

WIP: Empowering Change by Cultivating Critical Consciousness in Computer Science Education at a Hispanic-Serving Institution

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Abstract—This research WIP paper presents findings from an interpretive case study of computer science (CS) students in a leadership course at a Hispanic-Serving Institution (HSI). The course incorporated a curriculum centered on building students' critical consciousness so that students were empowered to recognize and challenge structural barriers related to race and gender disparities in CS education and the workforce. Such awareness is imperative for actively engaging in the transformative process necessary for effecting meaningful change. Furthermore, fostering students' critical consciousness stands as a key endeavor, particularly within disciplines such as computer science, given the profound societal ramifications inherent to this field. Data were collected from surveys, such as the critical consciousness scale [1] to examine students' levels of critical consciousness awareness at the beginning of the semester. Preliminary findings on students' understanding of critical consciousness demonstrate an initial misconception of the term critical consciousness, possibly due to limited exposure to the concept. However, after engaging in lessons on gaining awareness of various forms of oppression within the educational system, students exhibited feelings of validation for their own experiences. Towards the end of the course, students were able to identify ways in which systemic oppression manifested itself in CS contexts and devised plans for collectively combating these injustices. This data underscores the need for more opportunities for the development of critical consciousness, emphasizing its dual significance in both understanding systemic and social barriers that limit Hispanic students' access to CS education and the workforce. This skill is necessary for propelling students to take action in challenging barriers, especially in a stratified technological world.

Keywords – *Critical Consciousness, Leadership, Computer Science Students, Hispanic-Serving Institutions.*

I. INTRODUCTION

The ubiquity of technology across various social sectors and its impact on historically underserved and minority populations in the world and within the United States underscores the imperative need for computer science (CS) professionals who not only master technical skills related to the field but also embody a range of professional skills [2] and a lens grounded in

critical consciousness [3]. Exacerbating the problem is the significant lack of diversity within the computing field, which introduces additional complexity to the challenges encountered in computer science education and the workforce [4],[5]. In response, Hispanic-Serving Institutions (HSIs) are pioneering initiatives in computing education to bolster Hispanic students' development of both critical consciousness and leadership skills to better equip them for responding to the dynamic CS sector and its effects on minorities.

This study, informed by critical approaches [3] and relational leadership models [7], [8], delves into Hispanic CS undergraduates' perceptions of critical consciousness following their participation in two leadership courses at an HSI. It focuses on how a subgroup of these students articulated intersectionalities between their critical consciousness, leadership, and their ethical and racial identities. Our research specifically explores students' perceptions of the role computer scientist can have in exacerbating and ameliorating social inequities.

II. BACKGROUND

A. Critical Consciousness in CS

While many of the efforts to diversify computer science have focused on simply increasing enrollment of diverse students in computer science, researchers argue for a need to add criticality to computer science education [6]. This means providing students with a curriculum that helps them develop the critical lens necessary to examine how technology can often be designed and deployed in ways that harm and oppress communities of color. These researchers argue that being a “good” coder means also gaining an understanding of social contexts and the civic responsibility coders have toward creating a more just future [6].

Gaining critical consciousness is one way students can gain a critical lens to identify inequities in our society and feel empowered to address those inequalities. Critical consciousness is a powerful tool for societal transformation that focuses on motivating individuals to combat oppression, violence, and dehumanization within their communities [3].

Additionally, growing research has found that critical consciousness development can be an important predictor of positive outcomes for those who have been marginalized by inequities due to race, gender, ethnicity, class, immigration status, and language [9]. In a study on how core components of critical consciousness contribute to academic achievement, researchers found critical consciousness development among youth from minoritized communities, contributed to an increase in Scholastic Aptitude Test scores and grade point average. Furthermore, youth who gain critical consciousness are more likely to demonstrate resilience, mental health, self-esteem, academic achievement, and high professional aspirations [9]. In addition to that, research on related topics such as critical race consciousness has noted that such development among youth of color helped them develop a positive racial identity [10]. Therefore, by incorporating critical consciousness development in computer science curriculum, students have to opportunity to not only become computer scientist that are aware of the social, political and economic implications of technology, but are also gaining the empowerment to make change.

B. Leadership for Students at HSIs

This project used the Relational Leadership model which focuses on centers social justice and ethics [11], [8]. In this way, the Relational Leadership model is purposeful, inclusive, empowering, ethical, and process-oriented, which assists students in identifying leadership as a relational, non-hierarchical process [12]. For instance, this model involves students in managing conflicts and navigating ethical dilemmas by deeply reflecting on both personal and collective values. This process fosters a sense of positive interdependence and consciousness of self in relation to others, ultimately encouraging a commitment to their communities [12]. These socially constructed views of leadership enhance inclusion, diversity, and social cooperation by emphasizing the role of the community [14]. This approach is essential in HSIs' contexts because previous research found that students of color perceive hierarchical leadership models as approaches that are ways to perpetuate oppression, inhibiting them from viewing themselves as leaders despite their skills [15]. Further, some authors have highlighted the relevance of leadership models that involve students in reflective processes that support them in becoming change agents who acknowledge the humanity in those around them and aspire to create dynamic transformation that impacts both self and society [16]. This course Leadership program has focused on developing Hispanic CS students' professional skills by considering their cultural values, community perspectives, peer interaction, and professional field-based components [17], [18].

III. THEORETICAL FRAMEWORK

Critical consciousness is the ability to critique systems of oppression and inequity while also gaining an understanding of how agency plays a role in resisting these systems [3]. This term was originally conceived of Brazilian educator Paulo Freire while he was working with day laborers in Brazil. Freire came to understand that inequality is sustained when the people who are most oppressed are unable to understand their social conditions [19].

Critical consciousness is one component of Paulo Freire's critical pedagogies, which center around the idea that education can be used as a tool for social change and empowerment [3, 20]. Other key components of critical pedagogy include problem-posing education, dialogical methods, anti-oppressive education, cultural circles, and a strong emphasis on liberation [3]. Key principles of critical pedagogies assert that knowledge should emerge from and be relevant to the lived experiences of participants, be co-created among all participants in the learning process, and recognize that education is inherently political. [20]. According to Freire, applying these critical pedagogies in the classroom can lead to liberating individuals and communities from oppression, fostering a more just and equitable world.

Developing critical consciousness occurs in a series of stages. The first stage is gaining critical analysis, this requires developing an awareness of the systems and structures that create and sustain inequity. The second stage, sense of agency, enables people to develop a sense of power or the capability to make change. The last stage is critical action, this stage prompts people to make a commitment towards taking action against oppressive forces [3].

IV. METHODOLOGY

This study is part of a larger grant-funded project that aims to support CS Latinx undergraduate students in developing and honing professional skills and critical minds needed for positions in IT (e.g., software development, data science, cybersecurity) [6]. We chose a concurrent mixed methods approach to understand critical consciousness and its relevance within CS contexts. As a mixed methods study, we investigate students' perspectives and understanding of critical consciousness and leadership in CS. Both quantitative and qualitative data were collected in this study at approximately the same point in time. To understand their critical consciousness and leadership understanding, we apply the Critical Consciousness Scale, conduct participant observations, and analyze student's artifacts. The following research questions guided this study:

1) *Context and Participants*: This study takes place at a Hispanic-Serving institution in the southwest that enrolls a majority of Hispanic students. More than half of the students at this institution are Pell Grant eligible and the first in their families to go to college. This research was conducted at a prominent public Hispanic-Serving Institution (HSI) situated on the U.S.-Mexico border. Within this broader setting, the Computer Science department has introduced a leadership seminar to help CS students build and hone their critical minds and leadership skills. Twenty-four of the twenty-seven CS students enrolled in the leadership course consented to participate in the study (21 men and 3 women). Around 90% of the students in this project identified as Hispanic.

2) *Data Collection and Analysis*: For this study, we focused on examining CS students' views and understanding of the role of critical consciousness and leadership in CS. We drew on a concurrent mixed methods design because it provides

triangulation and complementary data [21], [22]. To gain quantitative insight into the changing perspectives among student participants, the research team implemented the Critical Consciousness Scale (CCS) [1] as a pre and post-assessment at the beginning and end of the semester. The CCS is comprised of 22 items with a 6-point scale ranging from Strongly Disagree to Strongly Agree. The CCS items were loaded onto three subscales and the research team examined the responses among the first subscale, Critical Reflection: Perceived Inequality, due to its conceptual overlap with the aims of the current endeavor. The pretest received 17 responses and the posttest received 8 responses with the research team observing a mixture of respondents who completed only the pretest, respondents who completed only the posttest, and respondents who completed both. Considering this, the research team decided that a descriptive analysis of these responses was most appropriate for incorporating in this specific study. Qualitative data sources included classroom observations and student artifacts (e.g., homework, in-class reflections, and group presentations). Data collected were analyzed through a constant comparative method in which data are coded, sorted, and organized in a structure to emerge into relevant themes [23]. We have used pseudonyms for all the students to ensure confidentiality.

V. PRELIMINARY FINDINGS

Quantitative Findings. Table 1 presents the findings of the analysis from the survey results. Within the subscale overall, an average increase of 0.4 points was observed from the pretest to the posttest, indicating a small shift towards agreement with the items. The largest magnitude average difference score (0.7) was observed from the item “Poor people have fewer chances to get ahead,” while the smallest magnitude difference score (0.0) was observed from the item “Women have fewer chances to get good jobs.”

Table 1. Descriptive analysis of Critical Reflection subscale

Question	Pretest Mean (sd)	Posttest Mean (sd)	Difference (Post – Pre)
Certain racial or ethnic groups have fewer chances to get a good high school education.	3.5 (1.4)	4.0 (1.4)	0.5
Poor children have fewer chances to get a good high school education	3.9 (1.6)	4.4 (1.5)	0.5
Certain racial or ethnic groups have fewer chances to get good jobs	3.4 (1.7)	3.9 (1.1)	0.5
Women have fewer chances to get good jobs	2.9 (1.8)	2.9 (1.7)	0.0
Poor people have fewer chances to get good jobs	3.5 (1.6)	3.8 (1.7)	0.3
Certain racial or ethnic groups have fewer chances to get ahead	3.2 (1.6)	3.8 (1.4)	0.6
Women have fewer chances to get ahead	2.5 (1.5)	2.9 (1.6)	0.4
Poor people have fewer chances to get ahead	3.4 (1.7)	4.1 (1.5)	0.7
Critical reflection subscale overall	3.3 (0.4)	3.7 (0.6)	0.4
Note: Items are scored on a scale from Strongly Disagree (1) to Strongly Agree (6)			

Qualitative Findings. The themes that emerged from the qualitative data, more specifically from the students' artifacts and our field notes from our participant observations illustrate that (a) developing critical consciousness helped validate students' experiences to empower them to become leaders and (b) students were able to make connections between the relevance of having a critical mind and leadership in CS.

A. Gaining Awareness of Inequities to Prompt Change

The first stage of gaining critical consciousness entails "learning to perceive social, political and economic contradictions." [24]. Preliminary findings from student observations and an analysis of students' assignments show that after gaining an awareness of the ways in which oppression is embedded in educational systems, some students in the study were able to gain feelings of validation when they compared their educational experiences with examples of oppressive systems at work in education. For example, one student shared, "I really enjoyed this presentation because I was able to relate to a lot of what was being said. I come from a working-class school and I wish we were given the education that the elite schools had." In this example, the student was able to make a connection between the inequalities they learned about in class to the inequities they personally experienced while navigating the educational system.

Additionally another student reflected on the critical consciousness lecture and stated, “ Critical consciousness is important for college students because it allows them to see their environment in a new lens that empowers them to take action to change the things that are not ideal. I found this presentation to be very enlightening and interesting as I had already heard about some of the things discussed and their importance, such as being willing to change the things about our environment (school, work, city, etc.) that we see are unfair or unequal.” In this example the participant shares the importance they felt gaining critical consciousness can have on college students and felt that this could help students act towards changing inequalities they observe in their environments.

B. Students' Views of Intersections between Critical Consciousness and Leadership in CS

After analyzing students' artifacts, we discovered that students' understanding of critical consciousness consistently related to their views of the relational leadership model. We found that students were able to integrate the elements of the relational leadership model (RLM) and synthesize them into their understanding of their role as computer scientists in detecting, addressing, and taking action to solve social and ethical issues that could impact the Latinx community. In other words, all the students conceptualized and understood the relevance of developing their critical consciousness to create "safe" CS education environments where their perspectives are valuable and relevant for developing new technologies that are inclusive and ethical.

These students' views of leadership also demonstrated their understanding of critically conscious leaders who use their power to promote justice, inclusion, and values in their communities to promote positive change in all contexts (e.g., CE education and workforce). For example, one student reflected the following after being asked what they saw was the

connection between a relational leadership model and critical consciousness development, “As we found out in the previous lecture, critical consciousness is the ability to understand/question social and political and economic structures... So, with this in mind I found that the reading [on relational leadership] was not only enjoyable, but it did relate to being critically conscious. It engages the readers to reflect on personal experiences and question established norms of leadership. It focused on inclusivity (hearing other opinions/views), empowerment (helping others with resources/motivation to contribute), and ethics (moral way) in all, relational leadership reflects a critical awareness in society.”

This student was able to draw connections between the role of critical consciousness and how an awareness of inequities in society aligns with relational leadership models that center on inclusivity, empowerment, and ethical considerations.

VI. CONCLUSION

In this paper, we discussed findings from an interpretive case study of computer science (CS) students in a leadership course at a Hispanic-Serving Institution (HSI).

Given quantitative results, for the item “Poor people have fewer chances to get ahead” we can see a significant shift in participants’ views on social mobility for economically disadvantaged groups. This could imply that the course effectively raised awareness or altered perceptions about the structural challenges faced by poor people. Moreover, this might also imply that students might personally relate to the statement as most identify as Pell Grant eligible impacting their responses and perspectives. Conversely, the item “Women have fewer chances to get good jobs” showed a minimal change, with a score of -0.07. This slight decrease might suggest that participants either entered the course with already established views about gender and employment that were resistant to change, or the course content may not have effectively addressed or impacted their perceptions in this area. The minimal change in perceptions regarding gender and employment opportunities could also be attributed to the small number of women participating in the study, leading to a lack of direct personal connection with the item. This minimal change in perceptions regarding gender and employment opportunities suggests a need for either a different instructional approach or more in-depth coverage to influence entrenched beliefs.

The preliminary qualitative findings suggest a significant impact from the lessons aimed at raising awareness about oppression within educational systems. The observations and analyses indicate that students who engage with this content are not only able to recognize the disparities inherent in their educational experiences but also find validation in understanding the systemic roots of these inequalities when comparing them to their own experiences. Moreover, the findings illustrate how gaining critical consciousness empowers students to perceive their environments through a new lens, fostering a sense of agency to address and challenge inequities. These insights underscore the importance of incorporating critical pedagogy into educational practices to promote student empowerment and advocate for meaningful societal change.

Additionally, the qualitative findings underscore the interconnectedness between critical consciousness and effective leadership paradigms, particularly relational leadership. Through insightful reflections, students showcased their understanding of how critical consciousness fosters an awareness of societal structures and injustices, aligning with the principles of inclusivity, empowerment, and ethics inherent in relational leadership. This highlights the potential of nurturing critical consciousness in individuals to cultivate leaders who prioritize justice and inclusion, not only within educational and workforce contexts but also in broader community settings. By recognizing and embracing these connections, educators and leaders can work collaboratively to foster environments that promote positive social change and address systemic inequities.

VII. LIMITATIONS AND FUTURE WORK

The data for this study was collected from a computer science leadership course specifically designed to enhance students' critical consciousness. Since this was the inaugural iteration of the course with a focus on critical consciousness, the number of participants was limited. Future research should include students from subsequent iterations of the course to increase the sample size and improve the generalizability of the findings, for example having more women participate could shed light on some of the quantitative findings.

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