Oxford Intersections: Racism by Context

(In Progress)

Meena Dhanda (editor in chief)

https://doi.org/10.1093/9780198945246.001.0001

Published: 20 March 2025 - **Online ISBN:** 9780198945246

ARTICLE

A Change Is Gonna Come: Transforming Computing (Education) from the Margins

Nicki Washington

https://doi.org/10.1093/9780198945246.003.0060

Published: 20 March 2025

Abstract

Successfully addressing the biases in technology resulting from artificial intelligence first requires successfully addressing the biases in academic/professional computing spaces that result from language rooted in white supremacy, stereotypical assumptions about students and faculty based on racial identity, false notions of objectivity and meritocracy, and epistemic exclusion of topics and research that deviate outside of what is considered quantitatively rigorous. This requires redefining computing epistemologies in terms of (1) what is considered computing knowledge, and (2) who are considered knowledge producers. Motivated by the global COVID-19 pandemic, Black Lives Matter protests of 2020, and Duke University's 'Race, Gender, Class, & Computing' course, the Cultural Competence in Computing (3C) Fellows programme used a 'train-the-trainer' approach to incorporate social sciences and humanities into postsecondary computing curricula while also creating more inclusive and equitable academic spaces for students, faculty, and staff from groups that are historically underrepresented in computing based on identity (e.g., race, ethnicity, gender, socioeconomic status, and disability status). The two-year professional development programme centred Black feminist epistemologies as a framework, and participants were encouraged to leverage programme material in the required development of identity-inclusive courses, modules, and other activities at their home institutions. This study examines the impact of five new computing courses on student cultural competence. The courses were piloted by 3C Fellows between the fall 2021 and spring 2023 semesters. Each course critically examined how identity impacts and is impacted by computing, representing the first course of its kind in each department. Results indicate not only a statistically significant improvement in collective cultural competence, but also the potential to significantly improve the cultural competence of students who are overrepresented in computing (e.g., white men), thereby improving academic and, ultimately, professional computing spaces.

Keywords: bias, computing, identity, Black feminist epistemologies, cultural competence

Subject: Artificial Intelligence, Race and Ethnicity, Higher and Further Education, Social Sciences, Arts and Humanities

Section: The Sciences, Medicine, and Technology

Section editors: Ebony McGee, Evelynn Hammonds, Thema Monroe-White

Collection: Oxford Intersections

Introduction

The rapid growth of artificial intelligence (AI)[1] reflects how the tech industry continues to push the boundaries of possibilities across every sector, including education, entertainment, healthcare, law enforcement, and more. However, scholars, particularly Black and other women of colour, activists, and citizens, have consistently raised alarms about the racism and other harms present that impact vulnerable communities (Bajorek, 2019; Broussard, 2018, 2023; O'Neil, 2023; Perez, 2019).

For example, healthcare software assigns race adjustments to Black patients based on assumptions about Black bodies that are rooted in white supremacy, thereby lowering their chances of receiving life-saving medical treatments (El-Azab & Nong, 2023; Seyyed-Kalantari et al., 2021; Siddique et al., 2024). Other healthcare software that determines medical services using historical spending patterns favours white over Black patients (Obermeyer et al., 2019; Owens & Walker, 2020). Facial recognition technology's low accuracy for darker skin tones (Benjamin, 2019; Buolamwini & Gebru, 2018), coupled with surveillance technologies that allow both law enforcement and private citizens to overpolice Black people (Browne, 2015), place them at higher risks of false arrests and imprisonment. Additionally, predictive software assigns higher recidivism rates to accused Black and brown offenders versus white ones, thereby increasing incarceration rates (Mattu et al., n.d.). Finally, the top search engine results for Black, Latina, and Asian girls were previously pornography websites (Noble, 2013, 2018), and AI images often return racist and misogynistic images of people of colour (Ananya, 2024; Tiku et al., n.d.).

While a more diverse tech workforce is a commonly presented solution to these issues, this implies that the only people who can properly identify and address these technological harms are those who experience them. It also ignores the harms that students, faculty, and staff from these same identities experience in academic computing spaces, further contributing to the lack of diversity, equity, and inclusion (DEI) in these and (ultimately) professional computing spaces (Huff et al., 2021; Jones & Melo, 2021; Marshall et al., 2021; McGee, 2020; McGee & Stovall, 2020; Miriti, 2020; Newsome, 2022; Rankin et al., 2021; Scott et al., 2017). For example, terminology that is rooted in white supremacy has long been part of the computing lexicon (Conger, 2021; *Words Matter*, n.d.). Stereotypical assumptions about the academic abilities of students based on their racial identities result in biased beliefs that students who are overrepresented in computing will succeed and those who are the least represented will fail (Marshall et al., 2021; McGee, 2018). Campus policing emboldens faculty, staff, and students to actively surveil and, in some instances, report Black people who appear to 'not belong' in these spaces (Carpenter et al., 2024; Cole, 2021; Russell, n.d.). Biased course evaluations that negatively impact Black women faculty who do not present as 'subservient' enough (Harlow, 2003) are prioritized in hiring, reappointment, promotion, and tenure decisions, while DEI-related service and invisible labour, such as mentoring students and colleagues from minoritized groups, are not (Matthew, 2016). When reporting instances of racism and other harms, students, faculty, and staff experience testimonial injustices that invalidate their credibility as 'knowers' of their own lived experiences (Hatch et al., 2022; Matthew, 2016). Finally, the epistemic exclusion of research, often performed by Black and brown scholars, is rooted in exclusionary notions of quantitative 'rigour' that limit what 'counts' as research, thereby again impacting hiring, reappointment, promotion, and tenure decisions (Ross, 2023; Settles et al., 2021; Washington, 2022b).

It is important that every computing graduate, regardless of racial identity, better understand not only how these biases manifest, but also how the root causes are often traced to historical instances of racism and other oppressions and their disproportionate impact on how minoritized racial groups consume and create technology. As consumers, the impact ranges from inconvenient to life-threatening and, in some cases, life-ending (Eubanks, 2018; O'Neil, 2016; Wachter-Boettcher & Emmes, 2017). As (future) creators, the impact ranges from lost academic/professional opportunities, lack of belonging (Fisher et al., 2019; Krause-Levy et al., 2021; Langin, n.d.), lost time that is not focused on academic/professional obligations (Shattuck & Cheney, n.d.), and (ultimately) low retention rates. For those who persist in the discipline, the weathering they experience and the physiological effects of constant stress from experiencing oppression further impact their overall health and life expectancy:

> Specific triggers of accelerated aging processes are more likely to be activated in oppressed people when they find themselves in relatively advantaged settings, like colleges...and professional workplaces that are predominantly white, often historically designed to exclude Black Americans, and rarely designed with their needs in mind.
>
> (Geronimus, 2023, p. 27)

This work posits that successfully addressing the bias in technology first requires successfully addressing the bias in academic/professional computing spaces. Doing so would redefine not only what is considered computing knowledge but also who is considered a knowledge producer. Ultimately, this would result in every computing graduate demonstrating a baseline cultural competence and understanding of identity-inclusive computing (i.e., how race, ethnicity, gender, sexuality, ability, and socioeconomic status are impacted by computing) (Washington, 2020; Washington et al., 2022), which is taught/cultivated in postsecondary computing departments.

Statement of Positionality

As a Black woman, my experiences navigating society as well as academic/professional computing spaces were heavily influenced by both my race and gender. Although I attended racially diverse, public K-12 schools, I still experienced adultification bias from white women educators at an early age because I did not smile enough or called out anti-Black statements in class (Epstein et al., 2017; Washington, 2018). These labels of 'aggressive' and 'angry' would later translate to controlling images of Black women that were used to describe me in academic (i.e., graduate school) and professional (i.e., summer internships and postgraduation employment) spaces that were primarily non-Black (Collins, 2009; Rankin et al., 2021).

As a Gen X'er who was born and raised in the South, the only academic/professional spaces in which my racial identity did not negatively impact my experiences were Historically Black Colleges and Universities (HBCUs), where I was both a computer science undergraduate and a professor. Outside of these experiences, I have usually been the only Black woman (or one of the few) in a department and/or academic unit. As a result, I have experienced epistemic exclusion and testimonial injustices such as:

- Graduate school professors and classmates who doubted my academic abilities and were therefore unwilling to serve as my advisor or accept my solutions to group assignments.
- Students who treated me differently as a professor than white and Asian male colleagues, including referring to me by first name or 'Mrs./Ms. Washington' instead of 'Dr./Professor Washington'.
- Being told I should teach a course because I would 'be a good role model'.
- Anti-Black statements from students and colleagues.
- Not believed and gaslit when addressing/reporting harms experienced.
- Research rejection as lacking in 'rigour', even in spaces dedicated to computing education research.

The impacts of these experiences ranged from wasted time defending my academic/professional abilities and practices to denied promotions and hostile work environments. However, my experiences were not unique, as Black women often experience misogynoir in computing spaces (D'Ignazio, 2021; Rankin et al., 2021; Ross et al., 2020). These experiences and their impacts were the primary motivation for developing 'Race, Gender, Class, and Computing', a three-credit-hour course that meets an elective requirement for the computer science degree at Duke University (Washington, 2022a).

Motivation

Several events served as catalysts for this study. First, the global COVID-19 pandemic that emerged in the spring of 2020 significantly impacted how people learned, worked, and lived. In the United States, K-16 school closings and shifts to remote learning highlighted a growing digital divide, especially in communities of colour (Lee, 2020). Black men expressed concerns with navigating masking requirements and racial profiling (Taylor, 2020). Finally, Black and brown communities suffered from high COVID infection rates as well as inequitable access to medical treatment and vaccinations (Tai et al., 2022).

At the same time, the murders of Breonna Taylor, Ahmaud Arbery, and George Floyd; the subsequent global Black Lives Matter movement (Burch et al., 2020); and the increasingly volatile sociopolitical landscape spurred a national discourse on race and racism in America, including the viral #BlackInTheIvory hashtag, where Black students, faculty, and staff shared experiences of anti-Black racism on Historically White College & University (HWCU) campuses (Subbaraman, 2020a). On 10 June 2020, researchers and organizations around the world participated in the #ShutDownSTEM and #Strike4BlackLives movements, where the day was spent learning more about anti-Black racism (Subbaraman, 2020b).

As postsecondary students sought ways to make sense of these experiences while still navigating academic expectations, many faculty also sought ways to better support and advocate for students and colleagues who were most impacted by these harms. This presented two challenges: (1) how to incorporate these topics into postsecondary computing curricula and (2) how to prepare computing faculty to do so. While many computing programmes include a three-credit-hour ethics course (*ABET*, n.d.; Washington, 2020), it often focuses on professional codes of conduct with respect to technology development, with little (if any) discussion of the nuanced ways in which people, policies, and practices impact different groups and, ultimately, technology development in different ways (Washington et al., 2022). Additionally, the theoretical focus of most computing programmes (*ABET*, n.d.) and overrepresentation of faculty who identify as white or Asian (race) and men (gender) (Zweben & Bizot, 2023) meant it could not be assumed that faculty were knowledgeable of these topics via formal education or lived experience. Finally, the varying and nuanced ways in which one's own identity shapes one's experiences as technology creators and consumers required an understanding of identity and intersectionality that extended beyond race and gender (Blaser & Ladner, 2020; Crenshaw, 1989). To accomplish this, a 'train-the-trainer' approach was necessary that blended the social sciences and humanities with computer science to help (future) faculty explore the impact of identity in computing spaces and their direct connections to technology development.

Cultural Competence in Computing (3C) Fellows Programme

The 3C Fellows programme is a two-year, virtual, professional development (PD) programme piloted in 2020 to: (1) help computing faculty, staff, and PhD students learn about identity, oppression, intersectionality, and how they manifest in academic/professional computing spaces, and (2) develop sustainable courses, modules, and other activities at their home institutions that directly connect these topics and the biases in both spaces and technologies developed (*3C Fellows Program*, n.d.). Programme participation was voluntary (via online application), and applicants were encouraged to form departmental/institutional 'teams' to increase the likelihood of sustainability.

In the first year, each cohort completed a curated preparatory packet (books, documentaries, and podcast episodes) and 10 two-hour workshops, including guest speakers and group (small and large) discussions. In the second year, participants designed/implemented a course, module, or other activity at their home institutions and completed two additional workshops that reflected on their programme experience, including personal, professional, and project-related successes and lessons learned. Participants also have access to a cohort-specific and greater 3C Fellows Slack workspace throughout and beyond the programme to build a community of practice.

To date, approximately 200 3C Fellows from 90 organizations spanning three countries have successfully completed the programme across three cohorts, with approximately 100 additional participants currently completing year 1 and 2 activities across two additional cohorts. This effort produced approximately 32 new computing courses, 30 new modules in existing courses, and 40 departmental activities. This study focused on the impact of courses that were piloted by 3C Fellows at their home institutions on student cultural competence. Specifically, this work seeks to answer the question: Do computing courses that transgress the traditional boundaries of computing epistemologies improve student cultural competence?

Black Feminist Epistemologies

Workshop session topics included race, ethnicity, sexuality, ability, socioeconomic status, white supremacy, misogyny/misogynoir, homophobia, transphobia, ableism, classism, and intersectionality. The exclusion of these topics in computing epistemologies (Ross, 2023; Washington, 2022b) required alternative epistemologies for programme design. Black feminist epistemologies became an important framework because they counter arguments of ‘neutrality’ and ‘objectivity’ that are foundational to computing (Flaherty, 2022). Additionally, they centre Black women, one of the least represented identities (Zweben & Bizot, 2023), as computing knowledge producers. The overarching purpose of Black feminist thought is to ‘resist oppression, both its practices and the ideas that justify it’ (Collins, 2009, p. 25). Given the ‘train-the-trainer’ model used, this framework not only challenged exclusionary claims to knowledge and credibility but also empowered the destruction of cultures of silence in computing spaces (Freire & Macedo, 2000), while preparing 3C Fellows to better develop and lead projects and discussions on these topics for students and colleagues.

Black feminist epistemologies include four key dimensions (Collins, 2009):

1. *Lived experience as a criterion of meaning*. Knowledge gained through lived experience is considered more credible than that gained through formal academic training (2009, p. 29). This criterion for credibility directly counters the postpositivist approaches to computing as well as the testimonial injustices often experienced in academic/professional spaces.
2. *Use of dialogue in assessing knowledge claims*. A key assumption for this tenet is the importance of ‘connectedness rather than separation’ for knowledge validation (Belenky et al., 1986; Collins, 2009, p. 279; Galotti, 1998). Additionally, hooks notes that ‘to hear each other (the sound of different voices), to listen to one another, is an exercise in recognition’ (hooks, 1994, p. 41).
3. *Ethics of caring*. This is explained as ‘talking with the heart’ (Collins, 2009, p. 281), which encompasses three components: individual uniqueness/expressiveness, the appropriateness of emotions in dialogues, and developing a capacity for empathy (based on increased understanding of each other’s positions), all of which counter notions of ‘objectivity’ in computer science (Flaherty, 2022; Peoples et al., 2023).
4. *Ethics of personal accountability*. An individual’s core beliefs cannot be separated from their knowledge claims and actions: ‘[E]very idea has an owner, and that owner’s identity matters’ (Collins, 2009, p. 284).

As hooks noted (1994), enacting this kind of paradigm shift in computing required closed training spaces that fostered community, accounted for educator fears, and allowed for constructive confrontation and critical interrogation. Table 1 maps each key 3C Fellows activity to a key dimension of Black feminist epistemologies.

Table 1 Mapping of 3C Fellows Activities to Key Dimensions of Black Feminist Epistemologies

Black feminist epistemology dimension	3C Fellows activities
Lived experience as a criterion of meaning	• Prep packet • Pre-session material • Workshops • Guest speaker selection • Large/breakout group discussions • Project development
Use of dialogue in assessing knowledge claims	• Workshops • Large/breakout group discussions • Slack discussions • Project development
Ethics of caring	• Prep packet • Pre-session material • Workshops • Community agreements • Large/breakout group discussions • Project development
Ethics of personal accountability	• Workshops • Community agreements • Guest speakers • Large/breakout group discussions • Slack discussions • Project development • Follow-up sessions

To ensure Black feminist epistemologies were incorporated into their course, module, and activity designs, 3C Fellows were encouraged to use all PD material, including the preparatory packet, pre-session material, and other information shared.

Methods

Participants

Participation in this study was open to postsecondary students aged 18 and older who were completing a course piloted by 3C Fellows from cohorts 1 and 2 between the fall 2021 and spring 2023 semesters. 3C Fellows from five institutions (15.6% of all organizations) within and outside of the United States self-selected to recruit student participation via their new course. A total of 186 postsecondary students aged 18 and older who were completing the course were invited to participate, with 113 respondents (60.8%) completing the study. Participants were selected by their instructor via course enrolment, and no compensation was provided. Institutional Review Board approval was obtained via Duke University, which determined that the protocol adheres to ethical principles and reporting requirements.

Participants were recruited in two phases: the first week of class (prephase) and the last two weeks of class (postphase). Approximate prephase participant demographics were as follows: Asian (44.4%), white (22.2%), Black (4.2%), Latine (gender-neutral reference to Latino/a/x) (11.1%), Middle Eastern or Northern African (4.2%), multiracial (no race/ethnicity historically underrepresented in computing) (8.3%), multiracial (one race/ethnicity historically underrepresented in computing) (4.2%), and undisclosed (1.4%). Note that races and ethnicities that are historically underrepresented in computing include Black, Native American, Native Hawaiian, Pacific Islander, and Latine. Approximately 51.4% of all respondents identified as men, 40.3% as women, 6.9% as nonbinary, and 1.4% as undisclosed. Approximately 11.1% of all prephase participants reported a disability, while 84.7% reported none, and 4.2% did not disclose. Computing majors comprised approximately 72.2% of all respondents, with 12.5% non-computing STEM; 5.5% social sciences; 1.4% humanities, arts, and business each; and 5.5% other majors. Finally, 37.5% of all participants were seniors, 31.9% juniors, 4.2% sophomores, 12.5% first years, and 13.9% graduate students.

Approximate postphase participant demographics were as follows: Asian (45.7%), white (19.8%), Black (3.7%), Latine (9.9%), Middle Eastern or Northern African (2.5%), multiracial (no race/ethnicity historically underrepresented in computing) (9.9%), multiracial (one race/ethnicity historically underrepresented in computing) (6.2%), and undisclosed (2.5%). Approximately 50.6% of all respondents identified as men, 44.4% as women, and 5% as nonbinary. Approximately 11.1% of all postphase participants reported a disability, while 81.5% reported none, and 7.4% did not disclose. Computing majors comprised approximately 74.1% of all respondents, with 14.8% non-computing STEM, 3.7% social sciences, 1.2% humanities, 1.2% arts, 2.5% business, and 2.5% other majors. Finally, 39.5% of all participants were seniors, 30.9% juniors, 3.7% sophomores, 17.3% first years, and 8.6% graduate students.

Table 2 includes the minority-serving institution (MSI) status, liberal arts status, total participants, and enrolment of each institution. Note that 'none' represents institutions that are not MSIs.

Table 2 Per-Institution Minority-Serving Institution and Liberal Arts Status, Number of Participants, and Enrolment

School	Minority-serving institution status	Liberal arts or research	*N*	*Enrolment*
1	Hispanic-serving institution	Liberal arts	14	20
2	None	Liberal arts	16	30
3	Asian American and Native American Pacific Islander-serving institutions	Research	63	98
4	None	Research	14	35
5	Hispanic-serving institution	Research	6	9

Materials

While the computing community includes a wide range of activities designed to broaden participation, the instruments that measure their impact traditionally centre on participants' sense of belonging, self-efficacy, academic performance, retention, and course/degree/career completion. These interventions, while important, are more individualistic in terms of participant development. They also focus solely on the most marginalized and minoritized identities in computing, with no activities or measurements that assess the impact of participants on others in the community (i.e., computing spaces). The 3C Survey (Washington et al., 2023) is a standalone, quantitative instrument that measures the individual cultural competence of students, faculty, and staff. Inspired by the development of instruments in counselling, social work, and healthcare, the 3C Survey is more discipline-agnostic, while also not restricting 'culture' (i.e., identity) to race. The instrument is most effective when used in longitudinal studies to measure the impact of identity-inclusive interventions that are designed to create more diverse, equitable, and inclusive academic spaces. The 3C Survey was an important and appropriate instrument for this work because it did not target specific identities. Cultural competence development/improvement is not limited to the most overrepresented or underrepresented identities. Instead, it is something that all people, regardless of identity, should improve to ensure equitable and inclusive spaces are created for all identities.

3C Survey scores range between [.2445,.978], with the highest possible score (less than 1.0) indicating cultural competence is never perfected but instead is an ongoing goal for improvement. Scores map to the following ranges:

- Cultural destructiveness [.2445,.63]: the least proficient stage, where people and organizations may be viewed as hostile towards and toxic for minoritized groups.
- Cultural incapacity [.63,.70]: organizations and/or people who may not intentionally aim to be destructive to minoritized groups but also do nothing to intentionally address destructive attitudes, policies, and practices.
- Cultural neutrality [.70,.85]: considered the midpoint and most common stage, which is often demonstrated via expressed beliefs of being unbiased and 'not seeing colour' in reference to race. However, these beliefs intentionally ignore cultural differences and encourage assimilation by rewarding those who best approximate the most dominant identities. These dominant identities in computing include white (race), cisgender (gender), able-bodied (disability status), middle-to-upper class (socioeconomic status), and men (gender).
- Cultural precompetence [.85,.92]: the first stage that is considered positive action, where people and organizations realize their deficits and attempt to improve upon them. While this phase cautions against

false senses of accomplishment or failures (Cross et al., 1989), it demonstrates a greater understanding of the varied and nuanced ways in which people navigate computing departments.

- Cultural competence [.92,.978]: people and organizations intentionally demonstrate inclusive policies and practices in the classroom and beyond, while continuously working to improve them.

The 22-item instrument includes subscales for skills, attitude, self-awareness, and knowledge, which correspond to core constructs of cultural competence (Cross et al., 1989; Kumaş-Tan et al., 2007). Participants indicate their level of agreement with statements such as 'I'd rather give someone a nickname if their name is too difficult to pronounce'; 'When it comes to race, I don't see colour'; and 'No race, ethnicity, or gender has any "privilege"' on a four-point Likert scale (i.e., 'strongly disagree' to 'strongly agree'). Cronbach's α ranged from.75 to.82 for each subscale, indicating acceptable internal consistency.

Data Collection Process

This study specifically focused on the cultural competence scores of students completing the pilot courses developed by 3C Fellows at five institutions across the first two cohorts. Courses were independently designed and implemented based on institutional demographics, curricula, and 3C Fellows' professional interests. Data were collected via a longitudinal study that measured participant responses in presurvey (first week of class) and postsurvey (last week of class) formats. 3C Fellows interested in distributing the instrument first completed an enrolment form via Qualtrics. They then received a recruitment email, informed consent form, and Qualtrics link to the presurvey to distribute in their courses. Approximately two weeks prior to the end of the term, instructors (3C Fellows) received a separate recruitment email, informed consent form, and Qualtrics link to distribute the postsurvey.

Students were instructed to complete the surveys when they could dedicate approximately 5–7 minutes to completion in a quiet setting with no distractions. Instructors (3C Fellows) did not have access to individual survey responses, and aggregate information (e.g., percentage of respondents scoring lower than 75% of the maximum score, per subscale) was provided via tabular and graphic data.

Analysis

The data collected were then exported into a CSV file. Pre/postsurvey responses were paired via unique IDs that respondents were required to provide via a specific combination of alphanumeric characters. Unique IDs were reviewed (via RStudio and manually) to identify potential input errors (e.g., one-digit inconsistencies in potentially matched pre/postunique IDs) and updated, as appropriate, for pairing.

Mean pre/postscores were compared using a paired *t*-test with partially overlapping samples (Derrick et al., 2017) via the 'Partially overlapping' package in RStudio. This analysis allowed for the inclusion of all paired and unpaired responses, which was important given some students may begin the course and later withdraw (i.e., presurveys only), others may enrol after distribution of the presurvey (i.e., postsurveys only), and some pre/postsurvey unique IDs contained too many differences to be considered an input error.

Results

Collectively, a significant difference was observed between the presurvey (.765) and postsurvey (.783) scores for all respondents, $p < .05$. Table 3 presents the minimum, maximum, and mean scores by race.

Table 3 3C Survey Scores (All Respondents), by Race

Race		Min	Max	Mean
Asian	Pre	.59	.91	.76
	Post	.54	.94	.78
Black	Pre	.84	.95	.88
	Post	.82	.97	.91
Latine	Pre	.7	.89	.79
	Post	.64	.91	.8
Middle Eastern or Northern African	Pre	.6	.81	.71
	Post	.61	.71	.66
Multiple Races (0)	Pre	.64	.9	.78
	Post	.68	.86	.78
Multiple Races (1)	Pre	.68	.89	.79
	Post	.67	.92	.78
Undisclosed	Pre	.66	.66	.66
	Post	.64	.69	.67
White	Pre	.57	.91	.75
	Post	.65	.96	.8

On average, all respondents demonstrated an increase in cultural competence following course completion, though they remained in the 'cultural neutrality' stage, the most common stage (Cross et al., 1989; Washington, 2020). Black respondents had the highest cultural competence, which corresponded to the 'cultural precompetence' phase (Washington et al., 2023). Table 4 further disaggregates scores by race and gender. Note that '–' indicates no respondents completed the survey.

Table 4 3C Survey Scores (All Respondents), by Race and Gender

Race	Gender		Min	Max	Mean
Asian	Man	Pre	.59	.91	.73
		Post	.54	.94	.75
Latine	Man	Pre	.7	.84	.77
		Post	.79	.87	.82
Middle Eastern or Northern African	Man	Pre	.6	.81	.71
		Post	.61	.71	.66
Multiple races (0)	Man	Pre	.64	.83	.73
		Post	.71	.86	.78
White	Man	Pre	.57	.76	.68
		Post	.67	.71	.77
Asian	Nonbinary	Pre	.79	.91	.85
		Post	.9	.9	.9
Latine	Nonbinary	Pre	.89	.89	.89
		Post	.91	.91	.91
White	Nonbinary	Pre	.81	.83	.82
		Post	.8	.89	.85
Black	Undisclosed	Pre	.84	.84	.84
		Post	-	-	-
Asian	Woman	Pre	.67	.91	.8
		Post	.66	.94	.8
Black	Woman	Pre	.85	.95	.9
		Post	.82	.97	.91
Latine	Woman	Pre	.71	.88	.79
		Post	.64	.88	.76
Multiple races (0)	Woman	Pre	.71	.9	.81
		Post	.68	.86	.77
Multiple races (1)	Woman	Pre	.68	.89	.79
		Post	.77	.92	.84
Undisclosed	Woman	Pre	.66	.66	.66
		Post	-	-	-

White	Woman	Pre	.74	.91	.82
		Post	.65	.96	.84

Women and nonbinary people of all races demonstrated more cultural competence than men, with Black women and Latine nonbinary people having the highest. Women of multiple races (none of which are from a race or ethnicity that is historically underrepresented in computing) and Latina women had the lowest cultural competence among all women and nonbinary people (with postscores indicating a decrease in cultural competence).

Middle Eastern or Northern African men and women of undisclosed races demonstrated the lowest cultural competence of any group of participants, with the minimum scores of men in this group in the 'cultural destructiveness' range: the least proficient stage, which is characterized by 'attitudes, policies, and practices that are destructive to cultures and consequently individuals within the culture' (Cross et al., 1989; Washington et al., 2023).

Table 5 displays the minimum, maximum, and mean scores for each school.

Table 5 3C Survey Scores, by School

School		Min	Max	Mean
1	Pre	.68	.91	.83
	Post	.64	.97	.86
2	Pre	.67	.91	.81
	Post	.71	.91	.81
3	Pre	.59	.91	.74
	Post	.54	.94	.77
4	Pre	.57	.76	.67
	Post	.61	.75	.68
5	Pre	.80	.95	.87
	Post	.73	.95	.84

Overall, four of the five schools experienced an increase in student cultural competence upon course completion, with School 1 demonstrating the highest (cultural precompetence), School 4 demonstrating the lowest (cultural incapacity), and School 2 demonstrating no improvement. Two of the three MSIs (Schools 1 and 5, both Hispanic-serving institutions) resulted in the highest postcourse cultural competence. However, School 5 exhibited a decrease in cultural competence by the end of the course.

The racial and gender identities of respondents with the highest scores varied by institution. For example, Black women had the highest scores for Schools 1 (.97) and 5 (.95), white women for School 2 (.85), Latine men for School 3 (.87), and Asian men for School 4 (.72). The following identities had the lowest scores across each school: Latina women (School 1:.76), men of multiple races/ethnicities (none of which are groups historically underrepresented in computing) (School 2:.71 and School 4:.64), men of multiple races/ethnicities (one of which is a group historically underrepresented in computing) (School 3:.69), and Middle Eastern or Northern African men (School 5:.73).

Discussion

It was expected that the average postcourse cultural competence across all participants was in the cultural neutrality phase (the most common phase). First, discussions of identity, especially race and ethnicity, have traditionally been excluded from postsecondary computing curricula (Ross, 2023; Settles et al., 2021, 2022; Washington, 2020, 2022a). Thus, computing majors gain no knowledge of these topics in their programmes of study. Second, since these courses were the first of their kind in each department, there was a likelihood that this was the first course in which students explored these topics in critical and nuanced ways, including their own positionality and how it impacts their navigation of academic spaces. Third, the overwhelming representation of juniors, seniors, and graduate students (83.3%: presurvey and 79%: postsurvey) reflects the impact of curricula that prioritize traditional computing epistemologies. Finally, the 120-credit hour requirements of ABET-accredited undergraduate computing programmes (*ABET*, n.d.) leave students with little to no opportunity to pursue courses more focused on such topics in other departments in the social sciences and humanities. It also further contributes to epistemic exclusion by assuming that computing, as a discipline, bears no responsibility for preparing graduates to understand the relationship between these topics and technology.

While nonbinary people and women of all races demonstrated more cultural competence than men, Black women and Latine nonbinary people had the highest. This reflects the impact of intersectionality on one's standpoint and further supports how Black feminist thought, by default, requires eradicating harms that extend beyond the needs of Black women (Collins, 2009; Crenshaw, 2022; Lorde, 1984). Conversely, Middle Eastern or Northern African and Asian men having the lowest cultural competence of all groups disclosing race, ethnicity, and gender may be attributed to not only cultural differences in the former but also beliefs about which racial groups have advantages in computing in the latter.

As an example, white and Asian people comprise approximately 68% of all undergraduate computing degrees and over 80% of all (non)tenure-track faculty, compared to 4% and 2.5%, respectively, for Black people (Zweben & Bizot, 2023). Despite this overrepresentation, Fairfax et al. (2024) found that Asian computing undergraduates perceived Black people as the most advantaged racial group in the discipline. Further supporting these results is the *2023 Students for Fair Admissions v. Harvard case*, filed on behalf of Asian American students, which resulted in the US Supreme Court overturning its prior decision on race-conscious college admissions (Krogstad et al., 2023). Such explicit beliefs of race-neutral views correspond to the cultural neutrality phase, as departments and people believe they are 'neutral' and that these spaces are meritocracies (Bonilla-Silva, 2017; Cross et al., 1989; Washington, 2020).

While the pre/postscores of white men only increased from cultural incapacity (e.g., discriminatory practices, 'know-your-place' aggression (Mitchell, 2018), and lower expectations of people from groups that are historically excluded) to cultural neutrality, they experienced the largest postcourse improvement (+.09). Given their overrepresentation in computing, this indicates the impact that continued refinement and implementation of these and similar interventions on a broader scale can have on academic (and professional) computing cultures, resulting in additional improvements in the cultural competence of those who navigate the most privileged positions in computing and society.

At the institutional level, the higher cultural competence of students from liberal arts colleges underscores the broader missions and curricula of these institutions, which often require all students to complete more non-computing courses. While School 5 (a Hispanic-serving institution) demonstrated some of the highest postcourse cultural competence, it was also the only one exhibiting a postcourse decrease (–.03). Several factors may have contributed to this: course design, small enrolment, and classroom dynamics. None of these were captured in this survey.

School 3 (Asian American and Native American Pacific Islander University) demonstrated the lowest cultural competence of any MSI. Approximately 35% of the students enrolled in this course identified as white, and 65% identified as Asian. Given the aforementioned perceptions of advantage in both computing and college admissions, this may have contributed to this result. Ultimately, these lower 'neutrality' levels of cultural competence in the overrepresented groups significantly impact department cultures, including who is considered to 'belong' in computing spaces. This also supports key findings from McGee and Stovall (2020) as well as The Kapor Center (Scott & Klein, 2017): Black and brown students/graduates leave computing majors/careers due to a lack of inclusive and equitable academic/professional environments.

Finally, students demonstrating the highest cultural competence per course were also those who were the least represented in the course. Given the range of identities, this was attributed to their positionality within the course (and likely, department) environments. As also noted in Black feminist epistemologies and universal design, which is rooted in accessibility for people with disabilities, those who are the most marginalized within an environment have the widest perspective on the issues present and ways to improve them (Blackwell, 2017; Collins, 2009; hooks, 1994).

Limitations

There were a few limitations to note. First, the study was limited to students completing new identity-inclusive computing courses developed by faculty completing the 3C Fellows Programme. Because 3C Fellows volunteered to distribute the survey in their courses, it would be helpful to understand the impact of each course in comparison to identity-inclusive courses developed by non-3C Fellows. Given the previously noted lack of courses exploring these topics in most postsecondary computing curricula prior to the 3C Fellows Programme, it will be difficult to identify/collect such data. Second, only one course (School 2) was a requirement for the computing degree, while all others were electives. Obtaining a better balance across required versus elective courses would help us to understand the impact of students who self-selected into the course versus those who did not. Third, while 32 new courses were developed from the 3C Fellows Programme, not every Fellow distributed the survey when piloting their course. As a result, some results were excluded from this study, such as results from the second or subsequent course implementations. As new courses are developed, more pilot data will be collected, and Fellows will be required to distribute the instrument.

Conclusion

While more diverse academic and professional computing environments are often touted as a solution to the harms of biased technologies, people from groups that are most harmed by these technologies and most excluded in computing spaces cannot afford to wait for this shift in representation. This study examines the impact of new postsecondary computing courses created by faculty who completed a two-year, cohort-based PD programme rooted in Black feminist epistemologies. This approach transforms computing 'from the margins' in two important contexts: (1) who are considered knowledge producers via alternative epistemologies rooted in Black feminist thought and (2) courses and topics that traditionally have been excluded from postsecondary computing curricula. These interventions have the potential to improve academic and, ultimately, professional computing environments for both students and professionals who have traditionally been more excluded based on their identities, as well as eliminate harm from technologies to consumers of these same identities. Results from courses piloted across five institutions indicate a statistically significant increase in overall student cultural competence, with potential for significant improvement for groups who are overrepresented in computing, such as white men.

Future work includes distributing the instrument across additional institutions in subsequent cohorts; follow-up studies of the institutions in this study to assess the impact of course repetition and refinement on student cultural competence; exploring the impact of consistent course implementations (e.g., once per year or semester); and comparison of the cultural competence of students participating in dedicated courses versus modules in existing courses or other activities.

Acknowledgements

This work is supported by the National Science Foundation under Grant No. 2118453.

References

3C Fellows Program. (n.d.). https://identity.cs.duke.edu/fellows.html

ABET. (n.d.). ABET. https://www.abet.org/

Ananya. (2024). AI image generators often give racist and sexist results: Can they be fixed? *Nature*, 627(8005), 722–725. https://doi.org/10.1038/d41586-024-00674-9
Google Scholar PubMed WorldCat

Bajorek, J P (2019, May 10). Voice recognition still has significant race and gender biases. *Harvard Business Review*. https://hbr.org/2019/05/voice-recognition-still-has-significant-race-and-gender-biases
Google Scholar WorldCat

Belenky, M F, Clinchy, B M, Goldberger, N R, & Tarule, J M (1986). *Women's ways of knowing: The development of self, voice, and mind* (pp. xiii, 256). Basic Books.
Google Scholar Google Preview WorldCat COPAC

Benjamin, R (2019). *Race after technology: Abolitionist tools for the New Jim Code* (1st ed.). Polity.
Google Scholar Google Preview WorldCat COPAC

Blackwell, A G. (2017). *The curb-cut effect (SSIR)*. https://ssir.org/articles/entry/the_curb_cut_effect

Blaser, B, & Ladner, R E (2020). Why is data on disability so hard to collect and understand? In *Proceedings of the 2020 Research on Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT)* (pp. 1–8). Institute of Electrical and Electronics Engineers. https://doi.org/10.1109/RESPECT49803.2020.9272466
Google Scholar Google Preview WorldCat COPAC

Bonilla-Silva, E (2017). *Racism without racists: Color-blind racism and the persistence of racial inequality in America* (5th ed.). Rowman & Littlefield.
Google Scholar Google Preview WorldCat COPAC

Broussard, M (2018). *Artificial unintelligence: How computers misunderstand the world*. MIT Press.
Google Scholar Google Preview WorldCat COPAC

Broussard, M (2023). *More than a glitch: Confronting race, gender, and ability bias in tech*. The MIT Press.
Google Scholar Google Preview WorldCat COPAC

Browne, S (2015). *Dark matters: On the surveillance of Blackness*. Duke University Press.
Google Scholar Google Preview WorldCat COPAC

Buolamwini, J, & Gebru, T (2018). Gender shades: Intersectional accuracy disparities in commercial gender classification. In *Proceedings of Machine Learning Research 81:1–15, 2018 Conference on Fairness, Accountability, and Transparency*.
Google Scholar Google Preview WorldCat COPAC

Burch, A D S, Cai, W, Gianordoli, G, McCarthy, M, & Patel, J K (2020, June 13). How Black Lives Matter reached every corner of America. *The New York Times*. https://www.nytimes.com/interactive/2020/06/13/us/george-floyd-protests-cities-photos.html
Google Scholar WorldCat

Carpenter, A J, Feraud-King, T, Lewis, T, Stephens-Peace, K J, Chinkondenji, P, Stanislaus, E, & George Mwangi, C (2024). Rage n (and out) the cage: Black students' negotiation of safety. *Journal of Black Studies*, 55(5), 00219347241233772. https://doi.org/10.1177/00219347241233772
Google Scholar WorldCat

Cole, E (2021). The racist roots of campus policing. *The Washington Post*.
https://www.washingtonpost.com/outlook/2021/06/02/racist-roots-campus-policing/
Google Scholar WorldCat

Collins, P H (2009). *Black feminist thought: Knowledge, consciousness, and the politics of empowerment* (2nd ed.). Routledge.
Google Scholar Google Preview WorldCat COPAC

Conger, K (2021, April 13). 'Master,' 'slave' and the fight over offensive terms in computing. *The New York Times*.
https://www.nytimes.com/2021/04/13/technology/racist-computer-engineering-terms-ietf.html
Google Scholar WorldCat

Crenshaw, K (1989). Demarginalizing the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. *University of Chicago Legal Forum*, 1989(1).
Google Scholar WorldCat

Crenshaw, K (2022). *On intersectionality: Essential writings*. The New Press.
Google Scholar Google Preview WorldCat COPAC

Cross, T L, Bazron, B J, Dennis, K W, & Isaacs, M R (1989). *Towards a culturally competent system of care: A monograph on effective services for minority children who are severely emotionally disturbed.* Office of Justice Programs.
Google Scholar Google Preview WorldCat COPAC

Derrick, B, Toher, D, & White, P (2017). How to compare the means of two samples that include paired observations and independent observations: A companion to Derrick, Russ, Toher and White (2017). *The Quantitative Methods for Psychology*, 13(2), 120–126. https://doi.org/10.20982/tqmp.13.2.p120
Google Scholar WorldCat

D'Ignazio, C (2021). *The abuse and misogynoir playbook*. MIT Media Lab. https://www.media.mit.edu/articles/danielle-wood-and-katlyn-turner-co-author-article-the-abuse-and-misogynoir-playbook-for/
Google Scholar Google Preview WorldCat COPAC

El-Azab, S, & Nong, P (2023). Clinical algorithms, racism, and 'fairness' in healthcare: A case of bounded justice. *Big Data & Society*, 10(2), 20539517231213820. https://doi.org/10.1177/20539517231213820
Google Scholar WorldCat

Epstein, R, Blake, J, & González, T (2017). *Girlhood interrupted: The erasure of Black girls' childhood* [SSRN Scholarly Paper 3000695]. Elsevier. https://doi.org/10.2139/ssrn.3000695
Google Scholar Google Preview WorldCat COPAC

Eubanks, V (2018). *Automating inequality: How high-tech tools profile, police, and punish the Poor*. St. Martin's Press.
Google Scholar Google Preview WorldCat COPAC

Fairfax, F, Kwesi, J, McFalls, E, Razon, R, Thursland, A, Peoples, C, Daily, S, Washington, A N, Bonilla-Silva, E, & Prefontaine, B (2024). Work in progress: The role of student backgrounds in understanding racial disparities in computing. *Proceedings of the 2024 American Society for Engineering Education Conference*, pending.
Google Scholar WorldCat

Fisher, A J, Mendoza-Denton, R, Patt, C, Young, I, Eppig, A, Garrell, R L, Rees, D C, Nelson, T W, & Richards, M A (2019). Structure and belonging: Pathways to success for underrepresented minority and women PhD students in STEM fields. *PLoS ONE*, 14(1), e0209279. https://doi.org/10.1371/journal.pone.0209279
WorldCat

Flaherty, C (2022, January 4). *How identity shapes science*. Inside Higher Ed.
https://www.insidehighered.com/news/2022/01/04/new-data-how-race-and-gender-shape-science
Google Scholar Google Preview WorldCat COPAC

Freire, P, & Macedo, D (2000). *Pedagogy of the oppressed* (M. B. Ramos, Trans., 30th Anniversary ed.). Continuum.
Google Scholar Google Preview WorldCat COPAC

Galotti, K M (1998). Valuing connected knowing in the classroom. *The Clearing House*, 71(5), 281–283.
Google Scholar WorldCat

Geronimus, A T (2023). *Weathering: The extraordinary stress of ordinary life in an unjust society* (1st ed.). Little, Brown Spark.
Google Scholar Google Preview WorldCat COPAC

Gray, K (2024, April 3). *a.i. Really is smoke and mirrors: [And for my next trick....] Also can we please start lower casing a.i. [Tweet]*. https://x.com/KishonnaGray/status/1775487368734163082
Google Scholar Google Preview WorldCat COPAC

Harlow, R (2003). 'Race doesn't matter, but...': The effect of race on professors' experiences and emotion management in the undergraduate college classroom. *Social Psychology Quarterly*, 66(4), 348–363. https://doi.org/10.2307/1519834
Google Scholar WorldCat

Hatch, B, McMurtrie, B, Myskow, W, & Zahneis, M (2022, June 30). *Why they left: Five stories from professors of color who'd had enough*. The Chronicle of Higher Education. https://www.chronicle.com/article/why-they-left
Google Scholar Google Preview WorldCat COPAC

hooks, bell. (1994). *Teaching to transgress: Education as the practice of freedom*. Routledge Taylor & Francis Group.
Google Scholar Google Preview WorldCat COPAC

Huff, E W, Castro, F, Jayathirtha, G, Jimenez, Y, Kong, M, Melo, N A, Solomon, A, & Tsan, J (2021). Going through a process of whitening: student experiences within computer science education. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education* (pp. 1348–1348). Association for Computing Machinery. https://doi.org/10.1145/3408877.3432497
Google Scholar Google Preview WorldCat COPAC

Jones, S T, & Melo, N A (2021). We tell these stories to survive: towards abolition in computer science education. *Canadian Journal of Science, Mathematics and Technology Education*, 21(2), 290–308. https://doi.org/10.1007/s42330-021-00158-2
Google Scholar PubMed WorldCat

Krause-Levy, S, Griswold, W G, Porter, L, & Alvarado, C (2021). The relationship between sense of belonging and student outcomes in CS1 and beyond. In *Proceedings of the 17th ACM Conference on International Computing Education Research* (pp. 29–41). Association for Computing Machinery. https://doi.org/10.1145/3446871.3469748
Google Scholar WorldCat

Krogstad, N G R, Tian, Z., & Manuel, J. (2023, June 8). Asian Americans hold mixed views around affirmative action. *Pew Research Center*. https://www.pewresearch.org/race-and-ethnicity/2023/06/08/asian-americans-hold-mixed-views-around-affirmative-action/
Google Scholar WorldCat

Kumaş-Tan, Z, Beagan, B, Loppie, C, Macleod, A, & Frank, B (2007). Measures of cultural competence: Examining hidden assumptions. *Academic Medicine: Journal of the Association of American Medical Colleges*, 82, 548–557. https://doi.org/10.1097/ACM.0b013e3180555a2d
Google Scholar PubMed WorldCat

Langin, K (n.d.). *A sense of belonging matters. That's why academic culture needs to change.* Science. https://www.science.org/content/article/sense-belonging-matters-s-why-academic-culture-needs-change
Google Scholar Google Preview WorldCat COPAC

Lee, N T (2020). *What the coronavirus reveals about the digital divide between schools and communities*. Brookings. https://www.brookings.edu/articles/what-the-coronavirus-reveals-about-the-digital-divide-between-schools-and-communities/
Google Scholar Google Preview WorldCat COPAC

Lorde, A (1984). *Sister outsider: Essays and speeches*. Crossing Press. https://find.library.duke.edu/catalog/DUKE000574439
Google Scholar Google Preview WorldCat COPAC

Marshall, A, Pack, A D, Owusu, S A, Hultman, R, Drake, D, Rutaganira, F U N, Namwanje, M, Evans, C S, Garza-Lopez, E, Lewis, S C, Termini, C M, AshShareef, S, Hicsasmaz, I, Taylor, B, McReynolds, M R, Shuler, H, & Hinton, A O, Jr. (2021). Responding and navigating racialized microaggressions in STEM. *Pathogens and Disease*, 79(5), ftab027. https://doi.org/10.1093/femspd/ftab027
Google Scholar PubMed WorldCat

Matthew, P A (Ed.). (2016). *Written/unwritten: Diversity and the hidden truths of tenure*. University of North Carolina Press.
Google Scholar Google Preview WorldCat COPAC

Mattu, J A, Larson, J, & Kirchner, S L (n.d.). *Machine Bias*. ProPublica. https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing?token=Gg58888u2U5db3W3CsuKrD0LD_VQJReQ
Google Scholar Google Preview WorldCat COPAC

McGee, E (2018). 'Black genius, Asian fail': The detriment of stereotype lift and stereotype threat in high-achieving Asian and Black STEM students. *AERA Open*, 4(4), 2332858418816658.
Google Scholar WorldCat

McGee, E O (2020). Interrogating structural racism in STEM higher education. *Educational Researcher*, 49(9), 633–644. https://doi.org/10.3102/0013189X20972718
Google Scholar WorldCat

McGee, E O, & Stovall, D O (2020). *Black, brown, bruised: How racialized STEM education stifles innovation*. Harvard Education Press.
Google Scholar Google Preview WorldCat COPAC

Miriti, M N (2020). The elephant in the room: Race and STEM diversity. *BioScience*, 70(3), 237–242. https://doi.org/10.1093/biosci/biz167
Google Scholar WorldCat

Mitchell, K (2018). Identifying white mediocrity and know-your-place aggression: A form of self-care. *African American Review*, 51(4), 253–262. https://doi.org/10.1353/afa.2018.0045
Google Scholar WorldCat

Newsome, M (2022). Computer science has a racism problem: These researchers want to fix it. *Nature*, 610(7932), 440–443. https://doi.org/10.1038/d41586-022-03251-0
Google Scholar PubMed WorldCat

Noble, S U (2013). Google search: Hyper-visibility as a means of rendering black women and girls invisible. *InVisible Culture*, 19.
Google Scholar WorldCat

Noble, S U (2018). *Algorithms of oppression: How search engines reinforce racism* (Illustrated ed.). NYU Press.
Google Scholar Google Preview WorldCat COPAC

Obermeyer, Z, Powers, B, Vogeli, C, & Mullainathan, S (2019). Dissecting racial bias in an algorithm used to manage the health of populations. *Science*, 366(6464), 447–453. https://doi.org/10.1126/science.aax2342
Google Scholar PubMed WorldCat

O'Neil, C (2016). *Weapons of math destruction: How big data increases inequality and threatens democracy* (1st ed.). Crown.
Google Scholar Google Preview WorldCat COPAC

O'Neil, L (2023, August 12). These women tried to warn us about AI. *Rolling Stone.* https://www.rollingstone.com/culture/culture-features/women-warnings-ai-danger-risk-before-chatgpt-1234804367/
Google Scholar Google Preview WorldCat COPAC

Owens, K, & Walker, A (2020). Those designing healthcare algorithms must become actively anti-racist. *Nature Medicine*, 26(9), 1327–1328. https://doi.org/10.1038/s41591-020-1020-3
Google Scholar PubMed WorldCat

Peoples, C E, Washington, A N, & Daily, S B (2023, June 25). Race and collaboration in computer science: A network science approach. *2023 ASEE Annual Conference & Exposition*. https://peer.asee.org/race-and-collaboration-in-computer-science-a-network-science-approach
Google Scholar WorldCat

Perez, C C (2019). *Invisible women: Exposing data bias in a world designed for men*. Abrams Press.
Google Scholar Google Preview WorldCat COPAC

Rankin, Y A, Thomas, J O, & Erete, S (2021). Real talk: Saturated sites of violence in CS education. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education* (pp. 802–808). Association for Computing Machinery. https://doi.org/10.1145/3408877.3432432

Ross, M, Hazari, Z, Sonnert, G, & Sadler, P (2020). The intersection of being Black and being a woman: Examining the effect of social computing relationships on computer science career choice. *ACM Transactions on Computing Education*, 20(2), 9:1–15. https://doi.org/10.1145/3377426
Google Scholar WorldCat

Ross, M S (2023). Let's have that conversation: How limited epistemological beliefs exacerbates inequities and will continue to be a barrier to broadening participation. *ACM Transactions on Computing Education*, 23(2), 17:1–4. https://doi.org/10.1145/3578270
Google Scholar WorldCat

Russell. (n.d.). *A Google engineering director who is black said he would be accosted less at work if he dressed like a janitor*. Business Insider. https://www.businessinsider.com/black-google-employee-faces-badge-bias-2019-9
Google Scholar Google Preview WorldCat COPAC

Scott, A, Klein, F, & Onovakpuri, U (2017). *Tech leavers study: A first-of-its-kind analysis of why people voluntarily left jobs in tech*. Kapor Center for Social Impact. https://www.kaporcenter.org/wp-content/uploads/2017/08/TechLeavers2017.pdf
Google Scholar Google Preview WorldCat COPAC

Settles, I H, Jones, M K, Buchanan, N T, & Brassel, S T (2022). Epistemic exclusion of women faculty and faculty of color: Understanding scholar(ly) devaluation as a predictor of turnover intentions. *The Journal of Higher Education*, 93(1), 31–55. https://doi.org/10.1080/00221546.2021.1914494
Google Scholar WorldCat

Settles, I H, Jones, M K, Buchanan, N T, & Dotson, K (2021). Epistemic exclusion: Scholar(ly) devaluation that marginalizes faculty of color. *Journal of Diversity in Higher Education*, 14(4), 493–507. https://doi.org/10.1037/dhe0000174
Google Scholar WorldCat

Seyyed-Kalantari, L, Zhang, H, McDermott, M B A, Chen, I Y, & Ghassemi, M (2021). Underdiagnosis bias of artificial intelligence algorithms applied to chest radiographs in under-served patient populations. *Nature Medicine*, 27(12), 2176–2182. https://doi.org/10.1038/s41591-021-01595-0
Google Scholar PubMed WorldCat

Shattuck, S, & Cheney, I (Directors). (n.d.). *Picture a scientist*. https://www.pictureascientist.com
Google Scholar Google Preview WorldCat COPAC

Siddique, S M, Tipton, K, Leas, B, Jepson, C, Aysola, J, Cohen, J B, Flores, E, Harhay, M O, Schmidt, H, Weissman, G E, Fricke, J, Treadwell, J R, & Mull, N K (2024). The impact of health care algorithms on racial and ethnic disparities. *Annals of Internal Medicine*, 177(4), 484–496. https://doi.org/10.7326/M23-2960
Google Scholar PubMed WorldCat

Subbaraman, N (2020a). How #BlackInTheIvory put a spotlight on racism in academia. *Nature*, 582(7812), 327–327. https://doi.org/10.1038/d41586-020-01741-7
Google Scholar PubMed WorldCat

Subbaraman, N (2020b). Thousands of scientists worldwide to go on strike for Black lives. *Nature*. https://doi.org/10.1038/d41586-020-01721-x
Google Scholar WorldCat

Tai, D B G, Sia, I G, Doubeni, C A, & Wieland, M L (2022). Disproportionate impact of COVID-19 on racial and ethnic minority groups in the United States: A 2021 update. *Journal of Racial and Ethnic Health Disparities*, 9(6), 2334–2339. https://doi.org/10.1007/s40615-021-01170-w
Google Scholar PubMed WorldCat

Taylor, D B (2020, April 14). For Black men, fear that masks will invite racial profiling. *The New York Times*. https://www.nytimes.com/2020/04/14/us/coronavirus-masks-racism-african-americans.html
Google Scholar WorldCat

Tiku, N, Schaul, K, & Chen, S Y (n.d.). *These fake images reveal how AI amplifies our worst stereotypes*. Washington Post. https://www.washingtonpost.com/technology/interactive/2023/ai-generated-images-bias-racism-sexism-stereotypes/
Google Scholar Google Preview WorldCat COPAC

Wachter-Boettcher, S, & Emmes, A (2017). *Technically wrong: Sexist apps, biased algorithms, and other threats of toxic tech* (Unabridged ed.). HighBridge Audio.
Google Scholar Google Preview WorldCat COPAC

Washington, A N (2018). *Unapologetically dope: Lessons for Black women and girls on surviving and thriving in the tech field*. Washington Integrated Consulting.
Google Scholar Google Preview WorldCat COPAC

Washington, A N (2020). When twice as good isn't enough: The case for cultural competence in computing. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education* (pp. 213–219). Association for Computing Machinery. https://doi.org/10.1145/3328778.3366792
Google Scholar Google Preview WorldCat COPAC

Washington, A N (2022a). Designed to disrupt: A novel course for improving the cultural competence of undergraduate computing students. *2022 ASEE Annual Conference & Exposition*. 2022 American Society of Engineering Education Annual Conference & Exposition, Minneapolis, MN. https://doi.org/10.18260/1-2--40413
Google Scholar WorldCat

Washington, A N (2022b, October 4). When are we gonna have a serious conversation about how unserious (and problematic) SIGCSE is? *Medium*. https://medium.com/@nickiwashington/when-are-we-gonna-have-a-serious-conversation-about-how-unserious-and-problematic-sigcse-is-839c4f28cc1b
Google Scholar WorldCat

Washington, A N, Romanova, A, Nelson, P, Grady, S D, & Burge, L (2023, June 25). On measuring cultural competence: Instrument design and testing. *2023 ASEE Annual Conference & Exposition*. https://doi.org/10.18260/1-2--43762
Google Scholar WorldCat

Washington, A N, Daily, S, and Sadler, C (2022). Identity-inclusive computing: Learning from the past; preparing for the future. *53rd ACM Technical Symposium on Computer Science Education*. https://doi.org/10.1145/3478432.3499172
Google Scholar WorldCat

Words matter: Alternatives for charged terminology in the computing profession. (n.d.). https://www.acm.org/diversity-inclusion/words-matter
Google Scholar Google Preview WorldCat COPAC

Zweben, S, & Bizot, B (2023). *2022 Taulbee Survey Record Doctoral Degree Production; More Increases in Undergrad Enrollment Despite Increased Degree Production*. Computing Research Association.
Google Scholar Google Preview WorldCat COPAC

1 Abbreviated as a.i. in accordance with Dr. Kishonna Gray's discussion of the importance of doing so as part of synthetic literacy (Gray, 2024).