COMPUTING FOR SUSTAINABLE EQUITY: CULTURALLY RESPONSIVE COMPUTING IN CS UNDERGRADUATE EDUCATION

By

Swati Mehta

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Educational Psychology and Educational Technology–Doctor of Philosophy

2021

ABSTRACT

COMPUTING FOR SUSTAINABLE EQUITY:
CULTURALLY RESPONSIVE COMPUTING
IN CS UNDERGRADUATE EDUCATION

By

Swati Mehta

This dissertation study is about understanding the beliefs of undergraduate computer science (CS) faculty to adapt culturally responsive computing (CRC) pedagogical approach in teaching computer science courses. Using the lenses of critical pedagogy, culturally responsive teaching, and culturally responsive computing, this study explored whether computer science faculty find a CRC approach relevant in teaching their CS courses and how can the university support the persistence and retention of historically disenfranchised students in undergraduate CS degrees. To achieve this, I interviewed eight computer science faculty at predominantly white teaching and research institutions. Using Braun and Clark's (2006) thematic analysis method, I found four overarching themes corresponding to the first research question - *pedagogical approaches to CRC, student voice and empathy, barriers and support for CRC, and going beyond professional development for faculty.* For the second research question, I found two overarching themes – *pedagogical approaches to support historically disenfranchised students and humanizing students and recognizing their existence.* The faculty's responses allowed me to see culturally responsive computing as a powerful pedagogical tool that can be used to create racially and socially equitable learning contexts in undergraduate CS education. My discoveries suggested the need to develop a culturally sustainable professional development for CS faculty that goes beyond diversity, equity, and inclusion training and has the potential to educate faculty on the nuances of leveraging community partnerships in a CRC pedagogy. This study suggests that community partnerships empower historically disenfranchised youth in computer science to see

the application of their computing skills towards political and social change and white students to acknowledge and understand the struggles of their peers. I call for further action towards systemic changes at the institutional level in regard to the tenure track system for CS faculty that can provide additional support to faculty to be driven to adapt a CRC pedagogy.

Keywords: critical pedagogy, culturally sustaining, culturally responsive computing, intersectionality

To my grandfather, and his stories of political revolution.
To my husband, my reason for being.
To my son, my forever love.

ACKNOWLEDGMENTS

I would like to thank Aman, for his patience, guidance, and support. I have benefited greatly from your wealth of knowledge and meticulous editing. I am extremely grateful that you took me on as a student and continued to have faith in me over the years. My committee members, Michael, Colleen, and Jen for your insightful feedback and unbridled support. Your encouraging words and thoughtful, detailed feedback were fundamental to my success. Michael, working with you helped me gain a plethora of understanding of the neoliberal capitalist technology market and how it dominates the discourses of diversity, equity, and inclusivity in computing education. You have taught me the importance of being grounded even when there is a whirlwind around you. Punya, your kind, encouraging, and supportive words of wisdom allowed me to see the big picture when everything else looked glim and hopeless. My interview participants, for your time and effort in discussing an unconventional non-tech topic. I feel fortunate to know such wonderful and knowledgeable people like you.

Jon, for our reflective critical discussions and for continuing to support me virtually – graduate school was tolerable because of you. Sarah (Gretter), for graciously sharing your work with me and your wisdom when I needed it the most. Alba, for hearing me crib about work and life and looking after me even after we moved away. My parents for traveling all the way to the United States during the pandemic to enable me to work on my dissertation and for your pride in what I have accomplished. My mother-in-law for their being with us and supporting us when Zehn was born and to my father-in-law for his constant support. Shilpa, for reaching out to me and listening to me. Shipra di, for caring for me when Zehn was born and for your constant well-wishes.

Rohit, the reason I am! For your constant encouragement, our endless intellectual discussions, spiritual talks, and guidance that made it a little easy for me to work even with Zehn around. Zehn, my son, for his cuteness and adorable shenanigans and sometimes letting me work when he had something better to do. Bones, our dog, for forcing me to go outside when I needed to see sunlight. Jean-Luc, our cat, for his comforting purrs that helped me with my anxiety.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

Background

With the pivotal role played by technology in today's highly digitized world, computer science education has gained key interest from politicians and policymakers (The White House, 2017; National Science Foundation, 2017). As automation of industries shows an important paradigm shift in the future of work, computing is becoming an essential skill-set to get ahead in the economy of today and tomorrow (Hegewisch, Childers, & Hartmann, 2019; Vee, 2017; (Benjamin, 2019)). Initiatives like CSforAll have also called attention to providing opportunities to every child in America (particularly girls and minoritized students) "to get ahead in the new economy" by building a knowledge base and capacity for rigorous CS education in schools (The White House, 2017). The majority of the recent efforts to expand diversity in computer science have focused at the K-12 level, including a focus on how to broaden the participation of women and minoritized students in computer science. For example, Exploring Computer Science (ECS), a high school introductory computer science course focuses on broadening participation in computing by using gender-inclusive practices (Goode, Peterson, & Chapman, 2019). By situating mathematical concepts in cultural contexts, Ron Eglash, Audrey Bennett, and colleagues have also illustrated how students can use web-based coding applications, which they call Culturally Situated Design Tools (CSDTs), to learn to code as they create digital artifacts by drawing upon of cultural designs from Indigenous quilting, African American Cornrow hairstyles, and others. This is an exemplar of how we can teach students to value Indigenous and African American knowledge and practices while teaching them to code and learn mathematical principles. It is important to note that broadening participation programs have focused on

creating culturally responsive practices that can help engage, attract, and retain Black, Latinx, and Indigenous folks into Computer Science at the undergraduate level.

The competition-driven framing for "broadening participation in CS" is indicative of technology companies seeking a highly skilled and creative labor force to meet their profit margins and the demand of the neoliberal market (Gilbert, Jackson, Dillon, & Charleston, 2015; Lachney, 2017). As indicated by Google's hiring trend, this 'highly skilled' and 'creative labor force' rarely includes folks from historically disenfranchised communities (only 5.5% Black, 6.6% Latinx, & 0.8% Native Americans were hired by Google; Google Diversity Report, 2020). A fundamental reason for the abysmally low hiring trend of people of color is children from historically disenfranchised communities are most likely to attend low-funded schools (Ostrander, 2015) that do not have the budget to offer a computer science class and therefore historically disenfranchised students are least likely to pursue a computing degree (Margolis, Fisher, Goode, Holme, & Nao, 2017). Conversely, "access determines interest" and the dominant groups in computing, white and Asian, who are affluent communities are more likely to attend well-funded schools guaranteeing access and interaction with a computer (Margolis et al., 2017, p. 62). The few people of color who are fortunate to pursue a tech degree despite the odds are rarely hired as tech companies are reluctant to broaden the schools they recruit from to include historically Black and Hispanic serving colleges and universities and rely heavily on personal referrals from current employees who are most likely to be white males (LA Times, June 2020). Furthermore, racial bias, discrimination, and exclusion play a large part in who enters tech spaces and thrives (Carter, 2017). However, Trim (2020) purports that linking smartness to ability essentializes the identities of folks from historically disenfranchised communities as lacking some discernible trait that is required to be technologically proficient. Research suggests

that this view is perpetuated by CS faculty who make essentialist assumptions about race-based abilities of historically disenfranchised students that have shown to harm their success (Canning, Muenks, Green, & Murphy, 2019; Trim, 2020). More concerning is the emphasis by tech companies on financial capital as it shifts focus from how the power and capital of the neoliberal IT market, dominated by white men, dictates how race gets to be perceived and included in the mission and vision of tech companies where the cultural knowledge of disenfranchised communities is set aside (Benjamin, 2019).

With the increase in relevance and discussion on race and gender inequity in computing, tech companies have begun diversity initiatives that they claim will promote the hiring of professionals from disenfranchised communities in the tech industry (Google Inc., 2020). As suggested by the hiring trend indicated above (Google Inc., 2020), the percentage of hires from historically disenfranchised groups are still extremely low and concerning. With neoliberal markets dictating how policies on racial diversity are adapted by educational institutions, institutions and CS degree programs have begun integrating racially diverse initiatives that have focused on providing students exposure to projects on issues like, access to healthy drinkable water, that inequitably affect communities of color. These culturally responsive initiatives have so far been implemented in coding clubs and summer workshops (CITE) but largely remain out of formal education at the institutional level. Furthermore, there exist few financial support systems including day care for single-parents and financial loans through colleges that can support the retention of historically disenfranchised student groups in CS degrees (Charleston, 2012; Charleston, George, Jackson, Berhanu, & Amechi, 2014; Gilbert et al., 2015). This dissertation contends that a culturally responsive computing pedagogical approach when adapted by faculty in teaching CS courses can help retain historically disenfranchised student groups by

increasing their belonging in the computing field. Before we can bring culturally responsive computing into the undergraduate CS curriculum, it is important to study the beliefs of the faculty on their conceptions of what culturally responsive pedagogy might look like in CS courses.

Literature Review

Participation of historically disenfranchised students in U.S. Undergraduate Computing Education. While progress has been made at increasing access and participation in CS at the K-12 level, there remain challenges for the participation of minoritized groups at the undergraduate level. Specifically, women tend not to enter computing fields at the same rate as men (National Center for Science and Engineering Statistics, 2019); and racialized minoritized groups (e.g., African-American, Indigenous, Latinx, and Native Hawaiian or Pacific Islander) tend not to major in computer science at the same rate as their white counterparts (National Center for Science and Engineering Statistics, 2019).

Degree attainment trends. In 2016, nationwide only 10.1% of the computer science bachelor's degrees were awarded to Hispanics/Latinx, only 8.6% to African Americans or Blacks, and only 18.7% to women (National Center for Science and Engineering Statistics, 2019). When compared to their white and Asian peers, Hispanic/Latinx women earning bachelor's degrees in computer sciences has remained stagnant at 2% from 1996-2016 whereas those earned by African American women declined from 5% in 1996 to 2% in 2016 (National Center for Science and Engineering Statistics, 2019). Furthermore, the graduation percentage of Indigenous women has declined over the last 10 years from already abysmal 0.8% in 2006 to 0.4% in 2016. The participation and graduation rates of historically disenfranchised students in

undergraduate CS education confirm that despite K-12 diversity initiatives at the national and state level, opportunities and support available to historically disenfranchised groups to enter and persist in computing fields remain dearth.

Reasons for low retention. The few historically disenfranchised students who do pursue a CS bachelor's degree are often confronted with feeling a lack of fit with being a computer scientist (Lewis, Anderson, & Yasuhara, 2016) and overcoming concerns about abilities to succeed in CS impacting their sense of belonging in the CS field and their motivations to persist in the major (Rodriguez & Lehman, 2018). Research also suggests that historically disenfranchised students have to overcome racial stereotypes that again impact their belonging (Cheryan, Plaut, Davies, & Steele, 2009) and be exposed to a computer science curriculum that reflects the views of the dominant group while not acknowledging and accommodating culturally diverse knowledge and practices of historically disenfranchised communities (Björkman, 2005). Based on the low retention statistics of historically disenfranchised students (indicated above) and lack of support, the reasons for their lack of persistence, fewer historically disenfranchised student groups than those who enter in secondary level computing education persist in their degrees. With few minoritized students graduating with a computer science bachelor's degree, a vital concern remains that current technological tools, artifacts, and software do not represent the minds and realities of minoritized groups. Furthermore, although researchers have focused on equipping faculty with better pedagogical practices at the undergraduate level in CS (such as peer instruction (Porter, 2016)); flipped classrooms (Maher, Latulipe, Lipford, & Rorrer, 2015); active learning (Freeman et al., 2014), there has been a limited focus on how CS faculty can make their teaching practice more inclusive of the experiences of women and historically disenfranchised students. To support historically disenfranchised student groups, it is important

to first understand how faculty can learn about and integrate culturally responsive pedagogical practices in their classrooms. Educating faculty on culturally responsive pedagogies can support the retention of students from disenfranchised communities who are likely to face racism in the classroom, to feel unsupported and unwelcome in computing education, and to face financial and social struggles as they navigate their degrees. To narrow my focus, I targeted computer science faculty teaching undergraduate-level courses.

Statement of Problem. Undoubtedly, representation in the field of computing is a prominent factor that promotes the belonging and motivations of historically disenfranchised students to pursue and persist in computing (Sax et al., 2018; Margolis et al., 2017). Representation not merely of programmers and coders who look like them but also among the creators of technologies and in its creation that reflect creative solutions for problems faced by folks in their local communities (disenfranchised communities). “New technologies today reflect and reproduce inequities” that are marketed and perceived as more objective, progressive, and free from bias (Benjamin, 2019, p. 5). As shown by a study done by Caliskan et al. (2017) on whether a human online writing algorithm would exhibit language biases, they found that the algorithm associated White-sounding names with “pleasant” words and Black-sounding names with “unpleasant” words. This reflects how racial and gender biases enter technologies through the backdoor of design perpetuating the biases of humans who created the algorithms (Benjamin, 2019). To address the role computer science plays in the design and implementation of technologies that are biased towards minoritized groups, we need to broaden participation in computer science at the undergraduate level. To do so, we need to center students’ lived experiences and use inclusive practices in the undergraduate CS curriculum.

However, there has been limited research on the pedagogical practices used by CS faculty that are inclusive of the ways of knowing, being, and doing of minoritized communities. One reason behind this divide between the faculty's teaching practices and the experiences of historically disenfranchised students lies in a larger focus by undergraduate-level computer science degrees exclusively on technical literacy (i.e., programming) with little to no focus on issues of diversity, community, culture, and identity (Scott, Sheridan, & Clark, 2015). Furthermore, the undergraduate computer science coursework (that is created around the ABET accreditation guidelines) remains governed by the principles and practices that were and are being set by white men who are part of the so-called "Nerdy", "Geeky" computer science clubs (Cheryan et al., 2009; Cheryan, Plaut, Handron, & Hudson, 2013). This is indicative of the uni-dimensionality of the curriculum that is still followed by most universities offering computer science bachelor's degrees. The undergraduate CS curriculum is embedded in the white, male, heteronormative, western ways of knowing and engaging in computer coding that does not reflect the experiences of historically disenfranchised students (Shivers-mcnair, Gonzales, & Zhyvotovska, 2019). One aspect of coding languages that reflects the dominance of western culture in computer science is the use of English throughout the undergraduate US and international curriculum (Shivers-mcnair et al., 2019). Another issue is an exclusive focus on coding assignments and projects that are far removed from the realities of students and their communities or even from the realities of their future experiences of coding.

A crucial step in retaining and helping historically disenfranchised students to succeed in CS is for CS faculty to use culturally responsive pedagogies (Ladson-Billings, 1995; Paris, 2012; Scott et al., 2015). Culturally responsive pedagogy (CRP) seeks to utilize the cultural experiences, characteristics, and perspectives of culturally and linguistically diverse students as

conduits for teaching them more effectively (Gay, 2000). It empowers faculty (Ladson-Billings, 200, 2004; Milner 2006) to create an educative environment that validates experiences of historically disenfranchised student groups and is comprehensive, multidimensional, empowering, transformative, and emancipatory (Gay, 2000). By using CRP in their classrooms, teachers seek to situate academic knowledge and skills within the lived experiences of students that can be personally meaningful to them (Gay, 2000). One way to support faculty is through professional development programs that focus on making culturally and socially inclusive practices an integral component of the pedagogies of CS faculty, who are at the center of introducing students to the world of coding. To do so, we need to first understand how CS faculty think about issues of equity & diversity, using culturally responsive approaches, and leveraging community-based resources in their courses.

Purpose of this Study

The purpose of this qualitative study was to explore the beliefs of undergraduate computer science faculty in using a Culturally Responsive Computing (CRC) pedagogical approach to teach computer science (CS) courses. I contend that despite structural impediments, many historically disenfranchised students are interested in and pursue computing education but lack culturally responsive opportunities to persist in their CS degrees. To understand how studying the intentions of faculty to use a culturally responsive computing pedagogy can support the retention and persistence of historically disenfranchised students, I rely on critical pedagogy (Paulo Freire, 1970)-a heuristic used in culturally responsive studies as a methodological tool (Ladson-Billings, 1995; Souto-Manning, 2010; Paris, 2012). Critical pedagogy offers a powerful approach for understanding how faculty, come to understand and be aware of the ways systems of power operate (theory) to expand possible recourse (practice) (Freire, 1970; Hooks, 1994).

Being a former information technology faculty from India, with a Bachelors' degree in Computer Science, provide me a "unique angle of vision" (Collins, 2009, p. 39) to understand how CS faculty can leverage culturally responsive ways of teaching Black, Latinx, & Indigenous students who have been historically minoritized in computing education. The following research questions guide my study.

Exploratory Questions

1 How do undergraduate CS faculty see the relevance of incorporating Culturally Responsive Computing (CRC) assignments in their CS courses?

2 What role do CS faculty consider they and the university play in supporting the persistence and retention of students from disenfranchised communities in undergraduate computer science degrees?

CHAPTER 2: LITERATURE REVIEW

Work on examining the underrepresentation of historically disenfranchised student groups in computer science (CS) has often in the past focused on their low academic qualifications and interest towards pursuing a CS degree and career (Smyth & McArdle, 2002). However, in recent years, researchers like Cheryan et al. (2009), Perrakins (2008), Scott, Sheridan, & Clark (2015), Rankin & Thomas (2017), Charleston (20s12), Vitores & Gil-juárez (2017), Washington and Romanova (2018), Washington (2020), and Wood and Harris (2012) have noted the importance of predictors such as ethnic identity (similarity to the people in the field), social isolation, sense of belonging, lack of culturally relevant courses, and environmental factors that impact the persistence of students from historically disenfranchised communities in computer science degrees. Given the role of these factors in the persistence of historically disenfranchised student groups in computing, it is important to design and use pedagogical approaches that aid the persistence and retention of historically disenfranchised students. In the following sections, I first review factors that influence the success of historically disenfranchised student groups in CS and then discuss how pedagogical approaches, such as culturally responsive computing (CRC) can support them to persist and succeed in CS degrees.

Factors impacting the success of historically disenfranchised students in undergraduate CS degrees.

Predictors such as social isolation (Charleston et al., 2014), sense of belonging (Perrakis, 2008; Sutherland, 2011), lack of ethnic identity in CS (Washington & Romanova, 2018), environmental factors (Wood & Harris, 2012), and lack of culturally relevant courses (Washington, 2020) impact the self-efficacy and persistence of historically disenfranchised student groups in their degrees.

Social Isolation. Given that most CS departments are skewed, primarily white-dominated spaces, feeling of cultural and social isolation largely impacts the sense of belonging of historically disenfranchised student groups (Charleston, 2012; Charleston et al., 2014; Washington, 2020). Charleston, George, Jackson, Berhanu, & Amechi (2014), on studying the experiences of 15 Black women pursuing CS degrees found that Black women often felt social isolation from peers and particularly from CS faculty and lacked any institutional support from within and outside their computer science graduate programs. Black women associated a feeling of social isolation with their racial experiences that were varied according to gender (Charleston et al., 2014). For instance, they felt that despite sharing the same race, Black men were more likely to work with white males and less likely to support and work with Black women. They also found that CS faculty were often complicit in perpetuating racial biases. For example, one black female participant pursuing her CS bachelor's degree noted that a faculty on being confronted with concerns about African American students being mistreated in the classroom responded that "white professors gave her grades because of her race and they felt bad about slavery" adding that "I don't think there are any real computer scientists who are Black, and maybe she can be the first." (Charleston et al., 2014, p. 172). This study highlights how CS faculty hold conscious and unconscious biases and socially ingrained racialized prejudices and stereotypes regarding the technological capability of historically disenfranchised student groups. These racialized assumptions of faculty impact the way they support historically disenfranchised students through their pedagogy and interaction.

Sense of Belonging. Perrakis (2008) found that Black male students' persistence and success in their degrees at community colleges was significantly impacted by feeling a sense of belonging which in turn was impacted by having a meaningful connection to the campus

(Perrakis, 2008). Sutherland (2011) through her work with Black immigrant males in 4-year degree programs found that black males' sense of belonging was impacted by the support they received from peers, family, and community members; negative interactions leading to a distrust of institutional agents like faculty and administrations; and "social incongruence", feeling of being othered, on the college campus (Sutherland, 2011, p. 275). This suggests that there is a need to better equip CS faculty and administrators in making students feel welcome and accepted in CS classroom spaces that could contribute to their persistence in CS.

Ethnic Identity. Ethnic identity has also been suggested as a significant factor that impacts the self-efficacy of historically disenfranchised students in the career choices they make. Ethnic identity is defined as "that part of an individual's self-concept that derives from his or her knowledge of membership in a social group (or groups) together with the value and emotional significance attached to that membership" (Phinney, 1992, p. 156). Washington & Romanova (2018), in their work on studying the relationship between ethnic identity and interest and participation of historically disenfranchised freshmen-level CS students, found that ethnic identity, including the presence of role models of the same ethnicity, directly influenced the self-efficacy, confidence, and willingness to persist and succeed in their degrees.

Environmental factors. Environmental factors also play a role in predicting the persistence of historically disenfranchised students in computing. Environmental factors are the ones that arise in students' lives external to the college campus but can disrupt students' academic persistence (Wood & Harris, 2012). Wood and Harris (2012) on studying the persistence of African American males in higher education found that environmental factors such as financial instability, lack of outside support and encouragement, and family obligations were

negative predictors of Black male persistence. Given that African American males enrolled in 4-year degree programs are 5.5 times more likely than white male students to leave within the first year due to family obligations, it is important to provide them with support systems that contribute to their persistence (Wood, 2012).

Lack of culturally relevant courses. Undergraduate computer science (CS) departments nationwide reflect a culture that benefits the dominant groups (White and Asian) and marginalizes others. One reason for the lack of diversity, equity, and inclusion in CS departments is the nonexistence of formal courses that exclusively focus on educating students about non-technical social issues affecting historically disenfranchised communities and ways to address and eradicate them (Washington, 2020). Washington (2020) in her work outlines a course for sophomore-level CS undergraduate students, that focuses on cultural competence by beginning with introducing students to basic terminologies such as "race, ethnicity, bias, microaggression, marginalization, and historically disenfranchised groups" through articles and publications (p. 217). And then moving on to teach students to focus on biases in technology development and finally end the course with a project where students select a book from a list of to learn about racism and present their reflections on it. The author argued that by educating students on racial and social issues we can create a workforce that actively considers issues of inclusivity, equity, and diversity when developing technologies (Washington, 2020). Although her course does an excellent job on centering the issues of historically disenfranchised communities, it does not address how we can broadly educate CS faculty on racial issues, especially given that CS faculty also receive little to no training in how to teach using learning theories or pedagogical practices. We need to educate CS faculty on how to inform their teaching practice by addressing the racialized context of the educational system in the United States that

has excluded historically disenfranchised students from receiving socially and racially equitable educational opportunities.

How pedagogy impacts the success of historically disenfranchised students. The current CS curriculum and pedagogies center heteronormative, white ways of knowing, being, and doing computer science that marginalizes and exclude cultural practices and ways of knowing, being, and doing of historically disenfranchised students (African American, Indigenous, and Hispanic folks) in the United States. Haynes and Patton (2019) used grounded theory and the White Racial Consciousness and Faculty Behavior model to illustrate that by moving away from neutrality in the CS curriculum we can engage White STEM faculty who fail to see connections between their teaching, course content, and racial justice. Their results suggested that college-level STEM faculty viewed diversity issues as incompatible with their discipline as they believed that teaching students about diversity issues requires faculty to break their "disciplinary integrity" (Gay, 2002, p. 107; Haynes & Patton, 2019). Furthermore, the authors also reported that most STEM faculty never received formal pedagogical training and bring a critical perspective into their teaching and even those who have some training felt that the institution did not value or reward their effort. These findings urged STEM faculty to commit themselves to disrupt racial inequities in classrooms by questioning their beliefs and assumptions on how race and racism impact their teaching, attending professional development workshops on culturally relevant pedagogies, and reading studies on women and historically disenfranchised student groups in STEM disciplines. Haynes & Patton's (2019) work strengthens the argument towards developing a critical professional development program that teaches CS faculty how they can inform their pedagogical practice through a culturally responsive computing approach. A culturally responsive curriculum that educates CS faculty to learn about their own conscious

and unconscious biases and racialized assumptions can help them enact culturally responsive teaching that is reflective, inclusive, and respectful of the cultural practices of historically disenfranchised communities of color.

Ivey, Johnson, Skorondinsky, Snyder, & Goode's (2021) recent work exemplifies the ways Black, Indigenous, People of Color (BIPOC) CS high school teachers have been centering their curriculum and teaching on the tenets of abolitionist teaching put forth by Bettina L. Love (2019). Their findings suggested that BIPOC CS teachers actively called out deficit perspectives, acknowledged the historical and systemic racialized injustices, moved beyond past diversity gimmicks and showed students how valuable their life is to teachers. Their work also suggested that BIPOC teachers approached their teaching as a collective social responsibility towards combating racism in their classrooms (Ivey, Johnson, Skorodinsky, Snyder, & Goode, 2021). They recommended how BIPOC teachers' use of abolitionist teaching in CS classrooms can act as a guideline for white teachers and faculty on how to be racially and culturally inclusive in teaching historically disenfranchised student groups.

At the CS undergraduate level, given that deterrents like stereotype threat (Charleston, 2012; Cheryan, Master, & Meltzoff, 2015), lack of perceived similarity to people in the field and ethnically relevant representation (Google Inc. & Gallup Inc., 2016; Washington & Romanova, 2018; Washington, Burge, Mejias, & Jean-Pierre, 2012), seeing limited job opportunities in computer science for themselves (Charleston, 2012), and expectations to succeed (Vitores & Gil-juárez, 2017) threatens the retention of students from disenfranchised groups, faculty need to use pedagogies that center historically disenfranchised students. However, limited work at the undergraduate level in CS programs urges us to direct our attention towards teaching CS faculty

how they can meaningfully design a curriculum using culturally responsive pedagogy that embodies an intersectional racially inclusive approach to teaching historically disenfranchised student groups in CS.

Hence, in this dissertation, I attempt to understand faculty's beliefs on what a culturally responsive computing pedagogical approach could mean when it comes to supporting the retention of historically disenfranchised student groups. Consequently, this dissertation will also attempt to understand faculty's views on how institutional support plays a role in supporting historically disenfranchised student groups and faculty who wish to adapt culturally responsive pedagogies in teaching CS courses.

Theoretical Framework

Critical Pedagogy. Critical pedagogy offers a powerful way to understand how systems and hierarchies of power operate to undermine and undervalue the lived experiences, knowledge, language, and culture of historically disenfranchised students and ways educators should teach historically disenfranchised students to find possible recourse to combat these power structures (Freire, 1973, 1974; Ladson-Billing, 1995). During the 1980s, teachers who used critical pedagogies and instruction found that including aspects of students' cultural environment in classroom instruction and organization aided in student achievement and success (Mohatt & Erickson, 1981; Cazden & Leggett, 1981; Erickson & Mohatt, 1982; Jordan, 1985; & Vogt, Jordan, & Tharp, 1987). However, each of these studies assumed that student "success" and achievement can be represented within the current social structures present in schools and universities. So rather than leveraging student's cultural capital into classroom instruction, the goal of education became how to fit students who were othered by their race, ethnicity, language,

or social class into a system of meritocracy (Ladson-Billings, 1995). Simply put, to match the home and community of historically disenfranchised students "culturally compatible" (Jordan, 1985, p. 110; & Vogt, Jordan, & Tharp, 1987, p. 281), "culturally appropriate" (Au & Jordan, 1981, p. 139), and "culturally congruent" (Mohatt & Erickson, 1981, p. 110) were terms used to fit "student culture" into the dominant white "mainstream culture" (Ladson-Billings, 1995, p. 467).

It is important to understand critical pedagogy (Freire, 1973, 1974) as it provides the theoretical foundation for culturally relevant pedagogy (Ladson-Billings, 1995), culturally sustaining pedagogy (Paris, 2012), and culturally responsive pedagogy (Howard & Terry, 2011). The urgency to have "culturally relevant" (Ladson-Billings, 1995), "sustaining" (Paris, 2012), and "responsive" (Howards & Terry, 2011) pedagogies has never been lost on communities of color but has only recently been recognized in computing education (Haynes & Patton, 2019; Ivey et al., 2021). This study uses critical pedagogy to understand how the undergraduate CS computing curriculum and pedagogy embody white supremacist ideologies that are reflected in the teaching practice of White and BIPOC faculty who as suggested by Ladson-Billings (1995) is still trying to fit historically disenfranchised student groups into a system of meritocracy.

A foundation for culturally relevant & sustaining pedagogies. Ladson-Billings (1995) proposed the term "culturally relevant pedagogy" to argue that pedagogical practices should encourage student achievement and success, and support students in affirming and accepting their cultural identities and developing a critical understanding of how schools and institutions perpetuate social inequities. In her work, she drew from the works of civil rights activists like Paulo Freire (1973, 1974) on critical pedagogy that provide a cultural critique of teachers'

inadequate understanding of social inequities that impact the lives of their students. However, Paris (2012) in his seminal piece on Culturally Sustaining Pedagogies, argued that the adoption of culturally relevant pedagogy at the K12 level in the U.S. does not support or sustain the "linguistic and cultural" practices of historically disenfranchised communities of color in the demographically evolving school and communities in U.S. (Paris, 2012, p. 95). Instead, Paris (2012) suggested that "culturally sustaining pedagogy" aims to help both students and teachers in supporting and sustaining the marginalized cultural practices and ways of knowing and being of historically disenfranchised student groups. Paris (2012) argues that culturally relevant and responsive teaching is still using the school curriculum to teach students to assimilate to the dominant curricula. Therefore, it is important that culturally responsive teaching be culturally sustainable by moving away from treating student's repertoire of knowledge as a deficit and valuing their cultural capital as rich knowledge on which learning can occur. I describe below instances of culturally responsive teaching that is also culturally sustaining in principle and practice.

Culturally Responsive Teaching. Culturally responsive teaching (CRT) has been suggested as one way to engage raced-gendered-ethnic minoritized learners and increase their academic achievement in computer science while disrupting the dominant stereotypical rhetoric of only white and Asian male nerds being computer scientists (Howard & Terry, 2011). CRT is a pedagogical approach that seeks to engage culturally and linguistically diverse learners (historically disenfranchised learners) by urging teachers to identify, strengthen, and leverage students cultural and community assets and reflectively engage in ways teachers' privileges shape their worldviews (Lachney, 2016; Ladson-Billings, 1995; D. Paris, 2012; Scott, Sheridan, & Clark, 2015, p. 414). Engaging historically disenfranchised learners requires empowering

learners, transforming the culture of schools, building student success through cultural validation, teachers integrating ethnic literature in building learners' comprehension skills, teachers developing instructional strategies with the realization that the cultural characteristics of learners are multidimensional and complex, and providing students the freedom to be ethnically and culturally expressive that removes the stress of covering up one's cultural inclinations (Gay, 2010). Unlike deficit models of thinking (Blanchett, 2009; Anderson & Stillman, 2013; Howard, 2013) which faults students' personhood, communities, backgrounds, and families, therefore, assuming "the solutions for improvement or reform are beyond the teachers' and university systems' control and influence" (Haynes, 2007, p. 6), CRT view the above factors as assets on which learning can occur. In general, the deficit approaches to teaching attempt to replace learners' social systems with more acceptable practices nested in the dominant culture (Paris, 2012).

For teachers, adapting CRT as a pedagogical approach means to be "reflective of how their social positions of power [are] in [relation] to the [social] and cultural contexts of their students" (Lachney, 2016, p. 4). Scott, Sheridian, and Clark (2015) explained that a reflective teacher should attempt to find available yet unconventional pathways that are typically not part of a school curriculum to connect to students and their communities. For teachers to truly understand their students and their communities this requires to be involved in social and neighborhood events that provide them the opportunity to make local connections and get an insight into their students' cultural wealth (Lachney, 2016; Paris, 2012). Such personal insights into the lives of their students allow teachers to find creative, culturally responsive, and unconventional connections with the curriculum content that may not be otherwise overt in the

school curriculum which is governed by the dominant culture's ways of knowing and doing (Lachney, 2016; Gloria Ladson-Billings, 1995).

Within computer science, an example of a culturally responsive and unconventional way to engage youth in computer science could mean inviting a hair braider as a guest speaker to a classroom instead of a computer scientist (Lachney, 2016). Similarly, Eglash and Bennett (2009) in their research on culturally situated design tools, described how a deep interactive experience with design tools that take account of students' cultural capital provides students the agency to manipulate what they create and view on their computer screen. This results in "students' construction of their own identity" that connects with their community practices while ensuring "their construction of computational ideas" (p. 60). In essence, a culturally responsive teaching approach in computing validates students' cultural characteristics considering them as assets on which learning can occur, ensures the curriculum reflects students' ethnic and cultural background, and develop instructional strategies that allow students to express their creative selves without the burden of hiding their cultural inclinations.

The discussion of CRT is relevant to undergraduate computer science education due to the value of CRT in increasing the participation and academic achievement of historically disenfranchised students (Ijei and Harrison, 2010). CRT has the potential to provide undergraduate faculty, researchers, and other university stakeholders with important connections with the local community, which in turn will help them identify important community-based cultural assets to bring to the CS curriculum (Lachney, 2016). However, few studies have examined how CRT can be applied and used at the undergraduate level in computer science. This dissertation seeks to bridge the research gap by first examining whether and how CS faculty see

the relevance of CRT in their teaching as one way to make CS undergraduate education more culturally responsive and sustaining. The findings from the study could help inform the application of CRT at the undergraduate level through culturally responsive computing (CRC). Informed by the extensive work on CRT and adapting it into computer science, CRC seeks to support digital technology innovation among learners from historically disenfranchised groups by empowering them to take a transformational stance towards technology creation and innovation as they do so by drawing on from their socio-culturally diverse context (Scott et al., 2015).

Culturally Responsive Computing offers us a new theory that relentlessly works against accepting current computing educational practices as distinct & separate from political, social, and cultural underpinnings of their students and the social world (Hooks, 1994; Ladson-Billings, 1995). Faculty have extended efforts to make their pedagogical practices more equitable by use being mindful of the gendered and racialized ways their teaching and content plays out for female students. There have also been attempts to understand how culturally responsive pedagogy can be successfully integrated into K12 classrooms. One CRC approach has been for CS teachers to actively engage with the local community in their school district, which helps them identify community-based assets and directly connects to the experiences of disenfranchised student groups in CS. While there has been some work on incorporating CRC in informal settings (Eglash et al., 2006; Scott & White, 2013), we know little about its implementation in undergraduate formal education (Rankin & Thomas 2017), especially in CS courses.

Culturally Responsive Computing. As a pedagogical approach, CRC urges us to rethink computer science education by identifying and creating opportunities that attend to the needs and experiences of historically disenfranchised students, who are often left at the periphery of equity discussions in computer science. CRC calls for creating learning opportunities that entail framing academic goals around identity issues, social empowerment, deeper understanding of heritage and appreciation for cultural diversity, and embedding these perspectives into students learning experiences (Eglash, Benett, O'Donnell, Jennings, & Cintorino, 2006; Scott et al., 2015). Given that technological artifacts reflect the different facets of students' cultural being, CRC is particularly relevant to the CS curriculum and the only way to include everyone's voices in the creation of technologies is by informing curriculum and pedagogy through a culturally responsive lens (Conole, Laat, Dillon, & Darby, 2014).

Scott et al. (2015) proposed five key tenets of CRC that advocate for the inclusion of sociocultural features in the learning environment, software, and the artifacts created by people and the application of this software outside of the classroom. The five key tenets are

(1) "All students are capable of digital innovation.
(2) The learning context supports the transformational use of technology.
(3) Learning about one's self along various intersecting sociocultural lines allows for technical innovation.
(4) Technology should be a vehicle by which students reflect and demonstrate an understanding of their intersectional identities.

(5) Barometers for technological success should consider who creates, for whom, and to what ends rather than who endures socially and culturally irrelevant curriculum." (Scott et al., 2015, p. 421)

The first tenet emphasizes that irrespective of one's race, social class, ethnicity, and/or gender all students can acquire "premium digital literacy" (Gee, 2012 as taken from Scott et al., 2015). This demands the creation of a learning context where teachers expose students to complex technological tasks despite their achievement or lack thereof in other subjects or courses. CS instructors could enact this CRC tenet in their classroom by setting high standards of achievement for all students and committing to regularly articulate to students that they can and will achieve expectations.

The second tenet encourages learners to take a "transformational stance towards technologies" by moving beyond gaining technical content knowledge (Scott et al., 2015, p. 422). This tenet urges learners not only to build knowledge and artifacts with technologies ("tools and techniques") but also to explore the boundaries of what these technologies can do (p. 422). Scott et al. (2015) illustrated through their "studio mentorship model" how this tenet has been particularly relevant to historically disenfranchised groups. The studio mentorship, developed by Clark & Sheridan (2010), trained African American youth between ages 8 and 18 to design and develop games and on completing their training students were given the option of becoming mentors who assisted other students as they worked on their game designs and projects. Their work shows us that providing youth autonomy in the choices they make about what they create provided them the opportunity to understand the constraints of the technologies they were using. In addition, enduring support from more experienced peer mentors as a youth worked out their ideas promoted more complex and personalized game designs and sophisticated

use of programming. CS instructors can enact this tenet by providing undergraduates the autonomy to choose the coding software and platforms they use to create their projects and assignments and by making experienced peers act as mentors as students work on their ongoing projects.

The third tenet relies on intersectionality to illustrate the powerful role that schools play in advancing the technological proclivities of historically disenfranchised students. This tenet aims to inspire students from disenfranchised communities to recognize that their expectations to receive technological education are not tethered in race or ethnicity and that their identities are not exclusively defined by social class or notions of privilege or entitlement. This tenet challenges the essentialist notion that defines a person's identities and experiences independent of the multiple factors that shape their identity and lived events (Harding, 2006). In their COMPUGIRLS project, a multimedia program centered on Latina and African-American girls, Scott et al. (2015) illustrated COMPUGIRLS's realization of what they do not know about technology and social justice and their gradual realization of themselves as "should-nots" (Scott et al., 2015; a term taken from Tapscott's (1998) description of the immigrants as "know-nots" who lack the technical skill to narrow the digital divide). As a CRC experience, this tenet promotes self-discovery among youth by helping them recognize that they are beings with multiple intersectional identities which in turn forms a significant aspect of technological innovation that students can utilize in displaying their technical prowess.

The third tenet leads into the fourth tenet, which prompts students to manipulate technology to learn about their various intersecting identities and the negative manifestations of themselves that are represented in the media while also encouraging them to create

"counternormative images of themselves" (Scott et al., 2015, p. 426). Scott et al. (2015) contest that in their experience, learning about oneself in a CRC context prompts challenging questions for youth, like, "How does becoming an innovator affect my racialized-genderized self?" (p. 427) How can I use the technology created by the dominant group for dismantling social inequities?

In a CRC context, the last and fifth tenet guides students in recognizing their communities as valuable assets that can contribute to their success and how students in turn can positively affect their community through their technological innovation. Scott et al. (2015) argued that rather than prompting more students to enter the computer science fields, the focus should be on how students from disenfranchised communities are capable of being inventors and creators of technologies. This tenet urges the need for providing youth with support structures that include their parents, peers, and teachers to help them understand "the self", "the other", and "the context" (Weinstein, Curran, & Tomlinson-Clarke, 2003 as cited in Scott et al. (2015)). Scott et al. (2015) explained that in a CRC context, learning about the "self" pushes students to realize their power as activists; "the other" is the structural barriers maintained through technology that prevent the pursuits of students from disenfranchised communities; and "the context" is the setting the requires dismantling the status quo leading to a more equitable culture necessitating participation from disenfranchised communities whose knowledge is often regarded primitive by the dominant culture.

To understand how a CRC pedagogical approach in computing sets it apart from prior culturally responsive and sustaining pedagogies we need to understand intersectionality. Given that the experiences of women of color, who are a minority in CS degrees, are distinct from their

male peers (Charleston et al., 2014), we need to understand how the intersection of race, gender, and social class impacts their persistence. Intersectionality makes CRC unique and helps us understand how technological practices interact with gender, race, and socioeconomic status to create an inequitable racially discriminatory computing culture for women of color. This will help us understand how we can develop pedagogical approaches that are culturally inclusive of the experiences of all students from historically disenfranchised communities.

Intersectionality in CRC. The integration of intersectionality into the CRC framework sets it apart from prior work on culturally sustaining pedagogies and intersectional feminism that have either exclusively focused on gender and race or race and socioeconomic status. Intersectionality in CRC urges us to frame the inequities and discrimination faced by people from disenfranchised communities across multiple, complex, intersectional identities of race, gender, and socio-economic status (Crenshaw, 1989).

Intersectionality provides a way to understand gender with other intersecting identities and hierarchies, particularly race, class, ethnicity, and sexual orientation, that form complex intertwining of identity and oppression of minoritized groups (Crenshaw, 1989). Crenshaw in her work on Intersectional Feminism used intersectionality to illustrate how the politics in the antidiscrimination law in the United States have been a source of marginalization and discrimination for Black women whose intersectional identities of race and gender are often not accounted for in the discourses on feminism, sexism, and racism. Given that historically disenfranchised students have their identities situated in gender as well as race, using one or the other does not capture their experiences and identities (Scott et al., 2015). In computer science, intersectional feminism presents us with a unique way to humanize the experiences of

historically disenfranchised students and move beyond stereotypic images that prioritize one identity over another (e.g., race or social class, or gender) by creating a space to make their voices heard (Ladson-Billings, 2000). Furthermore, intersecting race and technology with gender and social class promote distinct questions of self-image, oppression, and technological potential that are rooted in culturally inclusive beliefs and move beyond intragroup differences (Scott & White, 2013). Scott et al. (2015) contended that when students understand how their peers' identities, like themselves, is evolving across multiple social and cultural dimensions (like race, gender, sexuality, SES, etc.) it helps them feel a sense of belonging and allows them to draw on from these intersecting identities into their designs (p. 424). While culturally responsive pedagogy provides one way to address the inequitable access to opportunities available to students from disenfranchised communities, culturally responsive computing by factoring in the complex realities and lives of historically disenfranchised students helps examine the "interconnectedness", "co-shaping", and "co-constitution" of technological practices and gender, race, class, and sexuality (Shivers-mcnair et al., 2019, p. 46). In CRC, intersectionality brings into the question how the CS curriculum and pedagogical practices in CS classrooms have typically been developed by members from the dominant and privileged group thus indicating the uni-dimensionality of the curriculum that only incorporates a monolithic idea of what should be taught, what pedagogical strategies should be used, and the learning strategies that should be a part of a CS classroom if we want to teach 'authentic' coding.

CRC for K-12 learners. Significant work has been done by Scott and colleagues (2015; 2013), Rankin, Thomas and colleagues (2013; 2014), and Eglash and colleagues (1999; 2002; 2004; 2006; 2009) on understanding the connections between using culturally responsive technological tools and artifacts with culturally responsive pedagogies in teaching computer

science at the K12 level. Lachney (2017) in his empirical work, describes how CRC has the potential of creating a "symbiotic" relationship between educators and the communities that their students belong to (p. 3).

Scott and White (2013) in their work, COMPUGIRLS, discussed how a "culturally responsive multimedia program" can attract, retain, and promote interest and motivation in Latina and African American girls to pursue computer science in the future. For their COMPUGIRLS project, 41 high school girls with a mean age of 14.5 years attended 20 hours of summer sessions over 4 days for 5 weeks, 1-day after-school fall and spring sessions, and 10 weeks Saturday morning sessions over 2 years. COMPUGIRLS projected carefully selected graduate students from various disciplines from a participating university and in-service teachers from participating districts to be mentors for girls of color. The mentors engaged in 80 hours of training in how to create and implement culturally responsive computing practices of "asset building, reflection, and connectedness" (Scott & White, 2013, p. 664). Participants in COMPUGIRLS worked in groups to identify a community issue they would like to research. They used three different programs SIMS (a digital app that lets you design a virtual world in which they determined the trajectory of their characters' lives), SCRATCH (a programming language that lets participants learn and manipulate block-based programming language to create animations, games, music, and art), and Teen Second Life (where participants create characters, begin social justice projects, and execute proposed projects to affect change in a virtual world.) and loaned hardware (cameras, laptops, microphones, etc.) to display their scholarly journey. In collaboration with a university, COMPUGIRLS had access to all the resources like loaned hardware, library books, peer-reviewed journals, and programming software to finish their research projects. The authors argued that the COMPUGIRLS project's use of a culturally

responsive computing lens attracted and retained Latina and African American adolescent girls (ages 13-18) and supported in strengthening their identities as future technologists. Scott & White (2013) through their work also established that a culturally relevant assignment allowed high school girls of color to explore different facets of their technological beings, commit to social justice issues and advocacy in their communities, and increase their sense of self-belief to envision themselves as future technologists. Their data also suggested how disenfranchised girls of color experiences enable them to develop multimedia projects that question the dominant culture's "practice of power" (Scott & White, 2013, p. 675). Their work also established that girls of color entered the program with an understanding of the instrumentality of technology for their community and throughout COMPUGIRLS their view of selves as participatory members of the digital community grew significantly. Peer feedback allowed girls to work hard to access their "repertoire of knowledge", seeing them as assets on which learning can occur. Combined with innovative pedagogical techniques, the asset-building activities promoted dialogue amongst girls of color to continue in the program. Culturally responsive computing programs like COMPUGIRLS contend that despite structural impediments, girls of color are interested in technological fields but lack the relevant opportunities to pursue such disciplines. The success of COMPUGIRLS and the stereotypes that it breaks on girls of color interest and ability as technologists urges us to consider the powerful role a supportive culturally relevant mentorship program can play in supporting historically disenfranchised students' sense of belonging and in seeing themselves as active contributing members in their community who use technology to solve local community.

Lachney and Yadav (2020) in their work on using Cornrow Curves programming application with middle schoolers describe how collaboration between community partners (in

their case an African American cosmetologist) and teachers can successfully transform student interest in and engagement with programming concepts. The Cornrow Curves application is part of the Culturally Situated Design Tools (CSDT) that teach block-based programming and transformational geometry to K12 learners by having them explore its African mathematical history and origin (Eglash & Bennett, 2009). They illustrate how with Angela, a cosmetologist, and Brenda, a middle school technology teacher, they collaboratively developed a two-day programming lesson that allowed students to learn math concepts through virtual and physical braiding activities (Lachney & Yadav, 2020). Students learned to physically braid with Angela and programmed these braids with Brenda's support using the CSDT Cornrow Curves application. Lachney and Yadav's (2020) work that is grounded in culturally responsive computing illustrates that fostering deep community connections can allow teachers to form local partnerships outside of the school that can help them connect to the lived cultural experiences, knowledge, and context of their students. Their work also suggests that providing students opportunities that allow them to see the connection of out-of-school community assets to computing concepts fosters their participation and interest in computing and helps them see CS as a future career choice. Teachers play a key role in leveraging the tenets of culturally responsive computing into their coursework as they work in collaboration with local community partners to understand the cultural contexts and lived experiences of their historically disenfranchised students.

Rankin, Thomas, and Hawkins (2014) have also worked on broadening the participation of African American middle school students so that they pursue careers in computing-related fields such as gaming later. Through their work, they engaged 11 African American middle school students ages 10-13 years old in a 4-day game design workshop using Scratch to move

them from being “consumers to being producers of technology” (Rankin, Jakita, & Hawkins, 2014). Their findings suggested that most students were able to define the formal elements of their games, like game objectives, number of players, and rules but struggled with the concepts and boundaries of the game. Through the games that their participants created, their findings provide insight into how the mainstream perception of African American students as lacking interest in game design is flawed.

The work of the COMPUGIRLS project (Scott & White, 2013), Lachney & Yadav (2020), and Rankin and Thomas (2013, 2014) indicate that culturally responsive computing has been successful in supporting the self-efficacy and ethnic identity of historically disenfranchised student groups in their intentions to pursue a computing degree. Moreover, this work suggests that a culturally responsive computing pedagogy that uses innovative pedagogical practices to center the cultural characteristics of historically disenfranchised student groups and uses community connections as assets on which learning can occur has the potential of transforming how we approach teaching in CS undergraduate courses.

CRC in Higher Education. Rankin and Thomas (2017) have also explored the use of culturally responsive pedagogy at the higher education level. Rankin and Thomas (2017), in a three-year study, developed a module around food as part of a required introductory CS course. The authors reasoned that while few African American women enter college with prior programming experience, food touches the lives of every individual in every culture, and baking and cooking have shown to have value in providing an effective context for helping students develop scientific reasoning skills. The module, It’s All in The Mix, consisted of a set of integrated food-focused activities that exposed students to computational algorithmic thinking

(CAT) – the ability to design, implement, adapt, and assess algorithms. 100 African American female STEM majors who enrolled in the introductory CS course engaged with the module over a 16-week semester. The module began with introducing students to the concept of algorithms, their ambiguity, and as a tool for critical problem-solving. This initial introduction supported students to explore the idea that multiple algorithms can be designed to solve the same problem and that algorithms can be represented in multiple ways to solve multiple problems through different approaches.

Each semester students engaged in four different food-related activities as part of the "It's All in The Mix" module: "Peanut Butter & Jelly Challenge; Dessert Wars Challenge; Make My Dish; and Food-Related Video Game" (Rankin & Thomas, 2017, p. 116). While working on the "Peanut Butter & Jelly Challenge" in pairs, the authors found that students would often assume that making a peanut butter & jelly sandwich (pb&j) was common knowledge and did not give proper instructions to their partner to execute making a pb&j sandwich. This activity allowed students to understand the concept of algorithms and apply the characteristics of a well-defined algorithm in writing their algorithms. The authors used two more designs – "Dessert Wars" and "Make My Dish" – to further develop students' understanding of algorithm design and what it means to engage in computational ideas and practices.

Finally, Rankin & Thomas (2017) developed the "Creating a Food Related Video Game" challenge to help students apply the concepts and skills they had learned in the challenges to design a video game using Scratch, a block-based programming language. During this challenge, students worked in pairs to design and implement a video game centered on some aspect of food (like nutrition, diet, or sustainability). To transition African American women from consumers to

producers of technology, the results of this challenged revealed that students successfully engaged in all phases of the game design process, such as creating storyboards of gameplay scenarios, physical prototyping using arts and crafts materials, testing their prototypes to evaluate the design choices they had made, modify design specifications to accommodate any design changes, and lastly playtesting their games repeatedly with different teams.

This study highlights how the authors leveraged food to bring students' shared experiences across cultures and create a culturally and socially inclusive classroom environment in CS education. In addition, by anchoring student's experiences in Computational Algorithmic Thinking (CAT), the authors found that students developed a deep understanding of algorithms and algorithm design. Rankin & Thomas (2017) reported that the CAT approach in the first "It's All In the Mix" module led to a 100% retention in their course. This finding is important given that prior work has shown that the first programming project can lead women to have a lower self-efficacy, which can negatively influence their future performance when compared to men in the course (Lishinki, Yadav, & Enbody, 2016). Rankin & Thomas's work shows us that when culturally responsive pedagogies are effectively implemented in CS courses, students from disenfranchised communities who are more likely to have little programming experience are more likely to persist. In addition, it illustrates that culturally responsive computing can be implemented even at undergraduate CS courses that focus on more than just programming. While some efforts have been made to bring CRC into higher education, we know little about how CRC could be implemented in undergraduate CS courses and how it influences student outcomes. To bring CRC to undergraduate CS programs, we need to first understand faculty perspectives about CRC.

Hence, in this study, I seek to understand the perceptions of computer science faculty in adapting a culturally responsive computing approach in their teaching. I emphasize why and how CS faculty should have an ongoing awareness of how the intersection of race and gender unfold in their pedagogical practices. To help faculty embrace this intersectional approach, I urge them to pursue a culturally responsive computing approach in teaching their future CS courses. In doing so, I also focus on why there should be an ongoing emphasis in CS undergraduate education on developing projects and assignments around community-based issues that represent and connect with students from historically disenfranchised and marginalized communities. In addition, implications from this could inform how CS faculty could embrace and enact culturally responsive computing by emphasizing how gender, race, class, and sexuality co-shape pedagogical practices.

CHAPTER 3: METHODS

The purpose of this dissertation is to identify factors that influence CS faculty's intention to use CRC to teach introductory CS courses.

Exploratory Questions

This dissertation addresses the following research questions:

1. How do undergraduate CS faculty see the relevance of incorporating Culturally Responsive Computing (CRC) assignments in their CS courses?
2. What role do CS faculty consider they and the university play in supporting the persistence and retention of students from disenfranchised communities in undergraduate computer science degrees?

Method

This study utilized in-depth qualitative interviews to identify how CS faculty see the relevance of adapting Culturally Responsive Computing (CRC) pedagogy in teaching CS courses.

My Role as a Researcher

The intersection of my identities as an immigrant, woman of color, an international scholar, and a computer science engineer provides me a unique frame of reference to understand the relevance of utilizing a culturally responsive lens in teaching computing courses. Especially, my experiences as a faculty in a management school in India teaching computing courses (such as SQL and Database Management systems) make me a unique researcher to interview CS undergraduate faculty whose experiences although unique to the United States context align with

my own. My first encounter as a computing faculty in India teaching underprivileged Hindi-speaking Masters' students allowed me to understand the unique language barriers students face in understanding a westernized computing curriculum and how I had to switch to being an English teacher to help them understand the content. After moving to the United States, I realized similar challenges that historically disenfranchised students face in the United States to align with a curriculum that centers on white supremacist perspectives and excludes their voices, their communities, and their concerns. Through my practicum, I realized the overwhelmingly low participation rates of women in undergraduate computer science degrees are attributable to a lack of belonging with the curriculum and the heteronormative masculine culture of the computing field and their classrooms. My practicum interviews with two non-white women and the overwhelming population of white and international students of Asian origin made me question the very foundation of computer science programs. Why were we attracting only white males and Asian students into technological fields that will determine the future of tomorrow?

My inquiry led me to understand that the white heteronormative culture of computing is reflective of a systemic issue where institutions have developed computing degree programs that decenter the cultural and ethnic experiences of historically disenfranchised communities (Black, Latinx, and Indigenous) in the United States. Being a woman of color, I bring in my experiences of microaggressions, racial outcasting, and minoritizing through my presence and interactions with faculty in computer science academic spaces that are mostly white male-dominated. As a computer science engineer, I understand that sexist and racialized assumptions about technical ability and the interest of historically disenfranchised student groups are fallacious. I accept that historically disenfranchised student groups are at an economic and social disadvantage at receiving technical education due to the inequitable distribution of resources at the K-12 level.

However, I reject the fallacious assumption that undergraduate is too late to encourage historically disenfranchised students to learn, persist, and pursue a computing degree. As a teacher, I understood that pedagogical practices and instructional strategies of faculty are instrumental in bringing change in the way we teach computing to raced-gendered-ethnically diverse student groups. Hence, this led me to the selection of a culturally inclusive pedagogical lens that could inform how CS faculty's instruction is reflective of their perceptions on race, racism, and sexism in the United States and how their beliefs impact a continued dominance of white supremacist heteronormative ideologies prevalent in the CS curriculum.

My knowledge and experience around culturally responsive tools and pedagogies and my computer science teaching background allow me to understand the challenges CS faculty face in engaging and retaining students from diverse cultural and ethnic backgrounds. This is why leveraging my experiences helped me understand CS faculty thoughts on using culturally responsive computing as a tool to retain historically disenfranchised students in computing. I acknowledge that my biases as a liberal, immigrant, woman of color may prompt me to make gendered and racialized assumptions about my participants who were mostly male and white. So, I relied on reflexivity to expose my researcher bias through my reflective journaling (Creswell, 2014), and in my results, I provide "rich, thick description" of the participants and my findings with the intent of allowing readers to decide if the findings of this study can be transferred to a shared characteristic setting (Creswell, 2014). I relied on my knowledge and experiences of what it meant for computer science faculty to be culturally responsive in their pedagogical practice and on the expertise of undergraduate computer science faculty I interviewed.

Participant Selection

Criteria for Participant Selection. To obtain the most insight into the beliefs of computer science faculty on using culturally responsive computing in teaching CS courses, participants met the following criteria: (a) CS faculty held a Ph.D. in a Computing discipline (e.g., Computer Science, Information Systems, & Human-Computer Interaction) (b) Computer Science faculty had experience teaching computer science courses at the undergraduate level, (c) faculty who currently work in a postsecondary Computer Science department or program, and (d) CS faculty who were willing to dedicate 90-120 minutes for an interview to share their views on the use of culturally responsive pedagogies in CS undergraduate courses.

Participant Selection. In this study, I interviewed computer science faculty who had attained a Ph.D. degree in a Computing discipline (e.g., Computer Science, Electrical and Computer Engineering, Information Systems, and Human-Computer Interaction) and who taught in a Computer Science department at a college or university. I started my participant search by contacting CS faculty employed at Research-1 institutions and contacting faculty who were acquaintances of my advisor. In total, I contacted 100 computer science faculty from R-1 institutions and acquaintances of my advisor. I used the U.S. News computer science and engineering program rankings and contacted faculty from top-10 R-1 universities. These 10 universities were spread across the United States. Two contacts of my advisors who agreed to participate were faculty at teaching-focused institutions. Overall, I conducted a nationwide search to recruit participants for my study.

Data Saturation. The total number of participants was determined by data saturation, that is, data collection and analysis were carried out in tandem, and data was continued to be

collected until no new information or themes were observed in the data (Marshall, Cardon, Poddar, & Fontenot, 2013; Guest, Bunce, & Johnson, 2006). Therefore, I stopped my data collection at first eight respondents who fulfilled the requirements of the dissertation study and after which no new themes and codes appeared in the data, which is a reasonable sample size. The profiles of the eight participants are as indicated in Table 1.

Table 1

Profiles of Participants

Pseudonym	**Ethnicity**	**Gender**	**Level**	**Current Role**	**Institution**
Alan	Caucasian	Male	Associate	Tenure track	Teaching-focused
Liu	Chinese American	Female	Full	Tenure track	Teaching-focused
Paul	Caucasian	Male	Associate	Teaching track	Research-focused
Beth	Caucasian	Female	Assistant	Teaching track	Research-focused
John	Caucasian	Male	Assistant	Teaching track	Research-focused
Ivan	Croatian South Slavic	Male	Assistant	Tenure track	Research-focused
Juan	Mexican	Male	Associate	Teaching track	Research-focused
Noor	Indian	Female	Full	Teaching track	Research-focused

Compensation. Upon completion of the interviews, each participant received a $50 Amazon gift card for their participation in the study. I received the Dissertation Completion Fellowship from Michigan State University to fund my dissertation data collection, analysis, and writing.

Data Collection Methods

This study used a semi-structured interview protocol to understand faculty notions on the use of CRC in their future CS classrooms.

Interview measures. I asked participants to describe their educational and teaching timelines in U.S. Computer Science Education, from their undergraduate degrees to being a faculty, as if they were life chapters in a book or a novel. During the interview, participants reflected on two vignettes describing scenarios where a hypothetical situation illustrated how CS faculty can use CRC in their classroom (Appendix A). These scenarios were sent to the participants a week before the interview. In addition to these scenarios, participants also shared their views and understanding of culturally responsive computing and its relevance or lack thereof in teaching computer science courses. Furthermore, the interviews attempted to delve into faculty's perceptions on equity and diversity in computer science education and if they thought CRC could provide more equitable opportunities to students from disenfranchised groups.

The first scenario was based on an assignment developed collaboratively by two CS faculty at Harvey Mudd College. The goal of this assignment was for students to use C++ to generate their unique embroidery patterns and patches using an embroidery machine. The students were also provided readings at the end of this assignment; however, there were no questions or grades related to the readings. To help understand, faculty's beliefs on the use of such an assignment in a CS course they teach, I asked them 5 questions (Appendix A).

The second scenario was based on an assignment developed by me based on my experience as a critical computer science teacher educator having taught coding and computer

science courses in India and my understanding of how culturally responsive assignments can be designed and developed for a CS course. The professor in this hypothetical scenario was a Hispanic female computer science faculty teaching a web application development course. The goal of the assignment was for students to design a web-development tool that would allow residents to find clean drinkable water nearby and see where the water in their community was contaminated.

In addition to these scenarios, I defined and explained culturally responsive computing for participants briefly and asked them eight questions broadly related to implementing and using culturally responsive computing in their courses, how they could better support historically disenfranchised students and women in their universities/colleges, what teaching approaches other than culturally responsive computing can be used in retaining student interest and including their cultural experiences in CS courses, what resources existed at their university to integrate equitable teaching practices in their courses, and what role do pedagogical practices play in increasing diversity and equity in undergraduate computer science programs.

Interviews. Utilizing an intersectional and culturally responsive perspective to govern my knowledge validation process (that is, based on my experiences and knowledge on issues of diversity, equity, and inclusion in computing and culturally responsive pedagogy), I engaged directly with participants in online interviews. I accepted their stories as concrete evidence and employed ethics of caring and personal accountability to maintain their anonymity through the usage of pseudonyms. The interviews also entailed participants sharing their perspectives and experiences that I used to capture participants' responses to questions that were not directly a part of the interview questions (Atkinson, 2002).

Researcher reflective journal. Throughout the study, I used my journal to expose any potential biases, based on my experiences on issues of equity and diversity in U.S. Computing Education (Creswell, 2014). To refrain from imposing my opinions and biases onto the responses of my participants, I found it important to acknowledge my personal biases and preconceived notions about gender and cultural equity and diversity. I did not want my personal biases to distort or convolute participants' voices in any way (McAdams, 2001). I also used my journaling to capture observational notes during interviews, which were critical to providing rich detailed descriptions about the interview settings and participants' unspoken questions (DeWalt & DeWalt, 2011). I also used my journal as an audit trail throughout the study to capture various research activities (e.g., data collection, data analysis, interpretation, decision-making processes, and reflections) (Merriam & Tisdell, 2015).

Procedure

I contacted each participant to schedule a time for a 90–120-minute online interview over zoom with each. Participants emailed me a signed copy of a consent form before the interview that I had emailed them beforehand. I began the interview by first asking participants for permission to videotape our interviews. I conducted the interviews for 2 ½ months primarily during the Spring 2021 semester.

Recruitment strategy. I sent a recruitment email to individual professors, in Computer Science departments in Research – 1 institutions and top-ranking computer science programs across the United States. I also sent emails to identified contacts and acquaintances through my advisor. Within four days, I received responses from three participants and took the next month

to identify the remaining 5 participants through the same process (Sadler, Lee, Lim, & Fullerton, 2010).

Data Analysis

I simultaneously collected and co-analyzed the date elements of participants. I conducted a thematic analysis to organize the participants' responses into themes. Using the qualitative data analysis software MaxQDA, I coded the participants' responses into themes. Through thematic analysis and the clarification of emergent themes, I identified participants' collective standpoint about the use of a culturally responsive computing approach in teaching future CS courses.

Thematic Analysis. To identify, analyze, and summarize themes, I followed Braun and Clark's (2006) six-step process for thematic analysis. First, I familiarized myself with participants' data elements (interviews) through listening to interview video files and reading transcribed interviews. I used MaxQDA, a qualitative data analysis software, to load the data for ease of accessibility during the analysis process. Second, I created a list of codes (Table 2), which were derived from the interview protocols and research questions, and load them with MaxQDA. Third, I followed an inductive approach to code data, and I performed Open Coding (Saldana, 2012) (i.e., developing codes while reading the data elements) as needed. Additionally, as I read the interview transcripts, I highlighted keywords that represented the central focus of the exploratory questions. Fourth, I reviewed and refined my list of codes as needed. Fifth, I identified high-level themes by collapsing codes. Finally, I produced a report of emergent themes by exploratory questions to reflect my participant's responses.

Trustworthiness

The central purpose of this study was to magnify the CS faculty's intentions to adapt a culturally responsive computing approach in teaching CS courses. In doing so, faculty discussed their experiences teaching historically disenfranchised students and their views on the role gender and race play in the experiences of women and men of color and their persistence in their degrees. Hence, I incorporated reflexivity to ensure the trustworthiness of my results. I also used rich, thick data descriptions to describe my participants and my findings.

Reflexivity. As a researcher and the primary instrument, and as a liberal woman of color, I exposed my researcher's biases in my researcher's reflective journal (Creswell, 2014). Since reflexivity is a core characteristic of qualitative research (Creswell, 2014), I believed it was essential for me to reflect on how my previous experience in Computing Education and as an information technology lecturer shaped my interpretation of the findings, which I incorporated in the construction of the themes based on participant accounts.

Rich and thick description. I also used my journal to capture rich and thick descriptions of participants' nonverbal cues and the interview settings. I found it quite useful to capture an audit trail of my key experiences and research activities throughout the day. Collectively these methods helped me ensure the trustworthiness of my study (Creswell, 2014).

CHAPTER 4: DISCOVERIES

Introduction

My purpose in this qualitative study was to explore the beliefs of computer science faculty in using culturally responsive pedagogies in their courses with a particular focus on understanding their approach to teaching students from historically disenfranchised communities in the United States (African American, Hispanic, and Indigenous).

Exploratory questions. I constructed the following exploratory research questions to guide this study.

1. How do undergraduate CS faculty see the relevance of incorporating Culturally Responsive Computing (CRC) assignments in their CS courses?
2. What role do CS faculty consider they play in supporting the persistence and retention of students from disenfranchised communities in undergraduate computer science degrees?

Participant Educational and Career Trajectories

During the interview, I recorded participants' backgrounds and teaching approaches in CS. Specifically, I asked participants about their major education and career milestones, from undergraduate education to graduate school to become an assistant/associate/teaching/full professor of computer science at their present universities. In addition, participants also described their pedagogical practice in teaching CS courses. Below, I provide background on each of the participants in detail.

Alan. Alan is a Computer Science faculty at a predominantly white institution in the Southeastern United States. Alan's pedagogy is dictated by the unique design of the introduction

to programming (CS1) course offered at his university. The course spans across a year and revolves around introducing students with little to no coding experience to different research areas within computing. Students also create a prototype of a product using algorithms, C++, and Java that they learn during the course. Alan suggests this course helps students develop professional skills that help them succeed in advanced-level courses and internships.

Liu. Liu is a Computer Science faculty at a predominantly white private college in the Western United States. Liu is aware of her unique position as a woman and person of color in computer science. Having been at a liberal arts college, Liu's pedagogical approach entails using Process Oriented, Guided Inquiry Learning (POGIL) activities for teaching introductory level CS courses. Her classes are usually small which is rare in a computer science programming course at large research or teaching institutions.

Paul. Paul is a Computer Science faculty at a large land-grant public university serving a large population of students from historically disenfranchised communities in the Midwestern United States. Paul was first introduced to programming in high school. His unique position designing teaching practices to improve the pedagogical practices of faculty drew his interest towards the professional development of faculty. He presently heads a professional development initiative to help engineering faculty improve their instructional practices.

Beth. Beth is a Computer Science faculty at a Northeastern state in the United States. Beth's teaching journey began as a high school computer science. Her career path was unique as she began teaching high school computer science right after her bachelor's and pursued her master's degree as part of her teaching certification.

John. John is a Computer Science teaching faculty at a large land-grant public university serving a large population of students from historically disenfranchised communities in the Midwestern United States. John's teaching career trajectory entailed being an instructor of record of a programming language course for 10 years during his Ph.D. program.

Ivan. Ivan is a Computer Science faculty at a large predominantly white public research university in the Midwestern United States. Ivan's pedagogical practice is governed by his Ph.D. research focus on understanding human computer interaction. His own experiences in computer science shaped his compassionate view of student's financial and academic struggles that are unique to entering the elitist field of computer science.

Juan. Juan is a Computer Science teaching faculty at a public pre-dominantly white land-grant research university in the Midwestern United States. Juan's vast teaching experience entails teaching both electrical engineering and computer science courses. His pedagogical approach entails using active and collaborative learning techniques that have been shaped by his experience as a lecturer and a teaching faculty in computer science.

Noor. Noor currently serves as a Computer Science teaching faculty at a predominantly white university in the Northeastern United States. Noor began her teaching journey teaching high school programming. Her education and career took her across the world from Southeast Asia to Europe to the United States. Noor prefers humanizing herself by sharing her diverse educational and career journey with her students and connects most with international students from across the globe due to her diverse cultural experiences. Her education and career trajectories were filled with challenges from being an immigrant on numerous foreign lands to

being a woman of color in academia which can be particularly challenging in engineering and CS where the field is still majority male and white.

Emergent Themes

During the interview, participants described their views on how the two scenarios that were based on tackling community-based issues and leveraging community knowledge into CS courses would play out in the courses they teach. CS faculty participants also responded to questions on how a CRC pedagogy could allow them to draw upon student interests and cultural backgrounds, institutional resources that exist for CS faculty to integrate equitable teaching practices in their courses, pedagogical practices, and instructional strategies used by faculty to make their courses equitable, and how faculty support historically disenfranchised students and women in their courses. The first four emergent themes, pedagogical approaches to CRC, student voice and empathy, barriers and support for CRC, and professional development for faculty in critical pedagogies, addresses Research Question 1. Participants' responses to the scenarios provided insight into Research Question 1 as the scenarios helped faculty reflect on the relevance of incorporating Culturally Responsive Computing (CRC) assignments in CS courses. The next two themes, pedagogical approaches to support historically disenfranchised students and humanize students and recognize their existence, address Research Question 2 and helps in understanding how faculty can assist historically disenfranchised students in their retention and persistence in CS degrees. During the thematic analysis, I discovered that participants' views could be categorized into six overarching themes – 1) Pedagogical approaches to support historically disenfranchised students, 2) Humanize students and recognize their existence, 3) Pedagogical approaches to CRC, 4) Student voice and empathy, 5). Barriers and support for

CRC, and 6) Professional Development for faculty in critical pedagogies. Table 2 below illustrates how each research question connects to emergent themes and sub-themes.

Table 2

Summary of Emergent Themes

Exploratory Questions	Themes	Sub-Themes
1. How do undergraduate CS faculty see the relevance of incorporating Culturally Responsive Computing (CRC) assignments in their CS courses?	1. Pedagogical Approaches to CRC.	1.1 Integrating CRC is sustainable when courses are graded, elective, & with departmental support. 1.2 Providing student choice, autonomy, & listening to students is important. 1.3 Interdepartmental collaboration helps students see CS as interdisciplinary. 1.4 Students value & understand the societal impact of computing and its connection to diversity.
	2. Student Voice and Empathy.	2.1 Validate student's experiences and raise awareness in others. 2.2 Faculty displays empathy and awareness of minoritized students' educational struggles.
	3. Barriers and Support for CRC.	3.1 Requires time, effort, training, and being vulnerable by faculty. 3.2 Faculty fear essentializing, harming, and tokenizing historically disenfranchised students and being biased and political. 3.3 Faculty face institutional barriers like justifying time and interest in CRC. 3.4 Equity-focused institution-wide programs drive faculty to address racial and gender representation. 3.5 Faculty were unsure how to directly work with community partners without burdening them. 3.6 CS2/higher-level courses too late to work on student retention.
	4. Going beyond professional development for faculty.	4.1 Neutrality in curriculum design & support for historically disenfranchised students. 4.2 Appealing to females or only a few students who are interested in embroidery.

Table 2 (cont'd)

What role does CS faculty consider they play in supporting the persistence and retention of students from disenfranchised communities in undergraduate computer science degrees?	1. Pedagogical approaches to support historically disenfranchised students.	1.1 Expand student's worldview through cultural understanding & acceptance. 1.2 Allow students to connect to non-CS folks & share the tangible output. 1.3 Important students gain knowledge on the history & legacy of computing. 1.4 Pedagogy plays an integral role in making students feel a sense of belonging. 1.5 Faculty support for historically disenfranchised students. Interest, belonging, & engagement are tied to seeing the real-world and societal impact, the value of coding, & creating tangible output.
	2. Humanize students & recognize their existence	2.1 Humanizing historically disenfranchised students. 2.2 Traditional assignments are not motivating & dated for historically disenfranchised students 1.6 Faculty support historically disenfranchised students by showing examples of successful role models in tech & non-tech fields.

Pedagogical Approaches to CRC. This theme and its sub-theme illuminate how faculty can be supported in integrating CRC in their courses. Faculty indicated the importance of departmental support, providing students autonomy and choice, interdepartmental collaboration, and helping students understand the social impact and use of their computing skills as integral to sustainably use CRC in CS courses.

Integrating CRC is sustainable when courses are graded, elective, & with departmental support. Participants opined that a CRC curriculum can be sustainable if the assignments are graded, assignments are added to elective courses, and only when the department provides needed support to include culturally responsive assignments in their courses. Alan disclosed that CRC assignments are not sustainable in CS core courses as they take up a lot of class time, hence they should be part of elective courses.

> If you're giving up a lot of class time for sustaining this type of bigger project, then it's easier to do it in an elective course than in a required course where you know the department's counting on you to cover certain things so that they know what is required in the next course. So, I look at these scenarios. So, the first scenario where it's like, oh man, this is CS2, there's a lot hanging in the balance here. And so it's risky right. And the web development courses, most likely an elective and so you can do whatever you want.

Juan revealed the need for teaching assistants (TA's) to be assigned to a course that can make culturally responsive assignments sustainable. He indicated the need for unwavering financial support from CS departments to make it possible to pay the TA's and ensure that the course carriers over through each semester. He also stressed the significance of CRC assignments to be graded to make them sustainable.

> Yeah, in the case of professors, for example, they are not supported during the summer. So, they somehow need to find resources to support themselves during the summer. They need money. So somehow the universities have to put some money available for these types of things. And not only money for the salary of the professors but yeah there are resources in here that are needed for the student. For example, where are you going to host the application, tools that may be needed. Things like that. And yeah, usually the professor will also need a graduate student who can be involved. And the graduate student needs to pay for the tuition, needs to pay for salary as well. So, some of the money will go there as well. At the end of everything you need some money for this kind of projects.
>
> What can be done in that way is the professor has projects like this one. And then say students I have these projects, if you're interested, let me know or sign-up here. And then well basically at that case the students will get a credit for what they do, that is a good thing. So, they are going to be motivated to actually do a good work, do a good job. A graduate TA is assigned to the course because the students are paying tuition for that. And the graduate TA is going to help them. And then there is going to be a professor who

> is actually going to make sure that things are done. So maybe that would be the best way of doing it.

Liu expressed the need for CRC assignments to be graded so that students value their significance in the course. Furthermore, she suggested that graded assignments are more likely to be carried over from one semester to the next by faculty who teach the course.

> So, I mentioned earlier, the algorithm of the string searching assignment, which was an assignment about algorithms, where he brought in some other culture about names. So yes, I think you can [bring in community-resources in an algorithms course]. But it goes back to the question I have about is anything graded. Is there anything assigned assessed? That second scenario we never actually got to that question of what guarantees the students paid attention when the African American faculty member showed up. What guaranteed that they were going to pay attention when the other, the Culligan Water testing people showed up. And if sadly, I do. I feel like if it's not part of the assignment, but it's given as an optional reading like the embroidery, students don't value it because they know they're not being graded. So, I think it is very easy to add to any CS course, some community-based resources that are not graded in any way whatsoever. But if you were to give it, make it part of the graded assignment, it becomes harder to do that [for students to not value the assignment]. And, but, unfortunately, that's the way this.

Lui also suggested her apprehension in including readings in CRC assignments that do not help students learn any computing concepts.

> And are they going to read that extra assignment? Are they going to show up to the class where there's someone's going to speak to them about something that does not from their point of view, help them complete the assignment? I'm not sure that they will.

For Beth, CS clubs seem to present an ideal space for implementing CRC assignments. She suggested that the departmental procedures in their university present challenges in making changes in the curriculum within a short period. She noted this as the reason why CS faculty push community partners towards CS or coding clubs that work on helping community partners and solving community issues.

> When people come to us with these cool ideas, we usually push them towards like real code clubs and stuff like that were like a department could come to a meeting of the club and say, hey, can you guys make this website and then some group of students will be like, yeah, that would be cool. And we'll do it, but it's harder to get those things in the actual academic curriculum.

Through Juan's views, this sub-theme reflects that departmental support is integral for faculty to design assignments that leverage community-based resources. As reflected in the responses of five faculty participants, CS faculty seem apprehensive in including ungraded assignments in their course and including it in first-year courses as they fear facing institutional barriers like no financial assistance for their TA's (Juan), students missing out on covering required course work (Alan), the unsustainability of ungraded assignments (Liu), and challenges in sustaining CRC assignments (Juan) when another faculty takes on the course they teach. This sub-theme reflected that faculty were apprehensive in implementing CRC assignments in entry-level courses and more open to adopting them in elective courses, clubs, and summer internships projects as they felt that would deviate them from covering required coding concepts.

Provide students choice, autonomy, & listen to them. This sub-theme illustrates the necessity to include student voice in the development of a culturally responsive curriculum in CS. Student autonomy and student's voice emerged as a prominent theme throughout the responses of participants. Beth in discussing one of the assignments she implemented during her career as a K12 computer science teacher, stated the significance of providing students autonomy and choice when leveraging community-based and cultural resources into CS courses.

> I think choice is important when you do that. Unless you're going to have a comprehensive set where you're going to address a lot of cultures and you're going to make sure that you hit them all in your course which I think would be very difficult to do. I think voice is really important. So, when the courses that I taught [in her career as a K12 CS teacher] it was possible for somebody to go through everything only doing American Indian stuff. It was possible they could do that. They could also go through doing only African American stuff now. But I think most students did pick and choose and they would do something from their own culture and then the next time they would explore a different culture. I think that was useful. It was good. Then, in that case, I think the choice worked out well for individual students.

Juan reiterated the importance of student autonomy in choosing projects they wish to undertake.

> If the professor is in charge of that course, the professor is always looking for projects for the students to do. And very often they just leave the students to choose their projects. I also think that is a good thing, right.

Ivan expressed why he provides his students with quality assignments that teach CS concepts but have less homework and assignments to finish. He believed that this approach has helped his students understand complex ideas while not putting a lot of stress on them.

> So again, I tend to create assignments, similar to this in some ways that will work that will show something right. But I don't have this insistence on them doing an insane amount of work, because I don't think it aids in learning. I think small bits or bytes even, excuse the pun, can help in this kind of approach to the point where really at the end of the assignment. The last assignment is implementing a very complex model of visual search. Again, with most of the code given to them. But through that understanding of what are the small pieces that they need to add is where I'm trying to get them to better understand not just the programming parts but also the conceptual parts.

Overall, four faculty stressed that student autonomy and choice are integral when leveraging community-based resources to design CRC assignments. This sub-theme resonates with the value of liberating students from the burden of completing big projects and having them work on small assignments.

Interdepartmental collaboration helps students see CS as interdisciplinary. This sub-theme reflects the significant role of interdepartmental collaboration in allowing students to value the use of their skills across fields. Liu's response stressed that in smaller institutions interdepartmental teaching is more likely to occur as faculty are more connected due to their departments being closer together physically. She mentioned that in interdepartmental collaborative teaching both the faculty members should receive credit for their work.

> I think that happens more at a college like mine than others. So, when I was at an R1 institution, and it seemed like there were more silos. People knew only the faculty in their

> department. And now I think it's different at a smaller college. We don't even have a hallway. It's just computer science faculty are all over the same building. And actually, multiple buildings and we're next door to other faculty and other departments and so I think there's a lot more of that at small colleges. There's a lot of co-teaching. So, there's a lot of teaching in where a geology professor is teaching with a communications professor is teaching a course on history. Or science and power and things like that. And so, yes it happens all the time. Whether it happens when it's not required that happens less right so. Certainly, people are reaching across disciplines talking to other faculty having teaching classes together. So yes, I would say it happens a lot formally, yes. But less so informally, because we are careful not to ask too much of people who are not going to get credit for it.

Liu also suggested that faculty need to help students create connections of computing concepts with their interest and to the courses they take in other departments like geology or social sciences.

> I think I mean, it's still culturally responsive, but connecting to other fields, they're interested in. Right, so obviously what we've been talking about has been connecting to students' interest before they ever stepped into college. So, then also connecting to what they're learning in the other classes, what their intended major would be right. So double major students who have I mean I know not that many CS majors might be double majors, but they might have other classes they're taking. It could even be connecting to other computer science classes, but just drawing those connections so students can see why it matters. I mean, I think that's really what it's about. Right, just showing students, why the content we are teaching them right now matters.

Paul stressed the value of interdepartmental collaboration at his university that allowed him to grapple with the use of computing skills in various fields like agriculture, education, and music.

> So, I think, you know, bringing in this stuff makes a lot of sense from a lot of perspectives. I think some of the fun parts about being in a CS department is like, my department has a lot of CS plus degrees. CS plus music, CS plus education, CS plus agriculture. And it's always just like, to me, it's fascinating to find out that's how they use CS in this field that I never thought of using it and the ways that computer science can help. Like, help people wrestle with difficult maybe even intractable problems. And I think it helps like there are so many things. I would never have guessed that would be what you would use that for and so I think what's probably been fun. I think to see all the ways that every discipline can have some type of touch point with computing.

Within this sub-theme, six faculty participants valued the interdepartmental application of CS skills and were open to collaborating with faculty across departments to help students understand the use of their computing skills across varying fields. It echoes that persistence of students in CS is connected to understanding the interdisciplinary implementation of their coding skills which can be achieved by faculty by creating interdepartmental connections and co-teaching with faculty from other departments.

Students value & understand the societal impact of computing and its connection to diversity. This sub-theme illustrates how the persistence of students beyond their first years is linked to understanding the value computing can have in helping address societal and diversity issues. Ivan revealed why understanding how computing "fits into our society" can help students value its interconnectedness to assist community folks in addressing some of their issues.

> Make it so that they put three lines in. But give them exposure to things that are important at the entry-level. It's important to get a broader picture of what and how computer science and programming fit into our society. What value do they provide, if any? And what is its role? And what are the times when it shouldn't play a role?

He further stressed the value of exposing students to a diversity of topics to get them to evaluate the impact of computing on society.

> I also agree to try to find you know what's to broaden the diversity of topics that we discuss. Or that we think parallels with from society and then talk about the impact of technology on it is very important.

Paul indicated the significance of providing assignments that could help students link their interest and find how their interest connects to working with community folks to help address issues using their computing skills. Paul suggested that this helps students persist in their degrees as they begin to understand the value of their computing skills. He also indicated the

importance of teaching students to understand how data and algorithms can create bias depending on where it comes from and who creates it.

> To provide different terms of motivation. Hopefully. And ideally, it helps students who normally wouldn't see computing as a field of interest them, see it as a field of interest for them. I would hope it would start changing our culture to include this idea of I want to do computing because I want to help people. Yeah, I don't think we get to why do we teach algorithms as identity. Identity lists or valueless entities. Algorithms and particularly what data we feed to our algorithms matter and impact humans. Yes, I hope it could, in the long run, if implemented, broadly could create some cultural shifts in what we teach and why we teach it. I'm hopefully also better at computer science, I think, as I said earlier, like sometimes we make bad decisions. Just because we think data, data is without thinking about where that data is coming from and why, why does it matter. And yeah.

Liu illustrated how the entry-level CS course (CS1) that she teaches has integrated discussions on algorithmic bias to help students understand the connection between computing and diversity.

> In the last year, we've created assignments in our CS1 class where we've been talking about algorithmic bias and we've been having them think about diversity and why it's important. And that's been useful. The discussions are hard. We put them in breakout rooms, and we cross our fingers because there have been some awful discussions. You can't control what comes out of students' mouths. And of course, I use active learning and put students in groups and collaborative learning, which I think helps some of them.

As reflected through the responses of six faculty participants students must understand the impact of their computing skills on society which on one hand can help solve local and global issues and on the other can also have devastating effects. This sub-theme suggested that students who will be professionals in the field need to understand the origin of data and algorithms, who creates algorithms, and how algorithmic bias impacts historically disenfranchised communities.

Student voice and empathy. This theme represents participant's perspectives on the value of incorporating student input and voice when designing culturally responsive courses and

curriculum. It illustrates that historically disenfranchised students should be involved in developing a culturally responsive curriculum, as their voices will offer culturally diverse perspectives by drawing from their cultural capital. Below, I provide sub-themes and quotes from participants, along with interpretations, aligned directly with this theme.

Validate student's experiences and raise awareness in others. This sub-theme illustrates how faculty considered a CRC assignment could contribute to acknowledging the lived experiences of minoritized student populations while sensitizing their privileged peers to the contributions made by people of color in computer science. The faculty further indicated that assignments that introduce students to local community-based issues could raise awareness among the dominant student groups on the challenges people of color and students from low-SES backgrounds face in their daily lives. In his account, Ivan when asked about the feasibility of implementing CRC assignments in scenarios 1 & 2 in a CS course suggested that,

> Overall, I think that the intent of the assignment was also interesting and has potential. It's also very, very nice that it has a lot of examples that perhaps are more inclusive about people from different stakeholder groups and how they contribute to computer science. I think that's fairly important, not just for underrepresented groups who may want to be a part of computer science rightfully so, but also for the broader audience that needs to be sensitized to the contributions that people from various backgrounds made to computer science, despite perhaps even coming from, you know, backgrounds, that made it difficult to do so.

Alan, on the other hand, indicated the value of CRC assignments to validate the experiences of students from disenfranchised communities and raising awareness in dominant students groups to be informed on societal issues that impact communities of color. Alan suggested CRC assignments can motivate students to be informed software designers who develop culturally responsive and socially aware applications that cater to a broader audience than white males.

> It just validates other people's experiences, and it recognizes like it raises awareness of the world that people don't see. And in fact, there's a call for them to go and address like go and change this world too. I mean, don't just go to Silicon Valley and make up a whole bunch of apps that are going to appeal to the 20-year-old single white male. Like, I don't know how many good apps in the app store cater to that audience. Like, go build something that's going to help other people too. And so, I think the more opportunities there are for students as they're going through the university to sort of just be like, Oh, that's right. That I mean, maybe that's going to open some people's eyes and ultimately have a broader impact on society.

In Liu's response to Scenario 2, she stressed that students feel recognized and "heard" when faculty implement assignments around culturally responsive issues that are relatable to students' experiences and backgrounds. She also suggested that including CRC assignments also raises awareness in Asian and White students, who are a majority in technological fields, on issues that impact communities of color and hence their peers of color.

> We hope that it's going to help at two levels. It helps retain the students and it helps retain them in the future in the industry if we educate the other students in the classroom, who are going to be in the majority. Right, so the black students in this classroom that Professor Garcia's teaching are feeling heard right. But also, the white students, the Asian students are hearing here are the facts and it is an issue. And they're being reminded that they have to think about issues beyond what they know when they're thinking about technology. I think that's also going to help in the long run with the tech community that's my hope. I don't think there's research-based showing any of that. But that's what we're hoping for.

Five faculty participants echoed similar views on how CRC assignments and projects, can urge dominant student groups to understand the context of communities of color and acknowledges the experiences and knowledge of peers amongst them from historically disenfranchised communities. CRC assignments can provide opportunities to historically disenfranchised students to connect to the field and make them feel welcome, understood, and accepted in CS courses where the dominant rhetoric and pedagogy is white and western.

Faculty displays empathy and awareness of minoritized students' educational struggles. This sub-theme illustrates that faculty possessed an awareness of the struggles of

historically disenfranchised student groups and attempt to find ways to support them. Beth suggested that even though her university is in a historically black neighborhood and provides financial support systems to help students succeed, many students struggle to make ends meet and the dropout rate of such students in CS is highest at their university in the first two years.

> There aren't a lot of role models of color for people. So, I think there's already a little bit of an uphill battle when you have a student of color in your classroom. It is sort of like alright you've already pushed back past few obstacles to be here. Like you've already, you know, kind of stood up at a time when maybe it wasn't your way that it wasn't all that easy.
> And so because of that people are willing to go through a lot right through expensive education to know that they're going to have a job, their choice of job offers even. But getting through those first couple of years is hard and even like we have a lot of programs in place to help people, but they don't kick in until your third year. So those first two years there's like no financial support. And for a lot of these students, it's a really heavy lift intellectually to go from zero to 60 right in one year to be able to survive their sophomore year.

Alan underscored the significance of faculty moving beyond academic support towards humanizing students and their needs. He reiterated Beth's views that it is alright to provide students with additional support to help them succeed but creating a separate assignment for students who are struggling may discourage them to persist as they feel othered.

> But I think being willing as an instructor to be aware of students needs and situations outside of just their homework record that would allow them to know that you see them as a human being…The differences, you have to enable them to rise to that level of performance and you know if it means giving someone a couple of extra days or giving someone a little bit of extra help, like one on one, but so be it. But never send the message that you know this is enough. This is your version, and this is everyone else's version. Right, because that's just wrong on so many levels.

Ivan displayed a deep understanding of students' emotional, financial, and family needs suggesting that students are overburdened with finishing their course load with the added pressure of passing courses with perfect grades. He suggested that CS faculty need to re-evaluate their learning goals, assignments, workload, and assessments if they want to see historically minoritized students persist in computing.

> Right, so those are the kinds of things being able to provide the support being able to reflect on what are we asking from students in terms of, let's say, a weekly schedule from a regular student. Are we allowing, and this is hypothetical now, but a single parent, would a single parent be able to take classes and complete the required work from all of the courses? And whether it is necessary to drag them through the amount of work that we put them through just to learn or to test whether they're learning?

All eight participants responses echoed that faculty need to be mindful of understanding the challenges faced by historically disenfranchised students over their privileged counterparts, re-think workload that does not disrupt their persistence in the field, and actively play a role in encouraging historically disenfranchised students to persist by directing them to resources that may help.

Barriers and Support for CRC. This theme illustrates the institutional obligations, requirements, and hence ramifications of using a CRC approach that prevent faculty from spending the effort and time required in creating culturally responsive assignments. Few of the faculty seemed wary of essentializing the experiences of historically disenfranchised students and harming and tokenizing historically disenfranchised students and their cultural experiences. Overall, this theme suggests that institutional support in the form of providing tenure incentives to faculty who use culturally inclusive pedagogical approach and lessening the expectations of attaining tenure that overburden faculty in adapting culturally responsive approaches to teach CS course is essential.

Requires time, effort, training, and being vulnerable by faculty. All the participants resounded that applying a CRC approach in their classrooms requires much effort and time from the faculty and being vulnerable in front of students as faculty may not necessarily understand the racial context and issues historically disenfranchised students have faced. Alan echoed that added expectations from faculty can cause faculty burnout and often impact the intentions of

faculty to use culturally responsive pedagogies in their classrooms as they require time, effort and are not supported by institutions.

> But I mean I, so I have tried things like this. And I know others have. It takes a tremendous amount of effort to bring those other resources into the classroom and I would applaud that and celebrate that…But the biggest challenge has to be it's a lot more work than just do question 13 from the book, you know. And there may or may not be a clear cut solution…Right, what happens it can be really beautiful right and be memorable and high impact. But yeah, I can't imagine doing that sort of thing in every class every semester, I think I would just burnout. But it's a vision to strive for. And I think it should be valued and you know incentivized and taken into consideration for promotion and you know, things like that.

Ivan who works at an R1 institution reiterated Alan's views on time and incentive that CS faculty do not receive to create culturally responsive materials for their courses.

> But the biggest barrier, again, is that we do not get proper time to create these kinds of materials to teach. Once you teach it for three times, four times, maybe five times. That's it. That's the only time when you finally have something that you can even be proud of or think that works.

Liu suggested that CS faculty do not receive any professional training in applying teaching or in applying learning theories to their teaching. So, asking them to teach themselves about pedagogical approaches that create explicit culturally appropriate and historically mindful curricular spaces for Black, Latinx, & Indigenous students is quite far-fetched.

> So, this is one of the challenges is that all of those people who are trying to do this [create culturally responsive assignments], have no training in this. We're computer science professors who were taught how to program we're taught nothing about teaching and we're taught nothing about the social sciences that we're trying to get at with many of these ideas.

Noor elaborated further on the kind of pressure, stress, and education that is required of CS faculty to teach and integrate culturally responsive assignments.

> Swati, there's a difference between a computer science education researcher person doing this and a faculty whether tenured or non-tenured trying to do this. Because then, if it is the second you know segment of faculty then that would be quite difficult. Right, they must be aware of the literature. Aware of how to bring this pedagogically into the classroom and that's really expecting too much from someone who doesn't have this kind

> of background… So, I think for the general faculty member at any college in the United States who is not into computer science education research, this is really a tall order. And the time, the effort to educate yourself about all of this is significant.

All faculty indicated that they lack the time, effort, and proper training to develop and teach CRC curriculum. These barriers in addition to the obligations of being a tenure-track professor may prevent faculty from integrating CRC assignments into their courses.

Faculty fear essentializing, harming, and tokenizing historically disenfranchised students and being biased and political. Faculty were wary of being too political in implementing assignments that connect to social issues. They also feared essentializing the experiences of historically disenfranchised students and harming them emotionally or psychologically hence impacting their persistence in CS. Alan opined his openness to learn from his historically disenfranchised students but feared essentializing the experiences of historically disenfranchised student groups and including a CRC assignment to just "check a diversity box".

> One thing I worry about doing something like an embroidery assignment or a water quality assignment is I recognize that this is not my life experience. And so, I don't want to project myself. I mean, I want to be empathetic, and I want to invite students to teach me right. Or share with me their experiences and learning together, but I don't want to portray myself as checking a box. Like checking a diversity box and I worry about doing that either consciously or unconsciously what when adopting these sorts of things.

Juan stated the political implications of creating assignments based on social issues that can make the dominant student groups uncomfortable. Juan's views reiterate the institutional pressure that CS faculty face while also suggesting that some faculty are more open to adapting CRC in teaching CS courses than others.

> However, you have to be careful here. For example, you informed students that the water is contaminated in their community has many implications. Right now, there can be political implications and there can be implications that have an impact in the university. So, you have to be careful. Right. However, in the scenario they said whether the water is contaminated in their community. I would rephrase it in different way, if the water is safe

> to drink right or the degree of contamination of the water in the community. But, yeah, I think that that would be a good project [Scenario 2 assignment].

Paul asserted his lack of understanding of cultural and social issues prevents him from implementing culturally responsive assignments. Additionally, he suggested that the possibility of harming historically disenfranchised students makes him uneasy to create and implement such assignments.

> And that's the part where I will say, I'm like, I applaud people who were able to do this and do this well. I have lots of colleagues who do it really well and I'm always like, that sounds exhausting. So, I could see myself picking up something like the embroidery one easily. But coming up with these types of ideas intimidates me quite a lot. And make me feel like gosh that's a really high bar. And to really be like because of my own lack of understanding of this and I have to be honest with myself maybe I'm using this as an excuse. But like I know that this can be done very poorly and cause actual harm if not thought out really well. And that just paralyzes me.

Responses of five faculty participants signaled their apprehension towards tokenizing, essentializing, and harming historically disenfranchised students as they teach and integrate culturally inclusive assignments in their course. Designing assignments that brought up political issue seemed to concern Juan the most. Faculty's apprehension arose from not understanding how to implement community-based assignments and around lack of time and effort required to design such assignments.

Faculty face institutional barriers like justifying time and interest in CRC. This sub-theme illustrates that most faculty must justify the time they dedicate in creating culturally responsive assignments, time that institutions feel could be better spent in teaching CS concepts, in student advising, and in research work. It indicates that departments and institutions value teaching of CS concepts which are clearly ingrained in western ways of knowledge and knowing and are driven by meeting the capitalist demands of the tech industry. And devalue culturally and socially aware assignments that may create a welcoming and supportive environment for

students from historically disenfranchised communities to persist in their CS degrees. Ivan expressed

> Though I have had some experience which I was lucky and grateful to have. But having that kind of training because right now you know that there are two main barriers. One, and I'm going to judge it based on myself not based on my colleagues, I don't know how much I don't know to be able to assess whether I need help, and it's easier for me to say, I don't need help. And then the second thing is there's simply no time. Right so mandating that all faculty, including lecturers and tenure track faculty take them would also mean that there is an understanding that okay if you do take that training there isn't anything else that you must do during that time. Right, that there is no expectation that I will still have to mentor during that same time. Mentor my five PhD students, talk to all of the other students that I'm advising, teach courses, prepare new lectures for the course that I'm thinking maybe for the first time. All these things, especially when you're just starting as a faculty right that first semester is already stressful enough and already has a lot of things to do.

Juan clearly stated that implementing CRC projects will create obstacles for non-tenured CS faculty in obtaining tenure.

> Very often well if it is somebody who is looking for tenure, then this [Scenario 2 assignment] is not the type of projects that is going to get them tenure. It should be somebody who already has tenure and also this is the type of project that maybe they you're not going to write a paper on that right.

Alan, on the other hand, seemed to "despise the idea of covering content" and willing to adapt CRC as a pedagogical approach but seems to be under pressure to cover course work.

> But I mean, there is a trade-off of when you do these higher impact practices of the expectation of students and perhaps even colleagues about that there is all this content that needs to be covered. And I really sort of despise this idea of covering content because it's like, what difference does it make, nobody learns anything. But, you know, if you spend a whole class period, or even two class periods like, you know, the African American Studies Professor came in and did their spiel. And then the community person came in and talks about water. I mean I guess you compensate for that providing some kind of videos or other content delivery or instructions. But that final product has to really like hit the nail has to hit a home run to sort of justify using the class time for those non-CS you know instruction.

As suggested by Alan's comment, this sub-theme illustrates that the computing curriculum is designed with little space for integrating culturally responsive assignments in

courses. Five of the eight faculty participants opined that they would face challenges justifying time and effort they dedicate in including culturally responsive assignments and not covering up course content. Juan's comments illustrate that institutions needs to reexamine the requirements of the tenure-track system for faculty and incentivize faculty's integration of culturally inclusive pedagogies in their teaching while providing flexibility and autonomy in the required research obligations.

Equity focused institution wide programs drive faculty to address racial and gender representation. Participants in their responses suggested that institutional initiatives in the form of equity focused programs tackling racism and sexism in computing can be helpful in pushing faculty to understand and observe how these issues impacts historically disenfranchised student groups and women in their classes. Noor pointed towards the role a "care committee" set up by their college dean played in motivating faculty to listen, learn, and contribute their time towards learning about how "racism and inequity" impacts their students.

> So last summer our dean, we have a woman Dean who is very passionate about these issues who initiated what we call a 'care committee' for its against racism and for equity kind of committee. And there are a number of sub communities working on different aspects of the College life that we can transform by working on these issues. So that kind of has got a lot of not just staff but faculty and students involved. So it has been eye opening to see the number of people who have come forward to work on these committees and contribute their time and to do all these things so.

Beth stated the value of gender equity programs as prompting CS faculty to check their own conscious and unconscious biases and empathize with female students in their courses. But also mentioned that faculty are unintentionally engaging in sexist remarks or behavior.

> But at [college name] we have the women in computing, which has a really specific focus on what are we doing to support women in the field. And how do we increase women taking these courses. So, we have that which has a bunch of faculty on it and we do regular newsletters and outreach to the faculty. And the dean sometimes would say will you guys go talk to this professor to help them see the light. But it's all pretty informal.

> It's not like if a professor is doing something that's actually not helpful and often it's just, it's not it's not intentional. It's not intentionally negative.

Beth also shares an example of how through the women in computing group they were able to intervene and help a male faculty member teaching freshmen courses understand his error in "shining a spotlight" on females in his classroom as exemplars and motivators for other females. She urged that although this was not in bad interest, but freshmen women don't like being singled out as that may trigger a lack of belonging and embarrassment for women.

> And again, I can only really call on the women in computing initiatives. But like a really simple and clear and recent example was a professor who recently, last year would highlight and call out and basically shine a spotlight on a girl, a female, in his class, who did something well. And we kind of point out to them like look 18-year old girls don't necessarily want you to say, look everyone look this girl like she's a girl and she did it. I'm like, that's not positive, you're not creating a positive environment for that role. But this professor didn't understand. He was taking it from the perspective of but I'm highlighting the success of this girl. And we're like, yeah, but you're doing it in a way that makes her feel super awkward. Like, let's not do it that way. But yeah, we do have some mechanisms in place, but most of them are fairly informal. We just kind of work with each other to try and bring everything up a level. So we work with people who are struggling to make the adjustments necessary.

Five faculty participants explicitly stated institution wide efforts that support faculty in integrating equity and diversity-focused strategies and assignments can work in increasing a sense of belonging among minoritized groups in CS (historically disenfranchised students and women).

Faculty unsure how to directly work with community partners without burdening them.

This theme indicates an unfounded expectation from faculty for community partners to reach them with issues they need help with rather than faculty reaching out to the community and attempting to make connections. Faculty also suggested that they were wary of creating community or interdepartmental connections as they felt the partnership would only benefit the students and not the person representing the community firm or other department. Ivan opined

that it may be challenging to promise valuable output to the community partners as he is not sure if students may always deliver what the community partner's need.

> How can I promise value to any of the other stakeholders, right? So, what I have to do in some ways is find an interesting problem. But an interesting problem through which I can illustrate the challenges of creating associate technical system while not putting the burden on the actual stakeholders themselves. Right. And it's not easy. And I haven't necessarily succeeded in that yet. But hopefully gets. So now, to answer your actual question is, it is a feasible? Yes, it is [to leverage community-based resources in CS course]. It's possible. People have done them.

Liu in her response to the feasibility of implementing Scenario 2 suggested that she feels uncomfortable in overburdening faculty in the African American studies program that may already be dedicating their time to fulfilling request from other departments.

> I think oftentimes faculty within African American Studies program are probably black, are probably overworked right now this year. They have a lot of requests for their time that they aren't able to support. I mean, if every department in the college or university reached out to the African American Studies Program and asked them to come speak to their classes about Black Lives Matter. That is completely unsustainable… So, I think if the faculty in the African American Studies program have the bandwidth to do it and are interested in doing it, that's great. If it's one department, taking advantage of another, then it's not.

Beth, on the other hand, believed that it would be easier for CS faculty if community partners approached them with a problem that they think could best be addressed through coding.

> It's so much easier if somebody from the community steps up and says, I think this is important, and I want [university] to help. Then we're all like, sure. Come to a meeting and tell us what you need and then we will convene the right people. But it's really hard when we have an idea to try and find someone in the community who's willing to be on a committee and go to meetings.

Four faculty participants opined their apprehension in collaborating with community partners citing burdening community and departmental partners and lacking an awareness of how to reach out community partners as reasons for their resistance. This theme illustrates that faculty need institutional support and proper training on how they can create community connections and help their historically disenfranchised students thrive.

CS2/higher level courses too late to work on student retention. This theme captures faculty apprehension on working on student retention beyond CS2-level and higher-level courses as they feel students have already made up their mind if they want to pursue a CS degree or not by this time. Liu reflected this mindset in her response.

> Part of me feels like it's too late, a CS2 class is later than you would want to introduce that. I've lost those female students by CS2. Right. So I'm lucky to get them in CS1 and I have a very short window. Students who sign up for CS2 in my school most of them will go on to become minors and majors. The only ones who are signing up for CS2 who are not majors or minors are seniors who waited to the last minute to take CS1 and then find out that they loved it and then take CS2.

John too stated that since he teaches seniors it's too late to work on student retention as students who want to "drop out" have already done so and those who want to persist are already pursuing their degrees further.

> Part of the thing too that I worry about in my specific course; I'm teaching seniors and maybe master's degree level students, and I kind of feel like, by the time they have reached me anything that is going to happen will have happened already. They will either have dropped out of the program already or have been encouraged enough to stay in the program. So, I wonder how much more I add to that, I mean this course is often one that they wait to the last semester to take so they're really done. They're on their way out.

Ivan also suggested that if students are just exposed cultural issues and community-based concerns in their last year, how can we expect them to ingrain it and understand in-depth the applicability of their computing skills to solve societal issues. He stated that we need to get students to understand early on how their codes and applications can impact the community around them.

> So hopefully, by this time, we were already able to retain students who would benefit the most from this kind of exposure to technology and hopefully it's not too late for other students to get exposure to these kinds of issues. Because, you know, kind of similar thing happens with ethics. You can't just slap ethics as a fourth-year course. If you want to teach ethics you teach ethics somebody from the day that they joined the program, maybe even before they even joined the program. And it's part of everything that we do. Similar thing happens here. Right. You can't necessarily kind of separately, just do this, all of a sudden, in the last year courses, where you already filtered out all of your

> historically underrepresented group from the program. And all of a sudden, you're coming to a place where, oh look you're a wonderful, privileged bunch. Let's go solve these terrible, terrible problems. Sorry for being a little bit cynical in my response there as well.

The responses of five faculty participants resonated with the view that students need to be exposed to diversity and equity issues early on during their degrees as we want to provide them the time to reflect on their own biases that may prompt them to understand and empathize with the experiences of their peers from historically disenfranchised communities.

Going beyond Professional development for faculty. This theme urges to consider the question, why are faculty inclined towards pursuing a racially and politically neutral stance in the language they use in culturally responsive assignments? Perhaps faculty's resistance may arise from an understanding that the discipline of computer science is a culture-neutral non-political realm hence it is not relevant to base assignments around political issues in CS courses. Or faculty may simply be attempting to steer away from tokenizing historically disenfranchised students by including issues they are most likely to be affected by or making white students feel excluded and targeted by discussing political and racial issues.

Neutrality in curriculum design & support for historically disenfranchised students. Juan stated that culturally responsive curriculum contains assignments that cater to one segment of the student population.

> So yeah, doesn't need to be for marginalized students can be some common denominator for everybody. Right. And the problem when you choose one project that is for one segment then what about everybody else? Like, for example, in the first scenario that you were showing of embroidery. Okay. That can be good for one segment of the students. Right. But what about what about everybody else. You have to be as neutral as well. You have to have a common denominator. You need to pull everybody right that is your responsibility, not only a few. OK, so the goal of the professor is to actually get you to increase the knowledge of everybody right not only a group. That doesn't need to be one on the top doesn't need to be one at the bottom, it needs to be everybody.

Liu in speaking to the feasibility of buying embroidery machines (Scenario1) suggested that the assignment does not fit the demographic of her city and college which has a large population of Hispanic and Indigenous students. Liu points towards embroidery not being weaving which is a cultural practice in both Hispanic and Indigenous cultures but ignores the fact that she can alter the assignment as she sees fit and relevant to the context of her students.

> For me, and [city], we have very few black students, but we have Hispanic students, we have Native American students that's weaving that's not embroidery. So, it doesn't fit our demographics. And I guess that's the other thing we're talking about it. What are the demographics for this? If you're saying culturally responsive. How many students do embroidery before reaching their first year in college?

Juan particularly reinforces this ideology of neutrality in the design of the curriculum and wording of assignments.

> For example, you informed students that the water is contaminated in their community has many implications. Right, now, there can be political implications and that can be implications that have an impact on the university. So, you have to be careful.

The responses of four faculty, particularly Juan, reflected pursuing neutral topics that were not too political or race-centered in their courses. I argue that any form of education cannot be neutral. We are part of a socio-cultural society that is constantly evolving with the changing political landscape. So thinking or pursuing a neutral lens in the design of the curriculum is ignoring the impact of politics on education. Neutrality in the design of curriculum and focus on using a politically neutral language reinforces white heteronormative ideologies that conceal unequal power relationships that essentially shape the cultural identities of historically disenfranchised students. Faculty need to embrace and empower their students to be active agents of political change rather than shy away from discussing political issues.

Appealing to females or only a few students who are interested in embroidery. The faculty interpreted the embroidery assignment in Scenario 1 as more appealing to women. Juan stated that the embroidery/weaving assignment may only attract female students but not male students. This perception of faculty can be attributed to the historical and social foundations of embroidery as a feminized craft. Juan's views largely suggest an understanding of embroidery as a gendered craft that only women engage in, which when placed socially may be interpreted as true.

> Well, I think that the fact you are using embroidery you're going to see that women are more interested in embroidery, for example than men. Right. So, I think that this is one great way to engage women and to see how that skill can be applied. Like, for example, embroidery machines well right now there are some things that you just pass the pattern and automatically the machine is going to do it themselves. So students are mostly female like I think even though there are men who would be interested.

Liu in her response also echoes a view of embroidery as attracting female students primarily.

> My target is getting students who are into embroidery, which might be predominantly females, excited about coding.

John too presented a gendered view of embroidery suggesting that women who wove memory wires in the textile machines that marked the invention of computers were there for their tiny fingers, not their abilities. But he also recognized that his views may be skewed as he lacked a female perspective.

> I mean they weren't there for their abilities in computing, but they were there because they had tiny fingers and could do the detail. Um, if they did something more than just that then probably yes as it is now. Yeah, I am not sure, honestly. I mean, you know, if I had more of the perspective of a woman when in computer science and then reading that, then I could tell you more, but I haven't got that perspective.

Beth revealed the resistance based on gender stereotypes she would receive from students in implementing the embroidery/weaving assignment but also mentioned that such pushbacks do

not discourage her. Beth and Noor were the only faculty who despite the pushback they anticipated facing were open to adapting the embroidery/weaving assignment in their courses.

> I think looking at this, the pushback that I would anticipate getting is sort of a gender pushback like oh embroidery is girl, you know, is feminine, is a girl thing. And why do we have to do this? That kind of stuff doesn't phase me like No big deal.

The remarks of five faculty participants suggest an understanding of embroidery as a craft that can mainly engage women. Two female participants understood the resistance they would face and be open to challenging the stereotypically gendered assumptions of computing they would encounter in implementing an embroidery assignment. However, it is worth noticing that the assignment in scenario 1 was framed around embroidery but included readings on weaving so that's why some faculty may have interpreted the assignment as feminine as embroidery has been historically feminized. Since weaving and not embroidery is a form of craft that is prevalent in the artistic traditions of Indigenous, Black, & Hispanic communities, and practiced by men and women both, if the assignment was framed as a weaving assignment and had readings that were on weaving then perhaps faculty may have interpreted it differently.

Pedagogical approaches to support historically disenfranchised students. This theme and the sub-themes within it illustrate how faculty can support the retention and persistence of historically disenfranchised student groups through instructional strategies and non-academic support.

Expand student's worldview through cultural understanding & acceptance. Faculty in their responses suggested that the CS curriculum should help students expand their worldviews and develop acceptance for people from every cultural and ethnic background. Beth in her response suggested that assignments that provide students the space to explore their creative

potential and integrate different cultural perspectives can give rise to projects that help local communities.

> So I think overall, in computing education, the more open and authentic, creative team-based projects that we can give them [students] the better off we'll be in the end with accepting different cultures and points of view. And I think if we give them leeway in choosing their projects, we will find more projects that help the community and will probably find things that we wouldn't have thought of.

John illustrated how he uses the connection between different cultural languages and programming languages in one of his assignments to elucidate to students how finding solutions to difficult programming problems can be simplified using more advanced programming languages. Like how certain words were required in different languages to create simplified meaningful forms of expression.

> Well, like explaining that one Chinese word and explaining that because the culture needed certain forms of expression that they were part of the language and the way it fits in computer science. There's one assignment to make them do towards the end. And it takes them a week to do it. It's a hard assignment. But then on the last day of class, I change to a different programming language and it takes 15 minutes to solve this problem in that language. And so one of the things I emphasize in the course is that there are a wide variety of languages and some are very good at solving certain kinds of problems. And so maybe you won't use this on a day-to-day basis. But if you are at least aware that this language exists, then it gives you a lot of ability that you may not have had otherwise.

The responses of CS faculty indicate how a deeper understanding of different cultural knowledge, perspectives, experiences, and backgrounds can diversify students' perspectives making them more receptive towards cultural perspectives that differ from their own. However, Alan indicated that it is tricky to design assignments that "resonate" with all students yet integrate varying cultural perspectives.

> But again, there's a balance of, like, I want to give you the examples and the experiences that resonate to you while also opening your mind to other people's cultures and experiences. That's the challenge. How do you pick the right topics? How do you pick the right examples?

Alan's response suggests the challenges faculty face in designing culturally inclusive and responsive assignments. Six of the eight participants revealed how meaningful it is to integrate cultural perspectives of disenfranchised student populations that can allow students to empathize and understand perspectives that may differ from their own.

Allow students to connect to non-CS folks & share a tangible output. Faculty emphasized how creating a tangible product that family members and non-CS friends can relate to is valuable for students as it allows them to actively engage with the broader community outside of their CS peers and value the application of their coding skills across fields. John suggested

> It gives you something you can show to someone else. I think that's one of the major ones. You have something you can attach to your wall, you can show your mom. And it's something that someone who's not in CS can understand. And you know, I never showed it to anybody. It's just not something hey, look at this For loop, right.

Similarly, Paul suggested that traditional CS assignments are mundane and boring that do not allow students to share their work with folks outside of the CS field. Hence, he suggested that creative assignments like in Scenario 1 (Appendix A) can provide students with a connection to the world outside of their field and can also aid in community and identity building with their peers.

> Stuff in the CS curriculum lets students feel like they have some tangible evidence of what they learned. They can't just be like, hey mom, I took out this array of traversed over a matrix and I multiply them together. Isn't that awesome. I'm like, Uh-huh. You are great sweetie. You can't just show someone and expect them to be like, oh, that's cool, making them kind of appreciate what you've accomplished at a moment's notice. And this would provide that for some students. You could put this on your wall, tape it to your desk or put it somewhere and be like hey look what I did. And if you wanted to, I could imagine you creating some types of like group identification, where it's like these patches are very distinct. And you can tell instantly. Oh, you took CS 70 because you have this patch and you can kind of have that instant connection. And you can create other types of

> interactions around CS that the students might not have otherwise because there is some physical evidence of it. I like that.

Five of the eight faculty suggested that assignments that provide students the potential to explore their creative outlets can allow them to connect to non-CS folks and create a sense of strong group identity with peers in their courses. Moreover, this sub-theme suggests that CRC assignments can provide students the flexibility to explore their different forms of creative expression that are influenced by their unique cultural experiences and individuality. Hence, lived experiences and the voices of students from different cultural and ethnic backgrounds are essential in designing a CRC curriculum that allows for students to express their creative selves and does not bound them within a western idea of creativity.

Important students gain knowledge on the history & legacy of computing. Faculty underscored that contextualizing the historical underpinnings of computer science allows students to grapple with the often-hidden contributions made by women and people of color in computing. Noor stressed why understanding the history of computing helps students appreciate the history of programming languages and the future they hold in creating products that can make a lasting social change. Noor in her optimistic response purports how understanding the history of computing can help students understand the rationale behind 'why they code' and hopefully understand why computer scientists should code for the greater good.

> I think the sense of the history of, like when we start with when I have a slide about who are the developers of Java and why it's still evolving, and you know why the changes with every version. It is something that makes a connection to what comes before and hopefully what they're doing now. It makes more sense to them. So I think, in that sense, I feel like students knowing they're a part of this history and the movement towards something better, I think that makes for a richness of purpose in the class.
>
> I certainly see how it opens the door for them to go and find out more about what happened and not have to just do a dry programming assignment, but to think about all

> these historical references and know what an exciting past computer science had on how it evolved. I think that is the fun part of doing a workshop or worksheets like this.

Like Noor, Juan also reiterates the value of contextualizing coding assignments around the historical foundations of computing as illustrated by the assignment in Scenario 1.

> Right. Like, for example, well the part where there is a historic edition at the end that puts everything into context, I think that that is a good idea. Right. That is a good idea. The summary is at the top. Usually, my handouts are dry, they don't have figures like this. But I think this is a nice addition here. Well, yeah, I can see doing something like this.

Beth resonates with a similar point of view as Noor about the goodness in each human being while also suggesting that understanding the interdisciplinary historical context of computer science as originating in the textile industry helps students' value how their computing skills can be used across various fields.

> So I think anything we can do to make it more broadly applicable like it's really hard to find a human who can't care about humans right like in minutes people care about people.

> I almost feel like it is really good interdisciplinarity with the history of computing. Saying everything that we're doing with computers and we teach at [university] history of computing. And to say there was an entire industry in fabric that was instrumental in how we started to think about computers and instrumental in the fact that computers are digital. These things all started with fabric. Going back and I think it's generally good for people to know where stuff comes from, because then sometimes you can understand as we do it this way because here's where it came from. And whether you like it or not, whether you want to change it or not, it's just good to know like, well, that's the reason why.

Overall, four faculty participants suggested the need for a CS curriculum to teach students the history of computing that emphasizes the role of weaving and the textiles and their connection to computers.

Pedagogy plays an integral role in making students feel a sense of belonging. Most faculty participants underscored how essential it is for students to feel a sense of belonging in computing as that determines their persistence during and after their freshmen year in their CS

degrees. Alan suggests that role of CS pedagogies should be to allow students to feel supported by the discipline and the system that in turn helps them learn better and be successful.

> So teaching in a way that helps people feel like they belong to the community, that the discipline is relevant to their interests and priorities, and that they have the support structures to learn and be successful. You know that's all the role of the pedagogical decisions you're making as opposed to content delivery like that isn't the goal. I mean, if we wanted to just deliver content, then they could just read the book, or watch the video lecture, but that we know how well that works right in terms of actually learning something. So, yeah, I think it plays a significant role.

Beth reiterated the integral role that faculty through their pedagogy and their actions play in supporting students to be successful in their courses and degrees.

> But I think that 'fair isn't always equal' is a really good point. You know, and I think a lot of professors need to have that in their offices. Some people need more support and that's okay. You know, the same way some people need glasses to see, it's okay. You can support a person. You know I will occasionally hear faculty complain about spoon-feeding and it's like, well. If you can't, if you believe that they can get to the point where they won't need that support but right now they need that support to get to the point well then give it to them. Like that's teaching. That's the job description. So I think people need to, in general, professors need to feel a little bit more comfortable supporting people who need it.

Noor suggested that the Covid-19 pandemic pushed faculty to re-evaluate and re-invent their pedagogical approaches to teach CS courses and attempt to make their learning goals, assessments, and grading more inclusive in terms of access and less stressful for students.

> And I'm not saying that we have to wait for some such thing to open our eyes. But I think it just pushed forward the conversation and opened up the conversation to all kinds of discussion which we never would have had otherwise. But really what we're teaching is this equitable? Are all students able to even just have basic access to our content, right? Leave alone anything else. Are our exams fair if they are so time-bound and online? And just what are we doing to the stress levels? So, this [pandemic], I think has helped many of us to rethink how we teach.

For this sub-theme, five faculty participants realized the integral role they and their pedagogy plays in retaining students from low-SES backgrounds who may lack access to resources (like laptops, internet connections, finances to buy books, etc.) that CS faculty presume

students would have. CS students who are most likely to have lower access to required resources are those from low-SES backgrounds. A lack of access to resources required to continue their education may be the reason students from low-SES backgrounds and those from historically disenfranchised groups may drop out in their first year.

Faculty support for historically disenfranchised students. This sub-theme resounds the need for faculty to be flexible in accommodating students need in terms of assignment submissions, deadlines, and office hours, particularly for students from disenfranchised student groups who may have had little to no experience with programming languages and computing concepts due to the opportunities available to them at school. Ivan suggested for faculty to have a relationship with students that blurs power hierarchy as it dictates the fearful outlook that students often have towards their course instructors and computing as a field. He suggested that such a fluid relationship could allow students from varying socioeconomic and cultural backgrounds and experiences to be less fearful of failure and in turn aid in their persistence in CS.

> But help them understand that they are keen to learn and not to be judged. That's one thing. That there is no expectation that we're going to have a confrontational relationship where I'm here to catch them if they are, I don't know, cheating or something. Nobody cheats because they come and say, you know what I love to do. I love cheating. That's my favorite thing to do. Right. These kinds of things happen because of the kinds of system, we put in place where you have some students almost forced to resort to these things because they're fearing that the consequences of failing a course or losing financial support or who knows what other reasons, right. So being able to provide the kinds of special accommodations that will then inevitably benefit students who are coming with different kinds of opportunities or from different kinds of backgrounds.

Beth's views reflected a deeper understanding of students' educational and financial challenges. She revealed that faculty are unwilling to accommodate student needs which could dissuade students from persisting in CS as they feel the CS field and their instructors do not have

their best interests at heart and hence, they will not get the support they need to thrive in a white male-dominated field as CS.

> Being available to people in ways that work for them. Several professors only have office hours, you know, one to two in the afternoon on the days that they're teaching. And it's like, well, if you look at this student who's going to school full-time and working full-time. And the only time that they can talk to you is not going to be one to two on Tuesday and Thursday. You know and you can't say, well, that person never came to office hours to do well. They never sought help, but that's not true. You weren't available to them. So yeah, that kind of trying to enforce at least to say faculty to add a minimum appointment by request to their office hours. You know I have had students say to me, like, can we have a phone call at nine o'clock on a Saturday morning, because that's when they have time. And honestly what it takes 15 minutes 20 minutes out of my morning like it's not that big of a deal. But we have some faculty who are just like if you can't come to my very minimal hours then I'm not going to help you. Know that then you didn't come to me for help. So yeah, I think just maybe some organizational things to be more supportive of the students who need the support more.

Alan elucidated how one can support the needs of historically disenfranchised students and be flexible when needed to accommodate their needs particularly those who are struggling to persist because of the financial obligations that they have to meet by taking up part-time jobs to pay their college tuition fees.

> So, for example, I'll give you an example of just this morning. I have this student [African American female] who had messaged me about, you know, she had a question on the final exam. It's a take-home problem, right. So we went back and forth. And finally, I'm like, do you have a minute to talk about this. And so we talk for 10 minutes. Well, just a voice call over the internet. She's like, I'm a resident advisor, you know, an RA, which means she deals with the dorm. And there are all these issues going on and we're asked to go through and search all the student apartments for something. That's all I know, right. So, like they go give me like a canine, you know, guard Dog to do this. Anyway, so there's like this thing that's going on and she has two other finals tomorrow, but on Wednesday and tomorrow, we were supposed to like she's going to present the final exam to me. You want to just do this on Thursday. And she's like, let's do it tomorrow. I'm like, well I don't care if you do it on Thursday. And she's like, really? But I think willing as an instructor to be aware of students needs and situations outside of just their homework record that would allow you to do that, and they know that you see them as a human being. That they know that. She's wondering, am I going to even make it into major because she's on the border right now of [the grade]. You have to have a b-minus to progress to the next course and she's like 79.98 or something, right. But I mean, she's gonna make it to finish the project she will be over at 80, I'm sure. But she doesn't know

> that right. And so I mean if you're going to support students from marginalized groups like they have to know that you are aware of them. And that's hard.

As revealed by the responses of five participants, this sub-theme bolsters the notion that faculty suggested the need to accommodate the academic and financial needs of historically disenfranchised student groups particularly during their freshmen years [as Alan and Beth both teach freshmen level courses] so that they feel supported which increases their belonging and intent to persist in their degrees. It extends the notion that faculty can support the retention of historically disenfranchised student groups by recognizing their struggles and using simple strategies like deadline extensions.

Interest, belonging, & engagement are tied to seeing the real-world and societal impact, the value of coding, & creating tangible output. Faculty underscored that assignments that allow students to create tangible products and see the application of their computing skills in addressing real-world issues increase student's interest and engagement in CS and strengthen or create a sense of belonging to their field. Ivan in discussing the Scenario 2 assignment emphasized its value in creating a tangible product that is proven to increase students' interest in computing and their intention to persist in CS.

> I appreciate that the assignment itself is trying to do something practical, something that allows students to see the output of their work, something that is, in many ways, tangible, and perhaps even something that allows them to use the output or use the assignment in potentially even creative ways. And that I think is fairly important. There's a lot of research that also talks about how assignments that are more and more tangible for students and can aid in their learning.

Alan demonstrated the role of faculty partnering with stakeholders outside the university in allowing students to understand that the skills they are learning, the courses they are taking will equip them to address real-world challenges.

> So, I think that type of experience where it's leaving the classroom, somebody is showing interest. You're accountable to somebody else. You feel like what you're doing might be useful to somebody else. It's not just your client, maybe. Yeah, I think it's useful to the public. I mean, that's even better, because I think a lot of people find satisfaction in computing. Being able to build something that's put in the hands of millions of people or even hundreds. I mean, it doesn't have to be a huge number, but the fact that someone is using your thing and it's making their life better, whether that's for entertainment or for water quality like for survivability or whatever, like that. So that feels good and it feels more authentic if it isn't just a scenario in the classroom but you're partnering with people from the real world. Right. So yeah, I think those are the advantages for this type of assignment.

Beth reiterated the value of creating assignments that attempt to help address a real-world issue, which can create a sense of belonging in students while helping them create connections between classroom concepts to learning its application in their professions.

> It's also allowing them the freedom to choose a project like we've gotten everything like we got games, we got websites we got a home automation programs, all kinds of stuff. You know, really interesting things can come out of it. Even when it's all focused on one thing, which was clean water. So, I do think those kinds of assignments, especially the more you can make them real and impactful. And look someone in the eye and says, I can make a difference that will help somebody make a better decision. I think those things are really powerful for students as far as why did they get into this field. Do you know why it is important to push yourself to learn all this stuff and not just skim your way through college? So, I do think this kind of assignment has a lot of value to students. Yeah when they go on the interviews, they can say like, oh, I did this thing, you know, I worked on this project that had this impact on people and that's a powerful human story.

Beth also indicated that given her university's location in a Black neighborhood, it values 'community connection' that attempts to respect and help local community folks and have a positive impact on the community. She suggested that the assignment in Scenario 2 would fit into the mission of their university to collaboratively work with the local community.

> So, I think anything we can do to make it more broadly applicable like it's really hard to find a human who can't care about humans right like in minutes people care about people. So [university] we have like a promising community. [University's] in [location], which is a high poverty area of the city. So, we have something called a promise zone, which is the local community. So, people who live in [location], the [university] puts a lot of effort into having a positive impact on their lives and not a negative one. Like having a big university in the middle of your neighborhood can be, I guess not fun for if you are from that neighborhood. So we do a lot of things to try to be respectful of the neighborhood.

> This assignment would fall right into our mission of when possible, we do what we can to help the neighborhood.

This sub-theme emphasizes the need for faculty to connect students to organizations that allows them to value how their computing skills can address real-world problems. As indicated by seven faculty participants, it illustrates that an institutional initiative to create community connections should aim to work with communities of color to support and respect their traditions and cultural heritage. Hence, faculty's assertion on students valuing real-world application and respecting the communities of historically disenfranchised students increases the sense of belonging among historically disenfranchised students and aids in their persistence in the field.

Humanize students & recognize their existence. This theme illustrates that faculty felt the need to humanize historically disenfranchised students and their experiences to make them feel supported and welcome in a white heteronormative CS culture. It also illustrates that assignments in CS are dated and are unable to connect with experiences of historically disenfranchised students and hence engage them in the field.

Humanizing historically disenfranchised students. Faculty stressed the significance of validating student's existence, focusing on what they can do and achieve with the cultural resources they bring and expanding on their repertoire of possible selves. These assertions reflect faculty's move towards using a humanizing pedagogy in teaching historically disenfranchised students (Salazar, 2013). Alan articulated the need to value students and recognize their extensive skills outside of their superficial demographic markers to being a sum of varying individual and cultural attributes.

> Especially with the online environment like Covid-19 when you're trying to sort out, everything is getting so dehumanized right. To try to bring back the, you know, allowing

> students to be human, to be valued, but to also assert their values and to define who they want to be known as outside of things like oh you're black, or oh you're female. Oh, right. I mean, no it's not all I am. You know, I also have these other things that I have to offer. So yeah, I think that's probably some low-hanging fruit in addition to the collaborative crisis are culturally responsive to the framework you described.

John opined that something as simple as memorizing the names of students in your class makes students feel welcome and recognized.

> Saying hello to them helps. Making some effort to get to know them. I know that that's a big deal. No, it doesn't have to be creepy or anything, and you know, just say hey you know what I just ask, Hey, what's your name, I mean…One semester, I'm terrible at learning names, I decided I'm going to learn everyone's name in this class. There were maybe 30 students. So, it was achievable. They were all Hindu Indian Names, most of the students were from India or Pakistan. And that made a huge impression on them. I mean, now, I think, okay, there's just no way. I mean, a small class for us is over 100 students. So, I rarely even try anymore but I feel like you know maybe when I do interact with the students, I should at least ask what their name is and see if I can remember it. I think that can help a lot. You know, just to say like you've been noticed.

Beth expressed the need to value the communities students belong to as a way of understanding them and their unique cultural experiences. Beth uses a humanistic approach to understand the institutional and academic struggles historically disenfranchised students face in being successful computing professionals. She also mentioned that community connections help humanize the students and the computing profession.

> Yeah, so I think the community connection and the ethnic audience. They help humanize what they're doing...I would just think of it as showcasing that we value the community you came from. You know what your community is like, however you would want to put that. Like yeah, we do value your community and we think that as a computing professional, you will be able to do things that are a benefit.

Five participants resonated with the need for CS faculty to use a humanistic approach in teaching their courses. Hence, for CS faculty to understand the cultural contexts of historically disenfranchised student groups they need to create connections with the local community that allows them to value how their computing skills can address problems that are faced by locals in their neighborhood. The merging of humanizing and culturally responsive computing pedagogy

helps us value the intertwining of two pedagogies that take us towards dismantling educational institutions that maintain social inequities through their practice.

Traditional assignments are not motivating & dated for historically disenfranchised students. This theme illustrates that outdated assignments, like learning to type 'Hello World' and writing a program for the Fibonacci series are still being used in CS which can discourage youth from persisting in CS as they find the field boring and outdated. Ivan suggested that traditional assignments in engineering and CS courses do not always encourage creativity in freshmen-level courses. He suggested that this can discourage students who have been traditionally marginalized from seeing computing as a creative field which can impact their persistence in CS.

> In a computer science department or under the School of Engineering, that level of creativity is not necessarily always encouraged, especially, in entry-level courses. And that can be a huge turnoff for people outside of the engineering, but also for people or groups that have traditionally not been part of the engineering departments.

Beth's response reiterated the dated assignments that continue to be given to freshmen students as being dull which makes CS appear as a field that is limited to the IT industry alone. This may dissuade students from persisting in CS particularly those who have a little background on how they can use their computing skills and who wish to use their skills across different fields.

> And I think there's, an unfortunate reality and in a lot of the computing assignments that we give students, they're boring. Yeah. Like how many users you're teaching for loops. Well, so yeah, we're gonna do a countdown. I mean, like, there's just a lot of everybody everywhere is doing the same assignment. For some students, it's hard to be interested in something that you know that your parents probably got the same assignment in the college, right. Calculating the Fibonacci sequence is just not interesting to 95% of the students. There's 5% that is like this is the coolest thing ever. But that's not a lot.

Alan pointed at the value of integrating assignments that allow students to see the societal impact of computing in the community around them. He too resounds that traditional CS assignments are uninteresting to students.

> I think it's good to pick examples that are not just what you see and dozens of computer science textbooks that have no connection to, they don't have a motivating example of like, why are we doing this and what is the greater impact? Why is it important? I don't teach data structures. So I can't think of the vanilla examples. But I just think of things like why does it matter how I organize things in memory? or why does it matter how I sort things? The why it matters is for efficiency of performance or correctness. Right. But I mean, why does it matter to the rest of the world if I write this program for three weeks and it prints the number 17. And I'm relieved that I passed the test case and got a good grade on the assignment. But if that's the end of it, then it's sort of not very motivating not very inspiring, I guess.

All the participant's responses indicated a need for a fundamental re-evaluation of the content that is taught in CS introductory courses as entry-level courses are crucial stages where students drop out particularly those that find CS curriculum unrelatable or seem relevant for real-world application.

Faculty support historically disenfranchised students by showing examples of successful role models in tech & non-tech fields. This sub-theme reflects the need for faculty to increase students' sense of belonging by illustrating to historically disenfranchised students that there have been successful professions, role models, who share their racial backgrounds and look like them. Liu indicated her use of videos of successful women professionals in computing from different racial backgrounds in her computer science courses. She further suggested that showing videos of how computing is being used across disciplines is helpful for students in understanding the interdisciplinary application of their CS skills.

> Certainly, we know showing examples of others in the field. For a while, I used to show videos from the University of Washington. They had a whole series of videos about a day in the life of a CS person. The first three videos were videos of female University of Washington alums and what they did. That one worked for Microsoft, one worked for

> some other large tech companies. And then they had another series of videos that were of how people were using computer science in more interesting applications. So, there was a firefighter and those were white women and men. People of color right where were they? There were I think three white women. But I thought those videos helped in some ways. But I didn't like showing just the three white women videos because they were all female, which made it almost more obvious that it was like you want to sort of blend it like it's just a coincidence that more than half are female, but there are some videos of males too right. So, it's showing examples of others in the field. Right. I think helps a lot.

Juan stated that teaching assistants from different racial backgrounds and genders can also be good role models for students demonstrating that succeeding in courses is achievable.

> For example, with the TAs that I have, I always try to choose a combination of background and gender and everything. Not only one because in that way the students will see if this person was able to be junior and a senior and has the same background I have, then I will be able to do the same. Right. So, I think that is very important.

Noor revealed how she invited her past student who had successfully created a product that has contributed to social good and is successfully being manufactured. She opined that this approach has the potential to encourage students and show them that transitioning from being a student to a professional is achievable.

> So one of the projects was about a dashboard camera that senses whether the driver is napping and then gives metrics about to the driver at the end of the trip so that it reduces accidents that are caused by people sleeping. So it uses AI technology to figure out whether the person is awake and then can give a kind of a report to the driver. And they have now got some funding and they're working on getting that AI-tracking device manufactured, so that was one project that got off the classroom the into the world. And I've invited that student back to talk to the current class because that was one project that succeeded from beyond just the classroom so that can save lives. You know because I know how often it's easy to feel sleepy you know when you're driving, so I think that was one project that I remember now clearly was within this within the scope of what was asked.

This sub-theme suggests that five CS faculty recognized the importance of diverse role models in increasing the sense of belonging of historically disenfranchised students in their degrees (Liu), they can persist (Juan), and creating a space where students felt that they can become accomplished CS professionals (Noor).

CHAPTER 5: DISCUSSION

During this study, my primary purpose was to explore the beliefs of computer science (CS) faculty to adapt a culturally responsive computing pedagogy in their courses. I interviewed eight CS faculty who now serve as computer science faculty across universities and colleges in the United States.

I discovered six key emergent themes that connected to my eight participants' responses. These themes with my interpretations represented faculty's beliefs on culturally responsive teaching at the undergraduate level in CS.

Situating participants' responses in critical pedagogy.

The beliefs of participants indicated empathy towards the lived experiences of students from historically disenfranchised groups and an understanding of their struggles of being a minority in computer science. Some participants' responses aligned with valuing the experiences and knowledge of historically disenfranchised students by including them in the design of culturally responsive assignments. Critical scholars believe in valuing the experiential knowledge of communities of color by adapting culturally responsive pedagogy that nullifies majoritarian stories (Closson, 2010) that have governed the policies and dominated the generation of knowledge about historically disenfranchised communities (Delgado, 1995). Therefore, the fact that faculty are open to welcoming student views in the creation of CRC assignments supports critical scholars' notion about experiential knowledge creation.

My findings point towards a tension that faculty grapple with in trying to give students agency and autonomy as they explore their creativity in working on culturally responsive

assignments versus the need for CRC assignments to be graded. On one hand, where faculty like Beth recognized that student agency and autonomy in project choice play an empowering role in implementing culturally responsive assignments in CS courses. On the other hand, faculty struggled to see the sustainability of culturally responsive assignments as they felt that CRC assignments would need to be graded and part of the core CS courses for students to be dedicated towards the assignments. Faculty suggested that it would be difficult to make culturally responsive assignments a part of required courses that students take in their first year, a crucial stage in undergraduate CS degree where historically disenfranchised students are most likely to drop out. As suggested by Beth's experience implementing culturally situated application tools with high school students, similar to CSDT tools, when students had the agency to choose from a range of culturally situated assignments, they were more likely to continue with their CS classes. Beth's experience coupled with prior on Culturally Situated Design Tools (CSDT) with African American youth (Eglash, et al., 2009) suggests that when students observe and understand the connection between computing concepts and their cultural contexts and also feel represented in computing, they are more likely to persist in CS courses. A solution towards resolving the dilemma faculty face in providing student autonomy in CRC assignments and how they can ensure that assignments are graded is to include historically disenfranchised students in the development and design of CRC assignments. By providing students the agency to have a voice in what issues, such as local community focused problems that can be addressed using computing, could bolster students sense of belonging in their degrees and can also support faculty in deciding on what content meaningfully engages students and allow historically disenfranchised student groups to persist in computing.

A culturally responsive computing pedagogy demands teachers to reflect on how to find unconventional pathways, not typically part of a school curriculum, to create connections with historically disenfranchised communities allowing them to design courses that consider students cultural characteristics as assets on which learning can occur (Ladson-Billings, 1995; Paris, 2012; Eglash & Benett, 2009). My findings suggest that faculty struggled to see the feasibility of how they could find and justify the time, effort, and pedagogical training they would require to create community connections given the lack of institutional support and fulling obligations of a tenure-track professor that is demanded of them. Faculty participant's concerns are indicative of how the CS curriculum and pedagogical practices are embedded in white knowledge and practices that do not provide faculty the flexibility in the form of time and effort to integrate ways of knowing and doing of Black, Indigenous, and Latinx communities. Moreover, within the tenure-track promotional system institutions do not have any incentive structures in place to support the faculty who do integrate culturally responsive pedagogical practices in teaching CS courses. Hence, this suggests a need for faculty to receive institutional support in their intention to adopt a culturally responsive pedagogical approach in teaching CS courses. Furthermore, for the larger population of CS faculty who receive no training in how to bring culturally responsive pedagogy in their teaching, there is a need to develop professional development that educates faculty to understand how race and gender intersect in computing to create challenges for historically disenfranchised communities to succeed.

Pedagogical Approaches to CRC. My findings suggest that faculty realize that students value assignments where they can observe how their code helps people, where they can see the real-world messiness of how computer coders work with clients to create a product that helps them solve problems. They believed that interdepartmental collaboration can be meaningful in

designing assignments that show students the implementation of their skills across disciplines and help them understand how computing can help in addressing societal issues. As reflected by the third CRC tenet (Scott et al., 2015) teachers play a powerful role in uplifting students technological identities by connecting assignments to local community issues that increase their interest, sense of belonging, and engagement as they realize the real-world impact of their computing skills on their communities (Charleston, 2012; Charleston et al., 2014; Scott, Sheridian, & Clark, 2015). Embedded in the fifth CRC tenet (Scott et al., 2015), helping students realize that their communities are valuable assets that can contribute to their success as computer scientists, the beliefs and views of faculty participants emphasize the need for CS faculty individually, departmentally, and institutionally to create connections with local community organizations (Scott et al., 2015). Scott, Sheridian, & Clark (2015) through the second CRC tenet explain how students come to build technological artifacts and push the boundaries of what these technologies can do. Faculty in this study while not aware of these CRC tenets seemed open to allowing historically disenfranchised students to use their computing skills to work with locals and organizations to address socially and racially concerning issues. It is possible that bolstering student's autonomy and choice in the computing artifacts that they create could increase their view of themselves as future computer scientists.

Student voice and Empathy. Faculty acknowledged the need to include assignments framed around local community issues that would validate the experiences of historically disenfranchised students and sensitize the dominant student groups (white and Asian males) to the contributions and struggles of their peers from historically disenfranchised communities. The second tenet of the CRC pedagogical approach recognizes the value of validating the experiences of historically disenfranchised student groups. But it also urges faculty to help historically

disenfranchised students recognize that their technological prowess is not exclusively defined by race, ethnicity, gender, social class, or notions of privilege and promote self-discovery by helping students learn about their technological selves across multiple intersecting identities (Scott et al., 2015). Faculty participants in my study did not reflect an understanding of how the CS coursework and pedagogy can support historically disenfranchised students in prompting them to learn about the role their intersecting identities play in envisioning themselves as future technology professionals. This necessitates the need for faculty to receive training in culturally responsive computing approaches that educates them on how to make CRC relevant to CS courses that they teach.

Faculty also echoed the need to welcome, listen, and empathize with the struggles of historically disenfranchised student groups and re-think coursework that does not dissuade them from persisting in CS as they manage multiple financial and family responsibilities. Faculty's views resonate with the second CRC tenet that urges CS teachers to recognize that supporting historically disenfranchised student groups can promote complex ideation and sophisticated use of programming concepts in the development of computing projects (Scott et al., 2015). Hence, re-thinking CS coursework has the potential of providing historically disenfranchised students the autonomy to creatively express themselves without the concern of hiding their cultural identity.

Barriers and Support for CRC. Faculty feared adopting culturally responsive pedagogies on account that they felt they do not have the resources and institutional support in the form of time, money, effort, and policy to dedicate to creating these assignments. Hence, faculty were apprehensive about being vulnerable and less knowledgeable in front of their

students on issues of racism. Most faculty were hesitant of being “too political” (Juan) in their courses and essentializing (Alan), harming (Ivan), and even tokenizing (Liu) historically disenfranchised students in their classes. This finding is unique to my study where faculty openly expressed their hesitance in discoursing racial issues with students as they feared resistance from white students, hence they also expressed resistance in including culturally responsive assignments that focus on racially sensitive community-based issues. I argue that faculty’s resistance is reflective of a computing culture that fails to train CS faculty in learning how culturally relevant pedagogy can support and cater to the needs of historically disenfranchised students who feel othered in the white-dominated culture of computing. My findings also reflect that faculty fear institutional repercussions of discussing racism in their classroom as there is a lack of flexibility in the CS curriculum to integrate culturally responsive pedagogies.

However, one faculty believed that instructors through their pedagogies and instructional practices can make historically disenfranchised students feel welcome, validated, accepted, & supported in their classroom by actively engaging in conversations on topics like algorithmic bias (Liu). Ruha Benjamin (2019) in her work on how racial bias is embedded in the automated systems used across various industries, like healthcare and housing, discusses how tech companies like Google and Facebook continue to use algorithms that are racially biased and discriminatory. Furthermore, she purports how government policies by making it harder to fight racially discriminatory advertisements uphold the neoliberal markets' racial targeting of Black, Latinx, and Indigenous communities. Benjamin’s work necessitates the need for faculty to teach the dominant student groups how race and racism impact their peers of color now and their future as computer scientists. This allows white students to empathize with their peers from historically disenfranchised groups and in turn, creates a culture where historically

disenfranchised students feel accepted, welcome, and understood. It further urges institutions to push equity-focused programs that encourage and push faculty to effectively learn how racism and microaggressions in their classrooms may deter students from historically disenfranchised communities from persisting in their degrees. Faculty indicated that institutional and departmental barriers in form of expectations from tenure-track faculty to work on research, advise, and cover CS concepts as a requirement from faculty, may prevent them from integrating CRC assignments in entry-level courses where historically disenfranchised students and women are most likely to drop out.

Going beyond Professional Development for faculty. "Neutrality" in curriculum design was evident in participant responses suggesting a positionality that computer science is a culture-neutral, nonsocial realm where faculty focus on how not to make the dominant group (white students) uncomfortable by choosing to discuss racial issues rather than making historically disenfranchised students feel supported, respected, and welcome in these spaces. Haynes and Patton (2019) argued for a White Racial Consciousness and Faculty behavior model that they argued helps CS high school teachers move away from viewing computing as a politically, culturally, and racially neutral space. This model also helped teach and engage White faculty, who fail to see connections between CS content, teaching, and racial justice, in culturally relevant professional development.

Moving beyond engaging faculty in Diversity, Equity, and Inclusion (DEI) professional development workshops, my findings suggest that by supporting and working together with community-based organizations faculty can bring about change at the systemic level within and beyond their institutions. DEI workshops (a requirement for faculty at most institutions) that

engage faculty on gender and race-related issues that may impact their teaching inside and outside the classroom do so superficially making it difficult for faculty to see how they could design courses by including these issues. I argue that having faculty understand how community partnerships play an integral role in adapting culturally responsive computing in their teaching faculty can be active agents who bring about systemic change at the local level in the community that surrounds them while effectively engaging their students in not only understanding these issues but also being agents of political and social change. Such initiatives could involve faculty either themselves or through students working on research projects with local community-based organizations who work on issues like civic engagement or political change by leveraging computing. Community partnerships like these can not only empower historically disenfranchised students groups in CS to see how they can use their computing skills towards political and social change (for instance, by contributing through data analytics) but can also play an integral role in educating and engaging White students in race-related issues that may not necessarily impact them but can change the society they and their peers of color live in.

Furthermore, as illustrated by the findings of this study, undergraduate CS students today may not necessarily want to pursue the run-of-the-mill tech jobs but rather use their computing for a broader political change or social change. This is comsistent with a Google (2014) study that found that it is important for women to see computer science as a "fulfills both the academic passion (inventing, problem solving, exploration, etc.) and the intangible, social passions (helping people, conservation, medical breakthroughs, etc.) that make a profession personally rewarding" (p. 7). Faculty in this study also recognized that when students see and understand the interdisciplinary utility of their CS skills they are more likely to persist in their degrees. Moreover, community partnerships like in the example above play a powerful role in making

historically disenfranchised students feel like they are being heard, their community is being represented, and they can use their computing skills to positively affect change within their community, the fifth tenet of CRC.

A culturally responsive computing lens is a powerful pedagogical approach that CS faculty can use to understand and effectively create learning contexts that allow students to see how the intersection of technology, race, gender, and social class gives rise to racial and social inequities. As CS faculty learn how to integrate CRC in their courses, community partnerships will lie at the core of how faculty come to realize how their social positions of power are in relation to the social and cultural contexts of historically disenfranchised students in their classes. This approach can help faculty find unconventional connections with curriculum content to design transformative courses. Historically disenfranchised students in CS can understand that while computing alone cannot solve social problems its methods can be used to diagnose and characterize how social problems manifest in technical systems that can affect social change within their communities. For instance, Abebe et al. (2019) leveraged search data to surface unmet health information needs across the African continent — demonstrating when and how search engines display low-quality health information to users. In another study, Buolamwini and Gebru (2018) found that many commerically available facial analysis sustems perform significantly worse on women and people with draker skin tones. Their work prompted Microsoft and IBM to improve the accuracy of their facial analysis technologies along gender and racial lines. These are only two recent examples where computing has been used to diagnose and characterize social problems that has prompted action from big tech companies.

It is important to note that faculty like Juan indicated being more comfortable pursuing less or non-political topics in their CS courses. This further resounds the important role that a CRC pedagogy to systemically impact local political change can have on some faculty who need to unlearn some of the neoliberal white ideologies that governed their Ph.D. training. Furthermore, as two faculty (Liu & Ivan) suggested they receive no training in their Ph.D. degrees on how to teach, making it essential to teach faculty on learning theories and how they can use them in their teaching practice. Faculty found it difficult to make connections with community partners without burdening them signifying the need to provide professional development to faculty in critical race literature and change criteria for receiving tenure which dehumanizes faculty and does nothing to incentivize or recognize equity and diversity work of faculty.

Pedagogical Approaches to support historically disenfranchised students. All participants illustrated pedagogical ways they can support historically disenfranchised students. They suggested that expanding the cultural understanding of dominant student groups through assignments that integrate local community-based issues and hence increase students' acceptance of different cultural ways of knowing and engaging with computing can offer one way for CS faculty to pedagogical support historically disenfranchised students. Rankin & Thomas's (2017) work on using culturally responsive pedagogy in introductory undergraduate CS courses, illustrates how leveraging students' cultural capital into CS courses and connecting it to community-based issues can bolster a sense of belonging among historically disenfranchised students as they see themselves as technological innovators who have the potential to bring change in their communities. This can also raise awareness in dominant student groups on issues that impact communities of color helping them to empathize with their peers from historically

disenfranchised communities. A higher sense of belonging has been shown to impact the intentions of historically disenfranchised students to persist in CS degrees as they begin to see themselves as part of a field that is governed by white ways of knowing and doing (Charleston, 2012; Charleston et al., 2014; Washington, 2020; & Scott et al, 2015).

The faculty also suggested allowing students to create tangible products allows them to explore their technological creative potential and helps them engage with the broader community outside of CS. CRC assignments can provide historically disenfranchised students the freedom to express themselves without worrying about hiding their cultural proclivities (Scott & Clark, 2015). Eglash & Bennett (2009) in their work on culturally situated design tools working with high school students at a school serving predominantly Black students have illustrated how can teachers implement assignments that draw on students' cultural capital and provide them the creative freedom supports student's construction of their technological potential and identity while ensuring they grasp computing concepts. The views of CS faculty reflect this similar view of the potential of creative assignments in bolstering a sense of self among historically disenfranchised students as they envision themselves as future technologists and help them share their work with family and friends.

Faculty also resounded the need for CS faculty to be flexible in accommodating the need of students' color through deadline extensions and flexible office hours as that makes them feel supported and raises their sense of belonging in computing spaces that are dominated by white and Asian males. Charleston and colleagues (2012; 2014) in their work with Black females pursuing undergraduate computer science degrees found that Black females drop out of their degrees due to social isolation from peers and lack of support from faculty hence bolstering CS

faculty's assertation that indeed flexible assignment deadline can attribute to the retention of black females in CS degrees. Whereas Wood and Harris (2014) indicated that black males often drop out of their CS degrees due to financial burden, family obligations, and working two jobs to afford college tuition fees further indicating that CS faculty should be flexible in accommodating the needs of black males and those from low-SES backgrounds.

Humanize students & recognize their existence. Faculty felt that they can support students from disenfranchised communities by humanizing them and recognizing their existence. Freire discussed humanization as a "practice of freedom in which the oppressed are liberated through the consciousness of their subjugated positions and a desire for self-determination" (Freire, 1970, 1994; Salazar, 2013). Humanistic approaches have been adapted in education and culturally responsive computing by stressing educators to recognize that "all pedagogy is political and requires radical reconstruction of teaching and learning" and pedagogy needs to be meaningfully connected to social change by engaging students with the world that they can transform (Salazar, 2013, p. 126). Five faculty participants stressed the need to use a humanistic approach as a way of connecting with historically disenfranchised students who are most likely to feel othered by their peers and in the white dominant culture of computing.

As indicated by faculty, CS assignments are boring for students as they are outdated, racially insensitive, and students are not able to see their connection to solving real-world problems. Haynes and Patton (2019) argued that STEM faculty can move away from a neutral curriculum by questioning their racialized assumptions and through professional development that teaches them to implement culturally responsive and relevant pedagogical strategies in the classroom. My findings coupled with Haynes and Patton's (2019) work indicate that a culturally

responsive curriculum does not only embeds student learning and application of their computing skills in real-world issues but also aids faculty in breaking their racialized assumptions about communities of color. Adapting a CRC pedagogy in CS for historically disenfranchised students could also impact their persistence in computing degrees.

Faculty also stressed that showing examples of successful role models who look like them in technological fields helps raise the belonging of historically disenfranchised students and humanizes their experiences in computing. Washington, Burge, Mejias, & Jean-Pierre (2012) and Washington and Romanova (2018) suggest that "ethnically relevant role models" significantly raise the self-efficacy of historically disenfranchised student groups directly impacting their persistence in computing (p. 46).

Summary

My discoveries suggested a seamless connection between emergent themes, theoretical framework, and relevant literature. My most salient discovery was the need to develop a sustainable professional development that centers on educating faculty on integrating a culturally responsive computing pedagogy in CS courses. A professional development (PD) that centers on CRC and goes beyond DEI training has the potential of educating faculty to understand the racial context of historically disenfranchised communities. A PD that supports faculty in understanding the powerful role of community partnerships in adapting culturally responsive computing in their teaching and how faculty themselves with their students can be active political and social agents of change in the local community surrounding them. Faculty participants displayed empathy and compassion towards welcoming and supporting historically disenfranchised students and women in their courses. These beliefs of faculty suggest that they possess the will to adapt and learn

about culturally responsive computing pedagogy and how to use it in their classrooms but lack the institutional support to accomplish it realistically. However, few faculty still help the view that the CS field is and should not be impacted by racial, political, and social inequities which can be dismantled by promoting faculty to engage with the local community in tandem with educating them on adapting culturally responsive computing in CS courses. Hence, as suggested by CRC rather than fitting students into the existing curriculum we need a fundamental reevaluation of learning goals and assessments (how are we assessing student knowledge) to engage in coding.

Given that faculty discussed a need to have authentic projects, we should leverage that to build more community connections between CS and the local community. To take a culturally responsive approach to teach CS courses, faculty need to reach out to community folks and local organizations that may benefit from students working on projects for the social good. Connecting students to organizations allow them to value how their computing skills can address problems that are faced by locals in their neighborhood. It also helps dominant student groups understand and develop empathy towards issues that their peers from historically disenfranchised communities may have faced. And disenfranchised student population feels welcome, supported, and understood by their privileged peers. Hence, faculty's assertion on students valuing real-world application of their computing skills increases the sense of belonging among historically disenfranchised students and could aid in their persistence in the field.

Ivan expressed a view that was not a prominent theme but is relevant to the need for an institution-wide effort to change their approach towards increasing diversity and equity at their institution. Ivan suggested that institutions collaborate with big organizations who hire student

interns, but unfortunately, small organizations and their issues are not “profitable”, so institutions do not create ties with them.

> ‘Now that's the difference between flushed with money versus I'm you know trying here to bring drinking water to people that need it. It's a little bit unfortunate that that part is not as profitable but you know it's possible. It's just a question of how you make it work for the specific organizations that you're part of.’

Ivan’s views suggest that the neoliberal market dominates how institutional policies include, discuss, and integrate race and gender issues in CS. Neoliberal markets dominate, maintain, and reinforce economic and racial disparity in the IT industry where most organizations are owned by white men. Power and capital of the neoliberal market govern how race and gender get to be included in institutional policies and clearly since gender and race are now trending social constructs that have been picked up by big tech organizations, institutions to are integrating them in their policy, however only superficially so as indicated by faculty’s views.

Implications

My work indicates a need for self-sustaining faculty professional development (PD) that goes beyond training faculty on DEI issues and how to adapt CRC in undergraduate-level CS courses to forming local community-based partnerships that can support them to bring forth radical political change at the local level. My work also raises questions and pushes university leaders to rethink investing resources in training CS faculty who receive no professional training in applying theories of learning to their teaching and creating explicit culturally appropriate and historically mindful curricular spaces for Black, Latinx, & Indigenous. A self-sustaining PD means where faculty come to view their peers as a support system allowing them to create a community that is willing to learn from and support each other in learning about culturally

responsive ways of teaching in CS courses. Lave and Wenger (1999) have suggested communities of practice, as groups of people who engage in a process of collective learning in a shared domain and learn to do better in that shared domain as they interact regularly. My work with CS faculty points towards faculty forming such communities of practice that engage in a shared process of understanding culturally responsive computing pedagogy (a shared domain of interest) and how they can implement it in teaching CS courses. It also means that faculty collaboratively work towards questioning and actively reforming their conscious and unconscious raced-gendered biases and stereotypes that prevent them from adopting a culturally responsive pedagogical approach in teaching CS courses. Working as a cohesive group CS faculty can also figure out how to build mutually beneficial community partnerships that are sustainable beyond one-class activities. As expressed by faculty in this study, forming community connections is an exhausting task that demands time, effort, and institutional support. As such developing long-term sustainable community partnerships that benefit the community as well as faculty will require fewer resources in the long run. It is important to acknowledge the tensions that arise when trying to develop these partnerships within an existing system that does not always reward them. This is especially true of research intensive institutions that prioritize research over teaching and lack necessary support and structures for faculty to pursue culture-based pedagogy.

However, it is still important that faculty push for reforms and supports that prioritize pedagogical approaches, such as CRC to recruit and retain historically disenfranchised students.. For that to happen, faculty need institutional and departmental support that allows them the time and space to develop community connections and design a culturally responsive CS curriculum. A cohesive culturally responsive computing curriculum that leverages community-based

problems and issues has the potential in retaining historically disenfranchised student groups in CS. At the institutional level, this means that departments need to have dedicated staff who specialize in reaching out to local community organizations and connecting them to CS faculty. Such institutional support can save faculty time and effort that they could then dedicate towards designing CRC approaches within their courses and connect their students to community partners.

Furthermore, the responses of CS faculty suggest that in practicing a culturally responsive pedagogy in their CS courses faculty also need to re-examine the existing measures that assess student learning. Hence, this work urges CS faculty to think of success in a CRC setting as not defined by quantitative measures of student achievement alone. CS faculty and social science researchers need to work together to construct new methods for determining nuanced outcomes that emphasize activating student cultural knowledge into a digital product.

Furthermore, my findings point towards the need for a systemic change where university leaders are held accountable for upholding white supremacist ideologies that in turn shape racist institutional policies that do not provide historically disenfranchised students particularly from low-SES backgrounds with the flexibility and the financial support that they need to continue their education resulting in a higher number of first-year dropouts in colleges. My work also suggests a need for computer science faculty to work with social scientists, social justice scholars, interdepartmental colleagues, and local community leaders with expertise in understanding and supporting historically disenfranchised communities.

My work pushes white students to value culturally diverse perspectives as they engage as future computer science coders and developers in the design and development of software making the coding systems that computer scientists develop less biased (Noble, 2018).

My interpretation led me to realize that the faculty's resistance to inform their pedagogy through a culturally responsive lens reflect that they are a product of the CS education system (from undergraduate to Master's and Ph.D. programs) that is racially insensitive and dominated by white supremacists' policies and practices (Benjamin, 2019; Noble, 2018) so including effective racial change in their courses seemed to elude most faculty. Although Ivan stood out from the rest of his peers due to his educational background and experiences in human-computer interaction and sensitivity towards understanding the racialized context of CS education, he too fell victim to the system that nurtured him.

Limitations

Although sample sizes are justifiably small in qualitative research, my small sample size (n=8) presented a limitation in this study. As a result, my discoveries related to the perspectives of Ivan and Beth given Ivan's HCI background and understanding of racial issues and Beth's educational background and understanding of gender issues are not generalizable or transferable as they may not reflect the cultural consciousness of the majority of CS faculty.

APPENDIX

APPENDIX: Interview Protocol

Instructions

Hello! Good morning or afternoon or evening. I am Swati Mehta, a Ph.D. candidate in the Educational Psychology and Educational Technology program at Michigan State University. Thank you for taking the time to participate in this 90-120 minutes interview. I will be asking you a series of questions on teaching diverse students in computer science through culturally aware pedagogical approaches with a particular focus on issues of racial equity and diversity in computer science at the higher education level. Please answer the questions honestly and with information that you feel comfortable sharing.

Tape Recorder Instructions

Is it is ok with you if I video/audio record our conversation? This is so that I can be attentive to our conversation in real-time, without missing any details. This interview will be transcribed and used as data for academic journal publications and conference presentations. All your individual information will be kept confidential and anonymized.

Demographics:

1. Can you tell me about yourself, including your educational background and teaching experience?
    a. How long have you been teaching CS?
    b. What CS courses do you typically teach?
2. What position are you employed in at your university/college?

Instructions:

Now, I will be reading out two scenarios that you should have received from me prior to the interview. The goal of these scenarios is to better understand how they might play out in a university-level CS course? There are no right or wrong answers, I am just interested in your thoughts. There will be a few questions that accompany each of these scenarios. As I mentioned earlier, I am simply interested in knowing your honest views and if at any point you have any clarifying questions please feel free to ask them.

Scenario 1

Professor Lucas Bang and Julie Medero teach a first-year Data Structures and Program development course at a mid-western university. They have developed a unique assignment for their course that uses a C++ Turtle class to generate embroidery patterns. This is the first time students will work with C++. The assignments allow students to practice writing functions in C++, read input from a file, work with statically-sized arrays of primitives, and apply their CS skills to communicate information from other disciplines. The goal of the assignment is for students to be able to use the program to create their own embroidered patch as shown in the example below

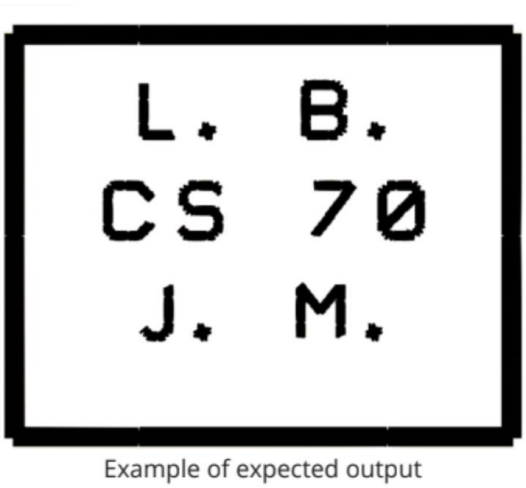

Figure 1. Example of expected embroidery output

To allow you to understand the assignment in detail here is a pdf version of it: C++ Turtle Class Embroidery assignment. (Note: This assignment is an intellectual property and should not be shared without permission from the researcher.)

1. What are your thoughts on Professor Bang and Medero's use of embroidery assignments in their Data Structures and Programming course?
2. What value do you think does the embroidery assignment has in engaging students' interest and their persistence in their degree?
3. How might something like this work in the CS course at the institution you teach?
4. Do you think the readings, 'Hilda Wove All Those Wires' and 'Jacquard's Web, Chapter 5 excerpt: From Weaving to Computing', add any value to this assignment?
5. What are some challenges that you see in CS faculty implementing such a programming assignment in their course?
    a. What do you imagine are some benefits of using such assignments in a CS course?
    b. What do you imagine are some challenges of using such assignments in a CS course?

Scenario 2

Professor Garcia teaches a Web-application development course at a mid-west university. She wants to do a better job at recruiting and retaining historically marginalized students in her computer science courses. In order to be culturally responsive in her teaching, Prof. Garcia has leveraged the expertise of faculty within the university's African American Studies programs and partnered with the local water quality and a testing firm, Culligan Home Water Testing, to help students understand the issues around access to drinkable water. A representative from the African American Studies program explains to the students how the contamination of water disproportionately affects Black and low-socioeconomic status communities at a higher rate than

their privileged counterparts. Employees from the Culligan Home Water Testing firm provide students with data on which communities have been hit by a lack of access to healthy water. As one of the assignments for this course, she has asked students to design a web tool that allows residents to enter location data onto the website, which informs them whether the water is contaminated in their community.

1. Professor Garcia leveraged community-based resources (at the university through African American Studies and at the local level through Culligan Home Water Testing) as a part of her assignment, what are your thoughts on the use of such resources in a CS course?
2. Would this be something you could accomplish in any of the CS courses you teach?
3. How might the use of community-based resources in CS work at your university?
    a. What challenges do you anticipate in implementing a similar assignment in the course/courses you teach?
4. How else might CS faculty use community-based resources in a CS course?
5. What are some challenges when considering community-based resources in a CS course?
    a. What do you imagine are some advantages of using community-based resources in a CS course?
    b. What do you imagine are some barriers to using community-based resources in a CS course?
6. Do you think such initiatives where faculty leverage community resources into their course will help retain historically disenfranchised students in CS?

Questions on culturally responsive computing (CRC)

We are to discuss some issues around CRC. CRC urges computer science educators to help students from disenfranchised/marginalized communities to

- envision themselves as digital innovators,
- provide students autonomy in exploring the boundaries of what technologies can do,
- help students recognize that irrespective of their gender or race they have as much as a right to receive technological education, and
- help them explore the interdisciplinary implementation of their CS skills to help solve local communities' problems (Scott, Sheridan, & Clark, 2015).

1. What are your thoughts on CS courses having projects and assignments that draw upon students' interests, experiences and cultural backgrounds?
    a. What might some challenges be related to implementing such projects/assignments?
    b. What are some potential benefits?
2. Are there other approaches that might work better in drawing upon students' interests and backgrounds in a CS course? If so, how?

3. What are some of the resources that exist at your university to integrate more equitable practices in your courses?
4. How can faculty include students' cultural and ethnic experiences in their own teaching?
5. What role do instructional strategies and pedagogical practices play in increasing diversity and equity in computer science programs?
6. What are some of the practices you use in your own teaching to address issues of diversity and equity?
7. In particular, how do you think faculty can support students from disenfranchised communities?
8. In particular, how do you think faculty can support women?

BIBLIOGRAPHY

BIBLIOGRAPHY

Abebe R., Hill S., Vaughan J. W., Small P. M., and Schwartz, A. H. (2019). Using search queries to understand health information needs in Africa. In *Proceedings of the International AAAI Conference on Web and Social Media*, Vol. 13. 3–14..

Benjamin, R. (2019). Race after technology: Abolitionist tools for the new jim code. *Social Forces*.

Canning, E. A., Muenks, K., Green, D. J., & Murphy, M. C. (2019). STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes. *Science advances, 5*(2), eaau4734.

Charleston, L. J. (2012). A qualitative investigation of African Americans' decision to pursue computing science degrees: Implications for cultivating career choice and aspiration. *Journal of Diversity in Higher Education*, *5*(4), 222–243. https://doi.org/10.1037/a0028918

Charleston, L. J., George, P. L., Jackson, J. F. L., Berhanu, J., & Amechi, M. H. (2014). Navigating Underrepresented STEM Spaces : Experiences of Black Women in U . S . Computing Science ... Navigating Underrepresented STEM Spaces : Experiences of Black. *Journal of Diversity in Higher Education*, *7*(May 2015), 166–176. https://doi.org/10.1037/a0036632

Cheryan, S., Plaut, V. C., Davies, P. G., & Steele, C. M. (2009). Ambient Belonging: How Stereotypical Cues Impact Gender Participation in Computer Science. *Journal of Personality and Social Psychology*, *97*(6), 1045–1060. https://doi.org/10.1037/a0016239

Cheryan, S., Plaut, V. C., Handron, C., & Hudson, L. (2013). The Stereotypical Computer Scientist: Gendered Media Representations as a Barrier to Inclusion for Women. *Sex Roles*, *69*(1–2), 58–71. https://doi.org/10.1007/s11199-013-0296-x

Eglash, R., & Bennett, A. (2009). Teaching with Hidden Capital : Agency in Children's Computational Explorations of Cornrow Hairstyles. *Children, Youth and Environments*, *19*(1), 58–73.

Gee, J. P. (2012). The Old and the New in the New Digital Literacies. *The Educational Forum*, *76*(4), 418–420. https://doi.org/10.1080/00131725.2012.708622

Gilbert, J. E., Jackson, J. F. L., Dillon, E. C., & Charleston, L. J. (2015). Broadening Participation African Americans in the US Computing Sciences Workforce, (March 2016). https://doi.org/10.1145/2770929

Goode, J., Peterson, K., & Chapman, G. (2019). Online Professional Development for Computer Science Teachers: Gender-Inclusive Instructional Design Strategies. *International Journal*

of Gender, *11*(3).

Google. (2014). *Women Who Choose Computer Science — What Really Matters -- The Critical Role and Exposure*. 1–8. https://doi.org/https://docs.google.com/file/d/0B-E2rcvhnlQ_a1Q4VUxWQ2dtTHM/edit

Google Inc. (2020). *Google Diversity Annual Report 2020*.

Harding, S. (2006). Science and Social Inequality Introduction.pdf. *Science and Social Inequality: Feminist and Postcolonial Issuas*.

Haynes, C., & Patton, L. D. (2019). From Racial Resistance to Racial Consciousness: Engaging White STEM Faculty in Pedagogical Transformation. *Journal of Cases in Educational Leadership*, *22*(2), 85–98. https://doi.org/10.1177/1555458919829845

Hegewisch, A., Childers, C., & Hartmann, H. (2019). *Women, Automation, and the Future of Work*.

Howard, T., & Terry, C. L. (2011). Culturally responsive pedagogy for African American students: Promising programs and practices for enhanced academic performance. *Teaching Education*, *22*(4), 345–362. https://doi.org/10.1080/10476210.2011.608424

Ivey, A., Johnson, S. R., Skorodinsky, M., Snyder, J., & Goode, J. (2021). Abolitionist Computer Science Teaching : Moving from Access to Justice. *IEEE*.

Buolamwini, J. & Gebru, T. (2018). Gender shades: Intersectional accuracy disparities in commercial gender classification. In *Conference on Fairness, Accountability and Transparency*. 77–91.

Lachney, M. (2016). Culturally responsive computing as brokerage : toward asset building with education-based social movements building with education-based social movements. *Learning, Media and Technology*, *9884*(August), 0–20. https://doi.org/10.1080/17439884.2016.1211679

Lachney, M. (2017). Computational communities : African-American cultural capital in computer science education. *Computer Science Education*, *27*(3–4), 175–196. https://doi.org/10.1080/08993408.2018.1429062

Lachney, M., & Yadav, A. (2020). Education: Computing and community in formal education. *Communications of the ACM*, *63*(3), 18–21. https://doi.org/10.1145/3379918

Ladson-Billings, G. (1995). Toward a Theory of Culturally Relevant Pedagogy. *American Educational Research Journal*, *32*(3), 465–491. https://doi.org/10.3102/00028312032003465

Ladson-Billings, Gloria. (1995). Toward a Theory of Culturally Relevant Pedagogy Author(s Toward a Theory of Culturally Relevant Pedagogy. *American Educational Research Journal American Educational Research Journal Fall*, *32*(3), 465–491. Retrieved from http://www.jstor.org/stable/1163320%5Cnhttp://about.jstor.org/terms

Lewis, C. M., Anderson, R. E., & Yasuhara, K. (2016). "I Don't Code All Day": Fitting in Computer Science When the Stereotypes Don't Fit. *Proceedings of the 2016 ACM Conference on International Computing Education Research - ICER '16*, 23–32. https://doi.org/10.1145/2960310.2960332

Marshall, Bryan; Cardon, Peter; Poddar, Amit; Fontenot, R. (2013). Does Sample Size Matter in Qualitative Research ?: a Review of Qualitative Interviews in Is Research. *Journal of Computer Information Systems*, *54*(1), 11–22. https://doi.org/10.1111/jan.12163.

National Center for Science and Engineering Statistics. (2019). *Women, minorities, and persons with disabilities in science and engineering*. *National Science Foundation*.

Noble, S. U. (2018). *Algorithms of oppression*. New York University Press.

Ostrander, R. R. (2015). School funding: Inequality in district funding and the disparate impact on urban and migrant school children. *Brigham Young University Education and Law Journal*, (1), 271–295.

Paris, D. (2012). Culturally Sustaining Pedagogy: A Needed Change in Stance, Terminology, and Practice. *Educational Researcher*, *41*(3), 93–97. https://doi.org/10.3102/0013189X12441244

Paris, Django. (2012). Culturally sustaining pedagogy: A needed change in stance, terminology, and practice. *Educational Researcher*, *12*(1), 93–97. https://doi.org/10.3102/0013189X12441244

Perrakis, A. I. (2008). Factors Promoting Academic Success Among African American and White Male Community College Students. *New Directions for Community Colleges*, (142), 15–23. https://doi.org/10.1002/cc

Phinney, J. S. (1992). The multigroup ethnic identity measure: A new scale for use with diverse groups. *Journal of Adolescent Research*, *7*(2), 156–176.

Rankin, Y. A., Jakita, T. O., & Hawkins, S.-M. (2014). From Consumers to Producers : African American Middle School Students as Game Designers.

Rodriguez, S. L., & Lehman, K. (2018). Developing the next generation of diverse computer scientists : the need for enhanced , intersectional computing identity theory. *Education Publications*. https://doi.org/10.1080/08993408.2018.1457899.

Salazar, M. D. C. (2013). A Humanizing Pedagogy : Reinventing the Principles and Practice of Education as a Journey Toward Liberation. *Review of Research in Education*, *37*, 121–148. https://doi.org/10.3102/0091732X12464032

Sax, L. J., Blaney, J. M., Lehman, K. J., Rodriguez, S. L., George, K. L., & Zavala, C. (2018). Sense of Belonging in Computing : The Role of Introductory Courses for Women and Underrepresented Minority Students. *Social Sciences*, *7*(122). https://doi.org/10.3390/socsci7080122

Scott, K. A., Sheridan, K. M., & Clark, K. (2015). Culturally responsive computing: a theory revisited. *Learning, Media and Technology*, *40*(4), 412–436. https://doi.org/10.1080/17439884.2014.924966

Scott, K. A., & White, M. A. (2013). COMPUGIRLS' Standpoint:Culturally Responsive Computing and Its Effect on Girls of Color. *Urban Education*, *48*(5), 657–681. https://doi.org/10.1177/0042085913491219

Shivers-mcnair, A., Gonzales, L., & Zhyvotovska, T. (2019). An Intersectional Technofeminist Framework for Community-Driven Technology Innovation. *Computers and Composition*, *51*, 43–54. https://doi.org/10.1016/j.compcom.2018.11.005

Smyth, F. L., & McArdle, J. J. (2002). *Ethnic and Gender Differences in Science Graduation at Selective Colleges for Admission Policy and College Choice*.

Sutherland, J. A. (2011). Building an Academic Nation Through Social Networks : Black Immigrant Men in Community Colleges. *Community College Journal of Research and Practice*, *35*(3), 267–279. https://doi.org/10.1080/10668926.2011.528665

Trim, M. (2020). Essentialism is the enemy of the good: How the myth of objectivity is holding computing back. *ACM Computers & Society*, *49*(2), 11–13.

Vee, A. (2017). *Coding Literacy: How computer programming is changing writing*. Cambridge, MA: The MIT Press.

Vitores, A., & Gil-juárez, A. (2017). The trouble with ' women in computing ': a critical examination of the deployment of research on the gender gap in computer science. *Journal of Gender Studies*, *9236*(June), 1–15. https://doi.org/10.1080/09589236.2015.1087309

Washington, A. N. (2020). When twice as good isn't enough the case for cultural competence in computing. *Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE*, 213–219. https://doi.org/10.1145/3328778.3366792

Washington, A. N., & Romanova, A. (2018). The Importance of Identity in Preparing a Diverse Computing Workforce. *Journal of Business, Industry, and Economics*, *23*, 42–59.

Weinstein, C., Curran, M., & Tomlinson-Clarke, S. (2003). Culturally responsive classroom management: Awareness into action. Theory into practice, 42(4), 269-276.