fellows highest goal and the natural result of the whole-child approach outlined earlier. Humanizing CS

experiences, as they are described by the fellows, are affirming of the whole person and rooted in family and community. Here Michelle talks about going beyond a typical approach with an early programming lesson with Scratch and how she transforms it into a humanizing experience:

> So it's like, to me if I'm doing a humanizing, if I'm in a humanizing experience and learning about myself and I'm learning to love who I am and through that, I'm learning that through that. I'm learning science through that. I'm learning computer science. Whatever I am learning is a way for me to deeply appreciate who I am as a person and what role I play in my community. And to use what I have learned to benefit those that I love and care about it. So, for example, if I'm in computer science and I'm doing a scratch project about, you know, my name, it might not be just like a click the M then it's like I am magical or something like that. I'd be, you know, tell the story of my name, you know? When I was being born, my grandfather was in the room and, you know, my mom said, OK. Her name's Michelle. And then they're like, oh, how many Ls do you want? And then my grandfather's the one who's like, two, it's luckier or whatever. How did people ever know that? You know, it's like a very like Chinese thing to have things in pairs. And it's so much richer to tell that story than like, you know, and it brings intergenerational love into like, oh, my grandfather was there in the delivery room, it's like all these like stories that are super affirming. (Michelle, SSI, 25:29)

In describing the lesson in such a way, Michelle does more than pander to novelty. She is, as another fellow describes it, “basically just turning up the mic on somebody else. And I think that that's huge for students rather than necessarily giving them a voice. You're just actually turning up the mic on theirs” (Shana, MT 05-09-20). The subtlety in the approach is that the teacher is not the one to impart a voice to the child, but simply affirms the power and importance of the

child's own voice. Lucia took a similar stance, grounded in empathy, noting that, "how they see the world could be very different than how we have seen the world when we were at their age.(Lucia, MT 04-18-19, 7:37)

While Lucia's realization is grounded in celebrating differences in ways her students may see the world, another fellow spoke of starting the school year empathetically with her students in a discussion about, "adulting." In doing so, she dispels potential barriers based on traditional hierarchies of power often found in schools:

> I know you all have been in classes and in the spaces where there is a very clear and definitive power dynamic, and that is the exact opposite of the inclusive and affirming environment that we want to create just as educators, period, but particularly in CS where we know that there are so many barriers and so many obstacles to be navigated just in order for students to be able to own their successes in their space. (Yusra, MT 04-18-19)

Power imbalances and resulting conflict can occur in educational settings because both what is said and what remains unsaid. As part of her empathetic approach to "adulting" Yusra talked about having, "real talk" with her students which in light of COVID, meant having conversations about her students' fears and uncertainty, helping to prepare for what was potentially to come. (Yusra, Intersectionality of Systemic Racism)

Acknowledging students' potential, affirming their worth and creating a space where students can be comfortable in who they are was one of Shana's main goals in her equity work:

> I've always allowed students to be their full selves in my classroom. Identity is important to me and kids feel safe and comfortable in my classroom so to make sure I honor and respect all identities, all races, all ethnicities, gender, non-gender conformity, anything a student would like to share. They know that they're comfortable and they're welcome to

> share that in my classroom and they're comfortable to be who they are. I think that's huge if a kid knows they can be who they want to be in the classroom; they're more likely and apt to be successful. (Shana, SI)

Modeling and cultivating empathy was another priority in the fellows' humanistic framing of CS education. While grades and test scores are metrics often used to ascertain a student's success, this was not always the priority for some of the fellows. For instance, Yusra described her priorities saying:

> ...good grades are actually not my priority. Yeah. Yeah. Great. And they're probably your priority. Good for you. Your student may have that. But for me, it's more important for me to have students who are genuinely kind and respectful humans more than it is for me to see that you have all A's in all your classes. (Yusra, SSI, 8:07)

Yusra often spoke of modeling empathy for her students in her CS classroom, often as it related to power imbalances, whether it based on their experiences with teacher-student relationships in other classes or in her own activism with her union and collective bargaining.

The strategies that the fellows described using as part of the whole child approach to equity-focused CS education are, for the most part, not unique to CS. This was a point that many of the fellows emphasized as important in that teachers, including teachers new to CS, could apply these equity-focused practices that may already be known to them due to their general or special education experience. What is unique is that these practices have not been widely applied across K-12 CS education, despite the persistence of inequities within the field. Furthermore, the fellows desire for great agency outside of their classrooms was at least in part, related to the failure of the larger CS education community to address the issue of inequity by applying these practices widely and flexibly.

Teacher Agency and Activism

The final major theme related to the second research question is related to the fellows' sense of agency and their activism on behalf of equitable CS education. Clearly, the fellows spoke to a general sense of agency within their own classrooms. However, another major theme was evident in the data related to teacher agency outside of the classroom. This agency or potential agency was described in several ways. Michelle on one occasion spoke to the other fellows about understanding using their spheres of influence to bring positive change (Michelle, MT 12-16-19, 1:06:21) Fellows spheres of influence varied. Several fellows spoke of their hopes to influence their teaching peers through the creation of equity centered professional development offerings or sharing unique approaches to teaching and learning. For instance, Abigail spoke frequently about wanting to help other teachers learn how to incorporate mentoring into their CS instruction. During member checking, she clarified her views on teaching versus mentoring and the affordances of the later:

> I think of teaching as the space to generate conditions for learning. Mentoring may include some teaching, but it is about opening doors to the unknown, creating pathways that may not be seen and cheering someone along the way regardless of which path they choose. Teachers try their hardest to make every student feel good about themselves, but those messages may not always be internalized based on extrinsic factors like grades or comparison to peers. A mentor is able to break through the negative voices or imposter syndrome a student may have to make them feel good about their path regardless of their current outcomes. (Abigail, MC, 07-21-21)

Other fellows wondered about opportunities to work with those in research and industry with whom they might share priorities around equitable CS. (Lucia, MT 07-27-20, 1:27:48) Similarly another fellow sought greater influence outside of her school setting, looking to work with:

> ...with more people in higher ed because I feel like we're not connected. I don't think K-12 and higher ed are connected in any form or fashion...And it's very frustrating for me because I care about research and that no organization is making an effort to basically bridge the gap between K-12 and higher ed. (Shana, MT 07-27-20, 1:26:20)

To that end, a suggestion was made about the possibility of working with researchers as part of Research Practitioner Partnerships (RPP) which are usually based on local problems of practice and seemed suited for the activist vision the fellows described:

> The current round of Research Practitioner Partnership NSF grants are just about ready to be awarded, but for the next round, that would be a great place, I think, for this group to maybe even sit in on advisory boards, which, of course, is a paid position, or I've spoken at one of those workshops that you've talked about specifically around RPP's. And I think that that would be really helpful, especially kind of pushing the fact that still so much of the research is kind of about your quote unquote, average kid. And people are often not specifically looking at issues of equity and diversity within their overall broader research. And so we see all these claims made about kids and learning, but they aren't really thinking about them beyond the average kid. (Todd, MT, 07-27-20, 1:29:28)

Lucia and Rose both spoke about successes during the fellowship in working with district and state-level collaborators, while others lamented their desire to participate in policy setting, which they saw as beyond their current sphere of influence. Shana described her frustrations thusly:

> I was wondering, is there any part of this process where CSTA is going to get started with, like are there district CS people or state CS people so that we can have conversations with them so that we can move the needle because we can move it in our own individual schools. Or if we're working in a role, we're supporting teachers. We can move it in that school district, whatever the case may be. Most of those are classroom teachers. And so I can shift equity in my school, but I'm not doing equity shifting work as far as [it being] CS related, like statewide or countrywide. (Shana, MT 03-19-20, 25:06)

Nearly all of the fellows clearly articulated a desire to make change beyond the classroom. While some found avenues to begin that process through fellowship activities and associated extensions, others remained frustrated, wanting more and bigger change yet some fellows were frustrated by barriers to even just beyond the CS classroom level. Yursa expressed her frustration with her lack of agency as such:

> There are lots of times where I don't feel that I have the level of authority or autonomy to be able to influence, change or exert power over the spaces in which I work and exist outside of the classroom setting. Just because the classroom is for teachers, with the exception of evaluations by your administrators... It's an extraordinarily autonomous space. If I need to rearrange the space physically to accommodate a student with ADHD or if I have to change, navigate the space emotionally due to a recent event to help students navigate, maybe Kobe Bryant's passing, just things like that, there are so many things that we can do. But the second we do leave the classroom space and kind of in effect, become the student in terms of understanding from an empathic point of view, [we experience] the denial of expertise, the unwillingness to leverage power on the top end of the hierarchy. (Yusra, MT 02-24-20, 1:37:41)

This desire to make change beyond the classroom speaks to the fellows' frustration with the status quo both in schools and in larger society. They repeatedly articulated that while they had great agency within the walls of their classroom and reported positive changes therein, for equitable change to be substantial and lasting, a greater impact was required. “I have never believed the educational system is broken, it is working as designed to disenfranchise marginalized student groups.” (Shana, MC, 07-28-21) Therefore, making classroom-level changes enabling greater equity was necessary but insufficient within a system that is designed to disadvantage many of the students historically underrepresented in CS education.

CHAPTER 5: DISCUSSION

The movement to scale K-12 computing education widely is fraught with issues. Perhaps one of the most complex of those issues is that of providing equitable CS learning opportunities and outcomes broadly. Previous studies have suggested that as much as access was an early metric used to gauge equity, it is insufficient and the approach risks over-simplifying the complex systemic, political, and socio-cultural forces at play (Dawson, 2014; Vakil, 2014). Other scholars have emphasized socio-cultural dimensions of equitable CS education in their approaches to studying equity and CS education (e.g., Goode et al., 2012; Goode et al., 2014; Ryoo et al., 2013). Many of these studies center on students' racial, cultural, and gender identities, and focus on positive CS identity development through meaningful, often locally bound, learning experiences (Nasir & Vakil, 2017; Pinkard et al., 2017; Ryoo, et al., 2013; Vakil, 2014).

As promising as these studies are, there is no one formula for broadening participation, building inclusive communities, or increasing the success of underrepresented populations who do participate in CS education (Lewis et al., 2019; Margolis et al., 2012). Challenges and potential solutions to problems of equity are often contextually bound and it is therefore important to look across contexts widely to ascertain what works, for whom and where. The current qualitative study, a first of its kind, allowed for a deep examination of issues related to equity and CS education by investigating the beliefs and practices of ten equity-focused CS teachers, including myself, from varied locales, across all grade levels, K-12, as they engaged in a year-long equity fellowship. By considering the ways in which students with disabilities were included in the participants' conceptualizations of equity and the strategies participants used to successfully include them, this study expands on the existing literature in a meaningful way. The

research questions that guide this study include: How did the CSTA Equity Fellows define and describe equity in K-12 CS education? How and to what extent they consider learner variability in general and students with disabilities specifically in their equity-focused CS education work? How did the CSTA Equity Fellows use strategies to support and promote success in CS education for historically underrepresented students, including students with disabilities? The findings of this study showed the fellows prioritized a deep understanding of the historical and current underpinnings of inequity in CS education and as a result of this understanding it was their view that all teachers had a responsibility to address issues of equity. The fellow's conceptualizations of equity in CS were constantly evolving, based on their experiences. Students with disabilities were included in the fellows' conceptualization of learner variability but fellows seldom spoke about dis/ability directly. In addressing learner variability, the fellows spoke to multiple, flexible approaches prioritizing the development of the whole child. Finally, although the fellows' strategies were deeply rooted in proven, research-based classroom practices and planning frameworks, teacher agency and activism were integral components ameliorating inequities beyond the classroom. This chapter includes a discussion of major themes and concludes with a description of limitations, and implications for practice and research.

Understanding and Addressing the Historical Underpinnings of Inequity

Although not all of the fellows entered the program with a uniform understanding of the historical forces at play in creating inequitable CS education, over the course of their time together it was clear that a consensus had developed as to the role these forces play and the need to address them. Moreover, the fellows related that due to the systemic and historical underpinnings of inequity broadly, it was essential that equity focused efforts in CS must also be

systemic and holistic. This is significant in that very few CS curriculums or professional development programs in CS, with the exception of ECS at the high school level, include equity as an overarching focus. It should be noted that out of the 10 fellows, only one had training in or taught the ECS curriculum. While the fellows had the benefit of being able to learn from each other and draw on each others' experiences and knowledge, most CS teachers (outside of ECS) do not have access to such a resource. Without the benefit of an equity focused curriculum or cohort of similarly focused peers, CS teachers are left to plan and implement learning experiences on their own within a system that is, according to the fellows' statements, inherently unjust and geared toward the maintenance of the status quo.

Addressing the historical and systemic causes of iniquity was a major driver of the fellows' work, as was an insistence on examining the relations between these forces and other psycho-social factors such as bias, deficit thinking and stereotype threat. The participants shared that although being aware of these contributing psycho-social factors is essential in helping to shift the equity needle, equally important was a continual examination of one's own bias and presumptions. Because teachers' attitudes toward, actions with, and expectations of diverse learners in no small way determine the outcomes for students, teachers must be aware of their biases and how such stereotypes can be a threat to students' learning (DeCuir-Gunby et al., 2010). As much as some CS teachers may shy away from such conversations related to systemic oppression and personal bias, believing that they, "teach CS, not politics," at the heart of social justice education is the idea that teaching is political (Nieto, 2006). Therefore, cultivating an ongoing dialogue related to causes and drivers of inequity in CS education specifically cannot be avoided if we are ever to achieve CSforALL. Whereas current research identifies the need for more preparation in this area, this study highlights the power in CS teachers exploring, over time,

how their own teaching is informed by historical and systemic power imbalances, psycho-social factors and their past, present and future identities. In approaching the understanding of equity in this way, the fellows were able to continually evolve their equity approaches. This study extends our knowledge base through the identification of these foundational equity priorities that could be included as embedded focus areas of professional development for teachers of CS.

Learner Variability

Learner variability is a recognition that all students differ and teaching diverse learners is a complex task (Ladson-Billings, 2011). The research is clear that acknowledging and addressing learner variability leads to better outcomes for a wide range of students. Rose and colleagues (2013) refer to addressing learner variability as the "science of the individual" as opposed to more typical instruction geared toward a mythical average. Hall et al. (2012) summed up learner variability as the following:

> Advances in neuroscience and education research over the past 40 years have reshaped our understanding of the learning brain. One of the clearest and most important revelations stemming from brain research is that there is no such thing as a "regular student." Instead, learning is as unique to individuals as their fingerprints or DNA (Hall et. al, 2012, p. 2)

The fellows approached the idea of learner variability broadly acknowledging that a one-size fits all approach is insufficient in promoting equitable access and outcomes for all students, especially those who have been historically underrepresented in CS education. They started by acknowledging that an individual's background and experiences (at school and in their communities) shape the learner. CS teachers who are focused on equity consider how learners' differences affect learning and align their planning and pedagogical approaches accordingly.

They consider students' race, gender, ability, socio-economic status, past experiences, likes and dislikes and in doing so select instructional pathways and tools with the most promise.

The fellows universally included students with disabilities in their conceptualizations of learner variability. However, with the exception of myself and Charlize, a former special education teacher, they seldom talked specifically about those students, their strengths and their challenges as they differed from other groups who had been historically disenfranchised in CS education. Furthermore, while there were initially a priori codes created during data analysis for evaluating tools and curricula for accessibility as well as using available accessibility resources, these codes were abandoned due to lack of application within the data. This is not surprising considering the broader underrepresentation of students with disabilities in CS education.

Defining Success in CS Education

Successful outcomes of broadening participation and other equitable CS endeavors are often delineated through increased participation and increases in test scores for target groups. Accordingly, several fellows relayed stories of increasing enrollment from historically underrepresented populations or of how their students from these same groups scored highly on AP CS tests. However, several fellows spoke to the idea that beyond access and even traditionally successful outcomes such as test scores, providing students with the opportunity and experiences whereby they could decide on a personal level whether or not continued CS education was the course of action for them. Incorporating CS into other subjects and expanding what is taught beyond programming were practices championed by the fellows. At the root of this idea was that students would not be dissuaded due to lack of opportunity or lack of successful experiences, but that they would make choices for themselves based on their own agency. This approach, in line with current scholarship questioning the goals of the CS education

movement at large (e.g., Ko et al., 2020; Tissenbaum et al., 2021), attends to the struggles that many historically disenfranchised students face in accessing and succeeding in CS while also acknowledging that education should provide options from which empowered individuals may choose.

Providing All Students What They Need to Succeed

Whereas other research has investigated specific approaches to addressing inequities in CS education, including curricula (e.g., Goode & Margolis, 2011; Margolis et al., 2012; Ryoo, 2019; Ryoo et al., 2013), pedagogy (e.g., Ryoo et al., 2013; Scott & White, 2013; Vakil, 2014) and professional development (e.g., Flappan et al., 2020; Goode et al., 2014; Goode et al., 2020), the fellows championed a flexibility that allowed them to tailor learning within and across varying contexts. Although contexts may differ, what we can learn about adapting to those contexts is widely applicable. One example might be Avery changing her instructional style to be more culturally responsive so that her methods better align to the learning preferences of her students from historically underrepresented backgrounds. To do this, she first had to be aware of her instruction methods, examine her own assumptions about the learners in her classroom, and think about how their culture and experiences at home and in previous schooling were formative. Only then could she adjust for the learner variability in her class. Accordingly, several of the fellows spoke to the idea that historically underrepresented students should receive "disproportionate" support and resourcing as a way to ameliorate the power imbalances of a system that was designed to work for a select few. In this way, learner variability is about the individual but also includes how the social context within which that individual lives empowers learning or disempowers learning. While other studies have addressed the idea of learner variability more narrowly, focusing on particular populations (e.g., Ray et al., 2018; Scott et al.,

2013, 2015), this study shows how a diverse group of teachers conceptualized and sought to address learner differences more broadly so that students received what they needed to succeed.

Strategies to Increase Equity in K-12 CS Education: Flexible Approaches

Without changes to the way we conceptualize CS teaching and learning, the social and economic disparities and achievement gaps of people who historically are underserved will persist and grow, and we will be at risk of marginalizing more and more students (Goode et al., 2012; Goode et al., 2015; Ladner & Israel, 2016; Vakil & Higgs, 2019). Participants in this study discussed the need for proactive, targeted and flexible approaches to increasing equitable access and outcomes for their students. Other studies have investigated promising approaches, including UDL (e.g., Israel, Wherfel, et al., 2015; Israel et al., 2020; Ray et al, 2018) and CRC (Scott et al., 2013, 2015). The fellows spoke to their use of a broad mix of strategies in line with their, "whatever is needed" stance on addressing learner variability in their classrooms. To this point, a handful of studies related to general education have focused on the possibility of blending UDL and Culturally Responsive Teaching (Chita-Tegmark et al., 2012; Kieran & Anderson, 2019; Waitoller & King Thorius, 2016). Furthermore, in 2020, CAST began an overhaul of the UDL framework called, "UDL Rising to Equity" aimed at addressing systemic barriers which result in inequitable learning opportunities and outcomes. Perhaps similar blended efforts will follow in the near future to assist in addressing inequities in CS learning.

The fellows' flexible model of planning and instruction was based on the individual student and imbued with an understanding of the social and cultural forces that helped to shape that student and their evolving identity. Similar to the blended approaches highlighted above, findings from this study suggest that teaching and learning of CS should be seen as both individual and highly contextual to best address ongoing problems of equity. Furthermore, the

fellows made it clear that as much as they sought to help their students become persistent, independent learners, it was the teachers job to create the conditions within which equitable learning could take place in the classroom and unequivocally address larger societal inequities that inform students' experiences in and out of school.

Educating the Whole Child

A whole child approach to education is one which focuses attention on the social, emotional, mental, physical as well as cognitive development of students (Darling-Hammond & Cook-Harvey, 2015; Lewallen et al., 2015; Slade & Griffith, 2013). For CS teachers who engage in whole child education, such as the fellows, that means attending to more than learning programming, or computing concepts and practices. The finds of the present study show that the fellows addressed each of the components of the whole child approach. At present no other studies detail CS teachers framing their equity-based CS education efforts in this way. Furthermore, while conveying clear norms, and having high expectations for all students was important for the fellows, creating and building on productive teacher-student relationships was perhaps the cornerstone of their flexible approaches and priorities. This prioritizing of relationships is directly aligned with the general and special education literature on the power of positive student-teacher relationships to enhance students learning experiences and outcomes (e.g., Blum 2004; Hamre & Pianta, 2006; Hawkins et al., 2004; Jennings & Greenberg, 2009; Klem & Connell, 2004).

Prioritizing relationships was but one part of a larger strategy to address students' social and emotional learning needs in the CS classroom. While the power of strong relationships is well documented in general and special education, there seems to be little work detailing the importance of establishing student-teacher relationships in the CS classroom. In prioritizing

relationships the fellows looked to validate the importance of the unique identities, backgrounds, and experiences of students and their families. The cultivation of strong relationships served as a foundational component of the fellows' larger commitment to the social and emotional health of their students. The findings showed that for all of the fellows, attending to the role emotions play in learning was of great importance. Studies have clearly shown that human cognitive processes are affected by emotion including learning and memory (Phelps, 2004; Um et al, 2012), attention (Vuilleumier, 2005) and problem solving (Isen et al., 1987). It follows then that further work related to affective learning in CS is warranted and may provide a powerful tool in helping all learners succeed in CS education.

Attending to the social and emotional learning needs of their students was an important component of the fellows' flexible, whole child approach. That said, traditional conceptualizations of SEL were insufficient. Their approach seemed to be in line with that of Camangian and Cariaga (2021) who assert that traditional SEL fails to address the societal forces that negatively impact the physical and mental health of many of the populations that are historically underrepresented in CS education. Social emotional practices often fail to focus on building awareness of or taking actions to address threats to students' social and emotional health (Ginwright, 2015). Camangian and Cariaga (2021) suggest a humanistic education model as a way to attend to the SEL needs of students while addressing the role that systematic oppression and power imbalances have played in creating and sustaining inequities in society generally. It is no wonder that fellows such as Michelle, talked a great deal about their CS education work as humanizing. This study is the first to detail a humanistic conceptualization of CS education.

Teacher Agency and Activism

Perhaps one of the more unexpected findings of this study was the importance for the fellows of teacher agency and activism outside of the classroom. The fellows as a whole repeatedly detailed examples of successful application of their agency and the desire for greater power to effect change outside the walls of their school rooms. Teacher activism can be defined as teachers who work for social justice both inside and outside of their classrooms (NYCoRE, 2003). The teacher leaders featured in this study sought to reconcile their vision of justice with the inequities they saw around them as they worked to create spaces of liberation for their students. As with other studies (e.g., Picower, 2012) the fellows also worked collectively against oppression. Teacher activists are often influenced by their own marginalizing experiences as students (Collay, 2010) just as Abigail and Shana detailed in the findings. Teachers who are fully committed to student learning take action on students' behalf within a system that simply does not work for all students. This holds true for all teachers. Moreover, teachers such as the fellows do so whether or not they consider themselves formal leaders. For the fellows, taking action requires both commitment to students and the capacity to enact change within and beyond the classroom. In this way, teacher activism can serve to create greater opportunities for more equitable student learning. The journey to take action to create equitable opportunities for CS learning often takes teachers beyond the classroom and future studies should attend to ways this activist work can be supported longitudinally and to what effect.

Aligning Strategies and Context: The New and Well Known

The demand for CS education and the importance of learning CS is growing. This is true for students, teachers and administrators (Google & Gallop, 2016; Wang et al., 2016) as well as parents, including parents of student populations that are historically underrepresented in CS

education (Google & Gallop, 2020). Equity in CS education is based on the idea that those with computing knowledge, power, and influence should be representative of society at large (Lewis et al., 2019; Ryoo et al., 2013). The fellows' conceptualizations align with research which shows that changing the landscape of equitable CS education is a complex issue for which there is no one formula for broadening participation, building inclusive communities, or increasing the success of underrepresented populations who do participate in CS education (Lewis et al., 2019; Margolis et al., 2012). While recognizing that a one size fits all approach is insufficient, we can learn from those in the field, like the fellows, who have prioritized equity in CS education.

Most of the strategies described by the fellows in this study are not unique to CS education yet they are not applied widely in K-12 CS instruction. Herein lies a major disconnect between the stated aims of the CSforALL movement and the failure to apply these strategies widely despite the fact that they are known to be efficacious outside of the CS education. We know about effective instructional practices from other disciplines (e.g., math, inquiry science) but up to this point the field of CS education has largely failed to examine lessons learned in these disciplines. The strategies that the fellows used are practices of great promise and yet CS teachers, such as the fellows, are forced to struggle with the task of connecting the dots in the absence of a research base elucidating how to apply these practices well within varied CS education contexts. What is unique are the historic reasons for underrepresentation and marginalization specific to CS education. Furthermore, applying well-established frameworks and strategies developed outside the discipline is not so simple as just "let's use these in CS." These have to be adapted in light of the unique barriers and opportunities in CS, including the many variations in how and how much CS is taught across K-12 in different locales.

The history of technology education in schools is fraught with great promises of change and egalitarianism. However, these efforts have yet to show disruption or broad social change, and instead have demonstrated time and again a superficial reworking of the educational system and the maintenance of the social status quo (Cuban, 2013; Philip & Olivares-Pasillas, 2016; Sims, 2017). For the CSforAll movement to avoid the same pitfalls, CS teachers must stay centered on the goal of humanistic computing. Prioritizing equity and an insistence on diverging from strict content-based teaching, when and how they deemed necessary, was telling of the fellows' views on the all-too-common techno-solutionism (Papendieck, 2018; Vakil, 2018) found throughout the computing world. The fellows repeatedly spoke to the power of computing education and the role computing commands in society at large. Yet, their approaches acknowledge the underlying idea that human problems are not going to be solved by computers, but by an empowered, diverse, informed citizenry who are replete with the agency to question when and how they will use their computational skills and to what ends.

Limitations

Three limitations are identified to provide context for the findings from this study. First, the data for the study were not originally collected for research purposes. Instead, the data used in the proposed study evolved naturally out of the work of the fellowship and its participants for the purposes of growing the fellows and their equity-focused work and for sharing their learning with the wider practitioner audience which makes up the CSTA. Had the data been collected for research purposes, there would be an opportunity to tailor interview questions to more directly answer the research questions.

Second, due to the nature of the fellowship and the overall topic of equity, it is possible that some voices were more widely represented than others in the context of meeting notes and

transcripts. Moreover, it is also possible that these voices are not representative of many CS teachers in the field, which in and of itself could be considered problematic. Equity conversations can be difficult sometimes resulting in participants self-censoring for a variety of reasons. This was true for me to an extent as very early on, I became more and more aware of when, how and how much I, as a White man, was speaking during group conversations. This awareness led me to consider carefully when I was "taking space" and when I should be "making space" for other voices and perspectives.

Finally, before the onset of the COVID-19 pandemic, there were plans allowing for myself and Jett to travel to visit and observe other fellows in their classrooms. The addition of classroom observation data would greatly augment the current data allowing us to witness in real time how the fellows worked to enact their visions of equitable CS in their own classrooms. This additional data would have also provided for further triangulation of the findings given that much of what appears here is self-reported.

Implications

Several implications for practice, policy, and future research are described based on findings from the current study.

Implications for Practice and Professional Development

As noted in previous sections and consistent with prior research conducted in this area, more emphasis is needed in curricula and professional development opportunities to directly address the persistent problems of inequitable CS opportunities and outcomes for historically underrepresented populations. Curriculum writers, PD providers and practicing teachers should continually examine their stance on equity, how (and if) it changes and why. Equity work can be both personal and community based, but the focus should always be longitudinal. Equity is not

something that is done in a lesson or a chapter. Cultivating equity priorities and addressing inequities takes time, hard work, commitment and reflection.

In better understanding one's own equity stance, one's bias and assumptions, one becomes better equipped to tackle the difficult issues of equity that are pervasive in schools and society. Equity practices and strategies should be flexible, asset-based and directly aligned with the learner variability that is the norm in our schools today. Whole child, humanistic education that seeks to affirm and position the CS learner to make informed choices about their future, with or without formal CS education should be widely adopted. Inflexible, canned curricula and tools should not dictate priorities or learning outcomes. Teacher advocates must work with administrators and their peers to make sure that no groups are disenfranchised. Pointedly, this must include students with disabilities, whom this study shows are still not being served widely within CS education.

Implications for Research

Findings from this study provide a glimpse into how teachers who prioritize equity across K-12 CS worked to create powerful learning opportunities for all their students. Further research in how the various strategies detailed by the fellows may be applied across contexts and blended to best meet the needs of historically underrepresented students is needed. Having access to classroom observations and detailing strategy components and applications would prove valuable to practitioners and researchers alike. A major component of the CSTA Equity Fellowship was in supporting the fellows as continuing learners and champions of equity. Understanding what worked and what did not within the fellowship structure could lead to valuable lessons on how to grow fellowship like professional learning communities (PLC's) and develop professional learning opportunities.

Lastly, teacher agency and activism was a clear priority and component in the fellows approach to their work. Understanding how such activism in CS education can be supported and grown warrant further exploration. As noted earlier, access to qualified CS teachers can be a deterrent to equitable CS opportunities. It follows that a greater understanding of teacher agency may help retain and grow the CS teacher corp.

Conclusion

Prior to this study, the field of CS education was acutely aware of the problems of equity within the community. Findings from this study bring us one step closer to understanding how teachers who prioritize equitable CS enact it for the widest range of learners. We now have some understanding of both productive conceptualizations of equity from practicing CS teachers and the strategies they used to create change. There is still a lot of work yet to be done to understand how to best include and meet the needs of all CS learners but it is clear that a one-size fits all approach is insufficient and counterproductive to the goal of democratizing computer science education.

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APPENDIX A: IRB APPROVAL

ILLINOIS

OFFICE OF THE VICE CHANCELLOR
FOR RESEARCH & INNOVATION

Office for the Protection of Research Subjects
805 W. Pennsylvania Ave., MC-095
Urbana, IL 61801-4822

Notice of Exempt Determination

January 7, 2021

Principal Investigator	Hedda Meadan-Kaplansky
CC	Todd Lash, Maya Israel
Protocol Title	*Equity, Accessibility and Action: Supporting Diverse Learners in K-12 Computer Science Education*
Protocol Number	21491
Funding Source	Unfunded
Review Category	Exempt 2(i)
Determination Date	January 7, 2021
Expiration Date	January 6, 2026

This letter authorizes the use of human subjects in the above protocol. The University of Illinois at Urbana-Champaign Office for the Protection of Research Subjects (OPRS) has reviewed your application and determined the criteria for exemption have been met.

The Principal Investigator of this study is responsible for:

- Conducting research in a manner consistent with the requirements of the University and federal regulations found at 45 CFR 46.
- Requesting approval from the IRB prior to implementing major modifications.
- Notifying OPRS of any problems involving human subjects, including unanticipated events, participant complaints, or protocol deviations.
- Notifying OPRS of the completion of the study.

Changes to an **exempt** protocol are only required if substantive modifications are requested and/or the changes requested may affect the exempt status.

APPENDIX B: CONSENT FORMS

Equity, Accessibility and Action: Supporting Diverse Learners in K-12 Computer Science Education

Dear CSTA Equity Fellow,

You are being asked to participate in a voluntary research study. The purpose of the proposed qualitative study is to understand how a diverse group of K-12 educators, selected by the Computer Sciences Teachers Association (CSTA) to serve as the 2019-2020 CSTA Equity Fellows, work to enact equitable CS education for the widest variety of learners across differing contexts and locales. To that end, the research questions of the proposed study are:

1. How do the Equity Fellows (EF), with varying backgrounds and experiences, define and describe equity in K-12 CS education?
    1. How and to what extent do the EF conceptualize learner variability in general and with students with disabilities specifically in their equity-focused CS education work?
2. How do the EF intentionally use strategies to (a) support equitable access to CS education and, (b) promote success in CS education for historically disenfranchised students, including students with disabilities?

Participating in this study will involve your agreeing to the use of data created as part of the 2019-2020 CSTA Equity Fellows program including previously conducted interviews, Zoom meeting notes, notes from the in-person meeting in Chicago, meeting agendas, and artifacts created as part of these meetings. Artifacts may include project planning documents, lesson plans, and/or outcomes of fellowship activities conducted during the meetings. Your further participation and only time commitment will involve your participating in member checks wherein you will receive an e-mail with a short summary of the findings and the interpretations and will be asked to verify, correct, or clarify the information within a week. We anticipate this to take not more than two hours of your time. While the work of the fellowship was highly public, a risk related to this research includes your being identified within the research materials even though all participants will be given pseudonyms to protect their anonymity; benefits related to this research are that the proposed study is unique to the field of CS education in that never before has a cohort of master teachers been gathered to share and learn from each other on topics related to equity. The study seeks to provide researchers and practitioners with new perspectives on equity in the K-12 CS education space and elucidate some of the strategies used by the participants to ensure equitable access, inclusion, and achievement. Given the pervasive nature of problems related to equity in CS education, this could provide great benefit to the community at large. The alternative to participating in this study is to decline involvement.

Thank you for your consideration

Principal Investigator Name and Title: Dr. Hedda Meadan-Kaplansky
Department and Institution: Department of Special Education

Contact Information: 217-333-0260 or meadan@illinois.edu

What procedures are involved?
The study procedures begin with the collection of secondary data related to the 2019-2020 CSTA Equity Fellows project after which the data will be prepared and organized. All data will be stored securely and the participants will be deidentified with the key being stored in a locked security cabinet, separate from other data. A qualitative, constant comparative analysis will be used to analyze the data. Member checks will be used to gather participant feedback on the researchers' initial interpretations of the data and confirm the credibility of the data drawn from interviews, artifacts, and meeting notes.

This research will be performed entirely online as it uses secondary, or previously collected data. You will need to participate once over the next nine months for the member check activity. Each activity will last a maximum of two hours.

Will my study-related information be kept confidential?
Faculty, students, and staff who may see your information will maintain confidentiality to the extent of laws and university policies. Personal identifiers will not be published or presented.

Will I be reimbursed for any expenses or paid for my participation in this research?
You will not be offered payment for being in this study.

Can I withdraw or be removed from the study?
If you decide to participate, you are free to withdraw your consent and discontinue participation at any time. Your participation in this research is voluntary. Your decision whether or not to participate, or to withdraw after beginning participation, will not affect your current or future dealings with the University of Illinois at Urbana-Champaign.

The researchers also have the right to stop your participation in this study without your consent if they believe it is in your best interests, or you were to object to any future changes that may be made in the study plan.

Will data collected from me be used for any other research?
Your information will not be used or distributed for future use, even if identifiers are removed.

Who should I contact if I have questions?
If you have questions about this project, you may contact Dr. Maya Israel at 352-273-4169 or misrael@coe.ufl.edu. If you have any questions about your rights as a participant in this study or any concerns or complaints, please contact the University of Illinois at Urbana-Champaign Office for the Protection of Research Subjects at 217-333-2670 or via email at irb@illinois.edu.

Please print this consent form if you would like to retain a copy for your records.

I have read and understand the above consent form. I certify that I am 18 years old or older. By clicking the “Submit” button to enter the survey, I indicate my willingness to voluntarily take part in this study.

SUBMIT

APPENDIX C: STRUCTURED INTERVIEW PROTOCOL

The structured interview protocol included five questions that were asked of all the Equity fellows in the same order. No additional questions were asked during the interview.

1. What do you hope to achieve as a CSTA Equity Fellow?
2. Can you describe how you've disrupted inequities in your classroom?
3. How did you get involved in teaching computer science?
4. What does equity in CS mean to you?
5. Why should others consider teaching computer science?

APPENDIX D: SEMI-STRUCTURED INTERVIEW PROTOCOL

1. What does equity in computer science mean to you?
2. How do ensure that you are centering equity in your teaching?
3. What are some general strategies that you use to be inclusive and make sure that all students can succeed in CS?
    a. Are these strategies grade-dependent? If so, how might they be adopted for other grades?
4. What are some strategies that may be more geared toward certain student populations or specific issues of equity?
    a. Are these strategies grade-dependent? If so, how might they be adopted for other grades?
5. Where do you look for strategies or ways to make your own teaching more inclusive?
6. What are some resources that you can share?
7. Are there existing curriculums that you use that you have found helpful (or elements of curriculums)?
8. What has not worked for you or what are practices that you have been mindful of stay away from? What should teachers know about these practices?
9. What should administrators know about equitable CS?
    a. What might you advocate that they look for in CS classrooms that show that students are being given equitable access, opportunity and are finding success?

APPENDIX E: POST FELLOWSHIP QUESTIONNAIRE

1. Briefly describe your experience with the fellowship. What did you learn?

2. Given your experiences as an Equity Fellow, how has your conceptualization of equity in CS education changed or stayed the same?

3. How has taking part in the Equity Fellowship affected you and/or your teaching? Have you had other opportunities as a result of your experience?

4. What recommendations do you have for future cohorts?

What things should we be sure to continue? What should we adjust?

5. How would you describe your experiences working with students with disabilities CS education?

6. How do students with disabilities fit into the broader idea of equity and CS education?

7. Do you yourself have or do any of your immediate family members have a disability? If so, please elaborate.

APPENDIX F: MEETINGS AND MATERIALS

Table 5

Equity Fellow Meetings and Materials

Meeting Date	Meeting Site	Artifacts
10-9-2019 Virtual Orientation	Online	Meeting notes and agenda Notes: Want to Learn, Contribute and Do as a group (activity)
10-18-2020 and 10-19-2020 Initial Convening of Fellows	In-person, Chicago, Illinois	Meeting notes and agenda
12-16-2019	Online	Meeting notes and agenda
2-03-2020	Online	Meeting notes and agenda Blog Post: What Could It Be? Blog post: #000000 History Month, Computing, and Schools
2-24-2020	Online	Meeting notes and agenda Equity Questions White Board Activity
3-19-2020	Online	Meeting notes and agenda Blog post: Complimentary Origins Towards Demystifying Computer Science for Non-CS Teachers

Table 5 (continued)

4-18-2020 Virtual Convening, Part 1	Online	Meeting notes and agenda Blog post: SCRIPTing Change in Connecticut:
4-27-2020	Online	Meeting notes and agenda Blog post: No Longer Hidden Figures Blog post: Complimentary Origins… The Social Science Educator Perspective Blog post: Emergency Remote Teaching: Challenges & Solutions
5-09-2020 Virtual Convening, Part 2	Online	Meeting notes and agenda
5-18-2020	Online	Meeting notes and agenda Blog post: Being a Warm Demander in a Sea of Inequity
6-22-2020	Online	Meeting notes and agenda Blog Post: Intersectionality of Systemic Racism, CS, and Our Role
7-7-2020	Online	Meeting notes and agenda Blog post: North to the Future
7-27-2020	Online	Meeting notes and agenda: Reflections on the Fellowship Reflection Blog Post

Note. Data for all online meetings include video, transcripts, and meeting agendas. Data for the in-person meeting includes agendas.

APPENDIX G: A PRIORI CODE MAP

Initial Codes	Evolved Codes	Codes and Categories
Within community discrepancies in CS offerings	Within community discrepancies in CS offerings	**Equity and CS**
Scheduling conflicts	Scheduling conflicts	**Students with Disabilities**
Prerequisite courses	School funding and resources	
Additional course requirements	Access to technology	**Classroom Practice and Pedagogy**
Pulled for services	Socio-political systems	Creating a positive classroom environment
Tracking out of CS	Organizational approaches and barriers	Guiding students use of feedback
School funding and resources	Access to qualified teachers	Promote student self-efficacy
Access to technology	Access to BIPOC teachers	Supporting student collaboration and communication
Organizational approaches and barriers	Teacher professional development	Supporting self-directed learning
Access to qualified teachers	School/District Policy	Using inquiry-based learning
Access to BIPOC teachers	Isolation of underrepresented students	Valuing and amplifying student perspectives and abilities
Teacher professional development	Isolation of teachers	Valuing and explicitly working to build relationships
School/District Policy	Access to a community of support	SEL Practices
Bias	Stereotype threat	
Isolation of underrepresented students	Bias	**Instructional Design**
Isolation of teachers	Deficit thinking	Analyze/Critique curricula
Support (for teachers)	Microaggressions	Connect CS to other disciplines
Access to a community of educators/PLC	Diverse representation curriculum and classroom	
Stereotype threat	Diverse STEM role models	
Deficit thinking	Active Recruitment	
Microaggressions	Using classroom data	

Incorporate diverse perspectives and experiences	Examine and counteract personal bias	Culturally Relevant Computing
Diverse representation in curriculum	Pursue PD focused on equity	Instruction/projects with personal meaning
Diverse STEM role models	Model continuous learning (of equitable practices)	Plan instruction to foster student learning
Active Recruitment	Leverage community resources for equitable CS	UDL
Using classroom data	Community and cultural identity	**Student Identity**
Examine and counteract personal bias	CS identity	Community and cultural identity
Pursue PD focused on equity	Current/future/possible selves	CS identity
Model continuous learning (of equitable practices)	Honoring identity and interest	Current/future/possible selves
Leverage community resources for equitable CS	Intersecting identities	Honoring identity and interest
Community and cultural identity	Racial/ethnic identities	Intersecting identities
CS identity	Student political identities	Racial/ethnic identities
CS agency	Personal experiences	Student political identities
Current/future/possible selves	Teacher CS identity	
Honoring identity and interest	Teacher agency beyond the classroom	**Teacher Identity**
Intersecting identities	Teacher intersectional identity	Personal experiences
Racial/ethnic identities	Teacher political identity/teaching as political act	Teacher CS identity
Student political identities	Analyze/critique curricula	Teacher agency beyond the classroom/activism
Personal experiences	Connect CS to other disciplines	Teacher intersectional identity
Teacher CS identity	Culturally Relevant Computing	Teacher political identity/teaching as political act
Teacher agency	Instruction/projects with personal meaning	
Teacher intersectional identity	Plan instruction to foster student learning	**Use data for decision-making to improve equity**
Teacher political identity/teaching as political act	UDL	Active Recruitment
Teacher roles		

Analyze/Critique curricula Connect CS to other disciplines Culturally Relevant Computing Instruction/projects with personal meaning Plan instruction to foster student learning UDL Equity and CS Students with disabilities Creating a positive classroom environment Encouraging student communication Guiding students use of feedback Promote student self-efficacy Supporting student collaboration Supporting self-directed learning Using inquiry-based learning Valuing and amplifying student perspectives and abilities Valuing and explicitly working to build relationships	Equity and CS Students with disabilities Creating a positive classroom environment Guiding students use of feedback Promote student self-efficacy Supporting student collaboration and communication Supporting self-directed learning Using inquiry-based learning Valuing and amplifying student perspectives and abilities Valuing and explicitly working to build relationships SEL Practices	**Use data for decision-making to improve equity** Active Recruitment Using classroom data Examine and counteract personal bias Pursue PD focused on equity Model continuous learning (of equitable practices) Leverage community resources for equitable CS **Systemic approaches and barriers** Within community discrepancies in CS offerings Scheduling conflicts School funding and resources Access to technology Socio-political systems Organizational approaches and barriers Access to qualified teachers Access to BIPOC teachers Teacher professional development School/District Policy **Social and psychological factors** Isolation of underrepresented students Isolation of teachers Isolation of underrepresented students Isolation of teachers Access to a community of support Stereotype threat Bias

	Deficit thinking Microaggressions Diverse representation curriculum and classroom

Note. Categories appear in bold.

APPENDIX H: CODE BOOK SAMPLE

Social and psychological factors	These factors can impact students' perceived ability, aspirations, and performance. [adapted from Kapor Center]		Use this top-level code only if none of the sub-codes apply.
Bias	**Unconscious bias** (or implicit bias): Prejudice or unsupported judgments in favor of or against one thing, person, or group as compared to another, in a way that is usually considered unfair. [adapted from Vanderbilt University] When the unconscious biases of well-intentioned teachers influence their judgment towards particular students (e.g., by race, ethnicity, gender, able-bodiedness), it can influence their instructional practices, the expectations they convey, and their recommendations for relevant outcomes like course placement, special education, and discipline. [Dee & Gershenson, 2017] See also tools for interrupting implicit bias.	Shana: "Whiteness is basically a social phenomenon. And basically, the behaviors and the group behaviors and perceptions of how people are supposed to act are basically insulated by this feeling of lightness. So it's basically an ideology tied to social status. Certain whiteness stems from white supremacy, and it basically believes that white, cis, hetero, able bodied, neurotypical, Christian, financially secure people are the default. "	

Isolation of underrepresented students	It could often be difficult for students from underrepresented groups to feel welcomed, as they entered an educational space with a classroom atmosphere and culture already defined by a more dominant group. This sense of isolationism is clearly a deterrent to identity development and a detriment to the continuing study of CS by underrepresented groups.	"Abigail [00:16:27] And I'll I'll go I'll dovetail on that, my why, as I was sitting, goes back to me studying computer science. And so my why is so that no other student has to have an isolating experience being a computer science major, if that's what they choose to be or an isolated experience in general and spaces where they're not the majority."
Isolation of teachers	Ongoing, high-quality interaction with experienced colleagues such as instructional coaches can play an important role in helping teachers, especially new teachers or teachers new to CS, succeed (Cornett & Knight, 2009; Johnson, 2004). Use this code when participants speak about working alone, being the only CS teacher (e.g., in a school, district) or not having colleagues with whom they can collaborate.	"Over the past five years, Alaskan CS educators have put that attitude to the test as we have worked to expand access to CS education and teacher training across the state. If this sounds like a Herculean task, you'd be right; the vast physical distances between colleagues and making contact with CS educators remain two of our greatest challenges. For some of us on this team, we were just as qualified to teach CS are we would have been to start a homestead (which is not at all). "

Access to a community of educators/PLC	Discussion about the ability to access a community of CS educators as a support in building professional knowledge, expanding access to CS education, providing ongoing social and emotional support, etc.	“Rebecca [00:17:19] I guess why that I'm starting to see right now, definitely, I think our students should definitely be centered, but in that process of creating student centered work, creating a community of teachers. Because beforehand, we just did like a department wide meeting without prompt of our administrators, because our administrators are just sitting there. So we created our own meeting and decided that we're going to proceed forward. Without any direction, and so we're just going to do it ourselves. And so I think if we could build a community of educators that are centering around their students and wanting to provide, because that's why teachers do what they do, they actually care and give a damn about kids, let us do what we know and hope and uplifting them. So that's that's definitely my why. “	Separate from Access to Professional Development which is more general. The two may be overlapping.

Stereotype threat	**Stereotype threat:** Being at risk of confirming, as a self-characteristic, a negative stereotype about one's social group [Steele & Aronson, 1995]. Even subtle aspects of classroom environments, such as the gender ratio of students in a class or posters associated with masculine CS stereotypes, can cause anxiety that affects the performance and academic engagement of females. [Dee & Gershenson, 2017] See also how to mitigate stereotype threat.	Narratives about who does CS and who can do CS; One example is the clearly outdated belief in the "geek gene" which posits that one is born with computing aptitude (Ensmenger, 2012; Lewis et al., 2012). Even more insidious are stereotypes which suggest that students from certain populations (e.g., students of color, girls and young women, students with disabilities) are not interested in CS or cannot learn CS, the rationale being that if they could do so, they already would be doing so.
Deficit thinking	Deficit discourses arise perpetuating beliefs about disinterest and inability situated in the minds, bodies, beliefs, and communities of underrepresented students (Dudley-Marling, 2015). For example, a student with learning disabilities may be presumed by the school system to be lacking in requisite cognitive skills required for success in computing.	"Shana [01:44:20] Deficit mindsets. When you sit there and assume that a certain group of kids can't do something or you have a deficit mindset about their parents, if they come from single parent families, oh, they must not be getting anything at home that you've heard those conversations. "

Expectations and assumptions (In vivo)	Teachers and other adults have expectations of and make assumptions about students and their capabilities. These assumptions can be high or low, positive or negative.	"There are some students that just because of their background, they have never been able to—they don't know how to problem solve...they don't have that ability or desire to figure things out or explore" (Margolis, et al., 2008, p. 40) Shanti [00:29:18] That. And so because of that, they saw the greatness in that they're like, OK, this is great. This is great. You know, you've never had, you know, all these kids get threes and twos in. Sad to say, the rest of the AP courses all got ones like always. So now my sophomores and juniors have a lot of pressure on them now. That actually got twos and threes. Like one kid was like, well, I passed AP computer science, I said. So now they assume well since you pass computer science, you should be able pass history. That's English and they're like it don't work like that.	Apply this code if these expectations and assumptions are not explicitly tied to bias, stereotype or deficit thinking.

Microaggressions	"Brief and commonplace daily verbal, behavioral, and environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative slights and insults to the target population or group," (Sue et al., 2007, p. 271).	Microinvalidation, and is characterized by communication that works to exclude, or nullify the thoughts, feelings, and lived experiences of the recipient (Sue et al., 2007). Beliefs that CS curriculum, teaching, and learning are neutral
Preparatory privilege (In vivo)	"We call it preparatory-privilege – kids who come from homes [with] multiple computers and where there are parents who know about computer science, these are the ones who come to school with all this background knowledge, and everyone then assumes that they are the only students with a 'natural talent' for the field," says Margolis.	"Noelle [00:04:28] Who are my students? So we are a very much a title one school. So we think we're at about 65 or 70 percent. Like low economic status. Kind of. And free and reduced lunch, so I would say they don't have a lot of. Harmonious, a positive access to technology. They're not often supervised, believes technology, so they don't. They often don't have the skills to self-manage when they're on computers and on their phones. Which I find. End up being a different kind of relationship to technology.

APPENDIX I: MEMBER CHECK EMAIL

I hope this email finds you well and that you are having a great summer. I am deep into my dissertation work and it is time for me to share with the group what my analysis surfaced. During our fellowship work, we created a great deal of potential data including way more than I could possibly analyze by myself in the time I have to work. Therefore, I chose to include the following as data sources for my analysis:

(a) Interviews conducted by CSTA staff in Chicago, (b) interviews conducted by Cindy and I, (c) meeting transcripts and agendas/notes , (d) blog posts written by fellows and hosted on the CSTA website, and (f) the end of fellowship questionnaire.

All of these are in our shared Equity Fellows G-drive should you want to look them over anytime. Finally, two members of our group have asked to be de-anonymized when quoted or cited in the text. Typically, participants in research are given pseudonyms for ethical reasons and to protect their privacy. If you would like to have your real name used instead of a pseudonym, please let me know and I will honor that choice.

Please read through the themes that emerged from our fellowship and offer a response as you see fit. These themes are specific to the research questions being asked and they are supported in the text with a great deal of quotes taken directly from the data. If there is anything here that you think is incorrect, needs emphasis or clarification, please let me know. Feel free to offer any other feedback as well.

RQ1: How do the Equity Fellows, with varying backgrounds and experiences, define and describe equity in K-12 CS education?

a. How and to what extent do the Equity Fellows consider learner variability in general and students with disabilities specifically in their equity-focused CS education work?

<u>Themes</u>

Understanding and Addressing the Historical Underpinnings of Inequity

- Relationship between psycho-social factors and systemic causes of inequity
- Perpetuation of inequities is an active, not passive process

It is a teachers' responsibility to address inequity

- Working within a broken system

Fellows experience and identity: Past, Present and Future

- Backgrounds and experiences help shape fellows' identity development, career path and beliefs
- Importance of family and community
- Professional development

Access is a metric (but it is a low bar)

- Issues with access to CS are similar to those in other subjects (e.g., make-up of gifted classes, over-identification of certain populations for SPED)
- Representation should mirror population

Fellows definitions of equity evolve

- Personal work and collaborative work are both important
- Understanding and attending to personal bias and knowledge gaps
- Desire to help grow other teachers in addressing issues of equity

Learner variability is conceptualized broadly

- Giving students what they need to succeed
- Shifts in power needed to address issues of equity

Helping students make informed decisions

- Providing understanding, tools and support
- Honoring the student by facilitating their making choice about CS and their future

RQ2: How do the Equity Fellows intentionally use strategies to (a) support equitable access to CS education and promote success in CS education for historically underrepresented students, including students with disabilities?

Themes

Taking a whole-child approach

- Classroom practices:
    - Building relationships
    - Creating positive classroom environments
    - Addressing Social and emotional learning needs
- Planning Frameworks and approaches:
    - Connecting CS to other disciplines
    - Culturally Responsive and Relevant Computing
    - Universal Design
        - There is no average
        - Developing expert learners

Teaching and learning as humanizing

- Rooted in family and community
- Turning up the mike on student voices
- Treating students as fully human
- Classroom management that is respect of the individual and affirming

Teacher Agency

- Strong sense of agency within the classroom
- Desire for greater agency and power to make change outside the classroom
    - Working to empower other teachers
    - Working with policy makers, administration, and researchers

Thank you for any feedback. I hope you and your family are well!

Best,
Todd

APPENDIX J: MEMBER CHECK RESPONSES

Participant	Response
Lucia	In the last quote, hopefully I can explain! Through this Fellowship, I started realizing that computer science is more than coding, that it is computational thinking. Through a new understanding of computational thinking as a skill, I started to apply the practice in my history, government, and economics classes. This past year we started to have conversations in social studies teacher groups of how we would like to see progression, curriculum, and skills in social studies to be used in our classrooms. I shared my thoughts on the idea that instead of social studies, we treat the subject as social science as it is at the university level. This came with some backlash that using more computational/scientific thinking would allow for certain understanding in our field of study that the teacher was not comfortable with. This past year when I was teaching my 8th grade coding class, I noticed the students were struggling with staying engaged with pure coding instructing, but when we started to have discussions on how the code could be used in our lives around us the students became a lot more interested in the possibilities and practical uses of coding beyond plugging into a program. Making sure the students found relevance in our classwork became really important this year. So excited to see your completed work! In absolute awe of your accomplishments! UDL really changed the way I approach the classroom and discussions with fellow teachers. Thank you so much for the UDL education!

Abigail	I think of teaching as the space to generate conditions for learning. Mentoring may include some teaching, but it is about opening doors to the unknown, creating pathways that may not be seen and cheering someone along the way regardless of which path they choose. Teachers try their hardest to make every student feel good about themselves, but those messages may not always be internalized based on extrinsic factors like grades or comparison to peers. A mentor is able to break through the negative voices or imposter syndrome a student may have to make them feel good about their path regardless of their current outcomes.
Rose	It's rough reading quotes after they have been translated. I will try to answer your questions. Basically, my district is very serious about placing students in the "best" schools; ivy league, ultra-competitive, AP-focused schools. So, while I make sure students know that THEY are the key - that what they do, their habits, etc, define the amount they get from their education, that message is dangerously different from what they might be hearing from counselors/family/admin. If I am contradicting messaging from admin or family, that could get me into some trouble. I do not "buy in" that the best choice for students is to chase the ivy league dream. I've met several students who did not do honest things ahead or within the Ivy league and this resulted in a less-than-great education in the things that really matter (character, learning information that will take you beyond school and make our society more positive). I've met several students who worked so hard from community to state colleges and ended up with a MUCH stronger education than any ivy league. I've met many students that worked hard and got a great education at ivy leagues too. The student is the key; not the institution. However, working for an institution makes me a little shy about saying that. Does that make sense? If you want to talk, feel free to call. I do miss our monthly conversations. I have great respect for this ongoing and critical work you are doing. :)

Jett	This is amazing! I'm so happy to hear your dissertation is coming along and so proud of you!!! I'm fine with either pseudonym or actual name- whatever is easiest for you. I wholeheartedly agree with the themes and can picture our (the equity fellows') conversations around them. It's been a journey since we first started in October 2019 and I'm still learning and growing. I really hope we'll get to meet up in Chicago next summer.
Michelle	I took a course many years ago as a part of a DoE grant that was testing students' increased participation and attendance in school based on whether they had arts education during the school day. This is not unlike many computer science initiatives that are also started for the same end (at least at the elementary level). I taught at a school they specifically wanted me to come in on Mondays because that was their date of highest truancy. Anyway, we learned about Studio Habits of Mind to complexity (for classroom teachers) what arts education could look like. It's more than just learning how to use a new painting tool or how to do a specific dance technique, it's also learning to stretch oneself beyond one's current capabilities, to engage with the larger arts community, etc. (Studio Habits of Mind: http://www.pz.harvard.edu/sites/default/files/eight_habits_of_mind%20.pdf) So when we think about computer science education, kids who are getting the full range of Habits of Mind are more equitably prepared to engage with others and members of the computer science community compared to students who solely remain in the "develop craft" habit of mind. It's like Bloom's taxonomy. Low expectations of students by teachers (or or just educators who aren't in tune with the CS world themselves) keeps students in the lower tiers. Finally, in bringing Studio Habits of Mind in the first place is to just get at how we need to de-silo computer science "thinking" from

	other subjects. Doing CS doesn’t require special prerequisite ways of thinking; that is a myth designed to keeps marginalized people out of CS spaces.
Shana	The quote I was talking about equity work in K12 education at a district or school site level and CS are different things. The only theme I don't agree with is I have never believed the educational system is broken; it is working as designed to disenfranchise marginalized student groups.

APPENDIX K: DE-ANONYMIZED PARTICIPANTS

In-text Name	Full Name
Michelle	Michelle G. Lee
Shana	Shana V. White
Abigail	Dr. Abigail Joseph