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Designed to Disrupt: A Novel Course for Improving the Cultural Competence of Undergraduate Computing Students

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Introduction

While there exist numerous efforts to broaden participation in computing, university computing departments (like the tech industry) still suffer from a lack of diversity, equity, and inclusion (DEI) [1], [2]. Despite commitments to fostering inclusive and equitable environments for students from diverse identities, current efforts have only marginally increased representation. This paper posits that this marginal improvement is because traditional efforts primarily center students from minoritized groups through deficit-based approaches such as mentoring, affinity groups, and readiness programs. However, these approaches fail to acknowledge and address the departmental cultures that include macro/microaggressions, biases, oppression, and intersectional experiences that are unrelated to students' academic abilities, yet significantly impact their sense of belonging and productivity. In addition, these challenges are also experienced by faculty of the same identities, as issues such as biased course evaluations and harmful work environments impact hiring, promotion, and tenure decisions [3]–[6].

Instead, there is a need to decenter students from minoritized groups and ensure that all computing students (especially those from dominant identities based on race, ethnicity, gender, sexuality, ability, and socioeconomic class) develop/improve their cultural competence prior to graduation. Cultural competence describes "a set of congruent behaviors, attitudes, and policies that come together in a system, agency, or among professionals and enable that system, agency, or those professionals to work effectively in cross-cultural situations" [7]. Accomplishing this in computing requires more intentional and innovative approaches, where students explore identity-inclusive computing (i.e., how identity impacts and is impacted by computing [8]).

Motivation

A person's identity is shaped by the relationships, experiences, and values that create their sense of self [9]. While identity development (including feeling, thinking, decision making, and engaging with the world) is continuous [10], late adolescence (ages 18-24) primarily focuses on cognitive development (e.g., thinking of ideas rationally and gaining a firmer sense of identity)[11].

The most salient parts of one's identity become those that set them apart as an "other" by capturing the attention of people around them (e.g., race, ethnicity, gender, sexuality, ability, and socioeconomic class) [9]. This "othering" in computing is present in two contexts. First, biased/harmful technologies (e.g., voice recognition software that only works for certain accents/dialects, rideshare apps that ban transgender drivers for non-matching ID pictures, and healthcare software that uses race adjustments) impact who can consume technology. Second, harmful academic and professional environments impact who can create technology.

The 2020 Taulbee Survey reported that approximately 42% of all bachelor's degrees in computing (i.e., computer science, computer engineering, and information systems) were awarded to white graduates, 27% to Asian, 9% to Hispanic/Latine (any race), 4% to Black, 0.2% to Native American, 0.1% to Native Hawaiian/Pacific Islander, and 4% to multiracial graduates [1]. In addition, 79% of all graduates identified as men, 21% as women, and 0.1 % as non-binary/self-identify. To further disaggregate, Black women earned approximately 0.008% of all bachelor's degrees (and 5% of all degrees awarded to women), while Native American women earned 0.0004% (and 0.2% of all degrees awarded to women), compared to white and Asian women (who each earned 6% of all bachelor's degrees and 39% of all degrees awarded to women). Data for people who are disabled, LGBTQ+, and from lower socioeconomic backgrounds is not adequately collected to properly assess representation [12].

These statistics (and lack thereof) highlight technologies and academic/professional environments are primarily developed by white and Asian, cisgender, heterosexual, able-bodied, middle-to-upper-class men [2], making them biased/harmful for those who do not hold these identities. Despite this, approaches to broaden participation in computing have primarily centered students/graduates from non-dominant identities, while ignoring (racially, for example) the 69% of all graduates (and 78% of all women) identifying as white and Asian who are often responsible for/contribute to the "culture" that is created/fostered. Instead, minoritized students and professionals are often expected to "persist" with more "grit," following targeted interventions [13], [14]. This misplaced focus has resulted in a significant knowledge gap and lack of cultural competence in most computing graduates entering the workforce [15]. This is further demonstrated by reports of discrimination in academic and professional environments [16]–[23], as well as events like the #BlackInTheIvory and #ShutDownSTEM Twitter hashtags [which highlighted the anti-Black racism experienced by Black students, faculty, and staff at predominately white institutions (PWIs)] [24]. This is also reflected in the Kapor Center's Tech Leavers report, which highlighted the primary reason why employees from minoritized groups voluntarily left their jobs in tech was unfairness [25].

To address these limitations (and better prepare graduates to expect/create more inclusive and equitable environments and technologies), all computing students must be introduced to more social science-related topics in their undergraduate curricula and encouraged to interrogate both the world around them and the products they develop. While an identity-related course was developed in 2018 at Stanford University [26], its focus was limited to how the computing workforce was developed, current Silicon Valley issues, and technology implications, with limited historical context provided via movies like "Hidden Figures." In addition, it does not include other aspects of identity (including sexuality, class, and ability) or the interlocking systems of oppression that contribute to the simultaneous hypervisibility and invisibility of certain groups in the context of both technology as well as social, academic, and professional environments (e.g., Black women) [27]–[30].

This work presents a novel computing course titled "Race, Gender, Class, & Computing," which introduces undergraduate computer science majors at Duke University to identity, including its impact on and from technology. The course was piloted in the fall 2020 semester and leverages different media (podcasts, videos, articles, and books) and assignments (critical reading/writing and journaling), as well as discussion-based instruction periods. Preliminary results from the first

three semesters of implementation indicate the course increases student knowledge/understanding of identity-inclusive topics, self-efficacy, and comfort discussing these topics in academic and personal environments. Additional themes related to student perceptions of identity and computing also began to emerge that support embedding such courses into postsecondary computing curricula.

The remainder of this paper first discusses the course design and implementation. Quantitative and qualitative results are presented and discussed. A brief discussion of the course scaling (internal) and replication across other university computing departments is then presented, followed by conclusions and directions for future work.

Statement of positionality

The author is a Black, Gen X, cisgender, heterosexual, able-bodied, upper-middle-class woman from the south, who earned a B.S., M.S., and Ph.D. in computer science. Her access to computers and computer science began at an early age, as her mother was a programmer at IBM before moving into management, and her father was a K-12 educator-turned-administrator. She also participated in summer internship experiences in the tech industry (IBM) from high school through graduate school. Her academic experience was shaped by attending an historically Black college and university (HBCU) for her undergraduate studies and a PWI for graduate studies. Her professional experience has been shaped by beginning her academic career at an HBCU Department of Computer Science for nine years, before transitioning to two PWIs in the south for the last seven years. She is currently a professor of practice (non-tenure-track) in the Department of Computer Science at Duke, having previously been in tenured positions at both prior institutions. As someone with racial and gender identities that are minoritized (both in society and computing), her personal, academic, and professional experiences with oppression (white supremacy and misogynoir) have largely served as the motivating factor behind her research in the space of identity-inclusive computing.

Course design

The three-credit-hour course is a 200-level elective that counts towards the computing B.S. and B.A. degrees, as well as the minor. It also holds a university designation for social science and writing-intensive credit. In the first half of the course, students define identity (including race, ethnicity, gender, sexuality, class, and ability) and intersectionality, understand forms of oppression (e.g., racism, white supremacy, sexism, misogyny, misogynoir, transphobia, homophobia, classism, and ableism), examine social justice movements to eradicate these oppressions, and identify policies that exclude/protect identities (across both society and computing environments). In the second half, this knowledge is used to examine how technology replicates/amplifies these societal issues, the impact on identities, and tech-related policies.

Identity-centered approach

The course was grounded in an identity-centered approach for the following reasons. First, critical theory focuses primarily on the structural instead of individual level, allowing learners to critique and challenge power structures while ignoring individual “bad actors.” This runs the risk

of being too abstract for computing undergraduates, many of whom have not been taught about structural inequities in traditional computing programs of study (or K-12 courses) [31]. This abstraction could potentially deter students from understanding how these structural inequities relate to their lived experience with identity and oppression (either personally or tangentially). An identity-centered approach allows every student (regardless of race, ethnicity, gender, sexuality, ability, socioeconomic class, religion, and more) to enter the classroom with varied and situated knowledge that was gained through experiences and interactions to date [28], [29]. This approach establishes that the students as well as the instructor enter the classroom as both situated knowers (via lived experience) and learners [32], [33].

The communication theory of identity (CTI) notes that "identity not only defines an individual, but also reflects social roles and relations through communication" [34]. CTI defines four frames (layers) of identity: personal (sense of self), enacted (how identity is expressed/performed), relational (how identity is co-constructed via relationships with others), and communal (how identity manifests based on group membership), all of which interact with and are influenced by each other. This framework has also been extended to STEM identities for undergraduates [35]. This course follows the argument in both works that all four frames of identity are not separate and should be considered as impacting each other. Given the corresponding identity-development stage in late adolescence (i.e., thinking of ideas rationally and gaining a firmer sense of identity) [11], this course design helps students think critically about how the course material relates not only to their own identities, but also those identities they do not hold. Thus, they enter the classroom with an understanding of their own sense of who they are (personal), how they think about/express this (enacted), and what experiences and collective understandings have impacted their sense of self (relational and communal). Students can then critically examine how identity (theirs and others') impacts and is impacted by computing, thus helping to reduce/eliminate identity gaps [34], [35].

The course includes the following content and deliverables.

Identity positionality statement

The first course assignment is a positionality statement requiring students to select a song that best describes their identity; then discuss why and how it reflects their identity, as well as how their positionality has impacted their knowledge/experiences to date. This allows students to begin the course by identifying their personal epistemology [36] through reflections on what is most salient for them, as well as its impact on their academic and personal experiences.

Pre-lecture review material

Pre-lecture material provides background information on each lecture topic. This material is publicly accessible via the web and/or university library, including Ted Talks, podcast episodes (e.g., Code Switch and Scene on Radio), documentaries (e.g., Eyes on the Prize and 13th), news articles, book chapters, and blog posts. This range of material allows students more variety in how they consume information (outside of the standard textbook) and made the material more accessible (especially during the COVID-19 pandemic).

Lectures

Students explored topics (including pre-lecture material and current events) through discussions with the instructor and peers. Each lecture was titled after a song and began with the following:

- *Song Title*- theme of the lecture discussion (e.g., "Four Women: Intersectionality" and "Is it Because I'm Black: Healthcare Software").
- *News You Can Use*-news article(s) on related current events.
- *Quote*-related to the topic (and spotlighting activists/scholars from minoritized groups).
- *Definitions*-terminology discussed throughout the lecture.

The lecture then incorporated activities (e.g., polls and word cloud generation), as well as breakout and larger group discussions that help students understand concepts and apply them in the context of their university and societal experiences.

Weekly reflections

Students submit weekly reflections on the pre-lecture material and class discussions, which were used to examine thought progression throughout the semester. They also allowed for privately sharing thoughts students were not comfortable discussing in class and direct feedback.

The reflection prompt was initially more generic (i.e., "*What are your thoughts on this week's material? Has your perspective on anything been confirmed/challenged? Is there anything you think this relates to that we didn't cover?*"). In the fall 2021 semester, these were revised to:

1. *What is one thing you learned this week?*
2. *What is one thing that was confusing this week? Why?*
3. *How have these topics/ideas reinforced/challenged your beliefs/assumptions?*
4. *Is there anything else you'd like to share?*

Book reflections

Students selected books from an instructor-approved list to read and completed a detailed analysis that answered the prompt:

What are at least three identities discussed in the book? How are they impacted by society in negative ways? What are ways in which they are impacted negatively in computing+tech? How can someone take the lessons from this book to change the minds of a "non-believer" in diversity, equity, and inclusion?

Example books from the approved list included *Why Are All the Black Kids Sitting Together in the Cafeteria*; *Sister Outsider*; *Racism Without Racists*; *The Privileged Poor*; *Thick: And Other Essays*; *Algorithms of Oppression*; *Race After Technology*; *Dark Matters: On the Surveillance of Blackness*; *Race, Sex, and Robots*; *Technically Wrong*; and *Weapons of Math Destruction*.

In the first two semesters, one book reflection was assigned at the beginning of the semester. In the fall 2021 semester, two book reflections were assigned across each half of the course, with

the book list corresponding to the topics in the respective half of the semester (non-computing-related in the first half and computing-related in the second).

Final presentation

Each student completed a final presentation that reflected on their semester and addressed the following questions:

1. What did I know/do before the semester?
2. How has my perspective changed? What happened?
3. Why was my perspective limited before?
4. What are some of the ways in which I can impact change in the short and long term?

Additional course characteristics

"House Rules" served as the class-defined code of conduct for each semester. These rules were developed on the first day of class, to ensure collective contribution and accountability. Example rules include "no derogatory or offensive language" and "know when to take and yield space."

Class participation was strongly encouraged, but not required. This allowed for more organic discussions, as students participated not to simply receive a grade, but because they wanted to. Students were informed on the first day of class and reminded throughout the semester that the course did not work without them. In addition, weekly reflections offered an additional participation format (even if for a more limited audience).

Third, this course was not a traditional computing course in terms of both content and pedagogical approach. It did not teach computing fundamentals other than critical thinking, which was used to interrogate what they were (not) been taught, the impacts of these gaps, and how these topics related to computing. Content intentionally centered people from minoritized identities. This material was not always in the format of a published manuscript or traditional lecture, nor was it always from those with formal training. As noted throughout Black feminist theory, collective standpoint for any identity values the expertise acquired through lived experiences as much as formal training [28], [29], [32]. Pedagogically, most computing courses follow a banking concept of education, where the instructor is the expert, and the students have no knowledge (other than what was expected to be previously deposited into them from prerequisite courses) [37]. Inquiry, removing hierarchical classroom structures, and the importance of privileged standpoints are less encouraged, but necessary, according to hooks [32]:

"If the effort to respect and honor the social reality and experiences of groups in this society who are nonwhite is to be reflected in the pedagogical process, then as teachers—on all levels, from elementary to university settings—we must acknowledge that our styles of teaching may need to change."

Students were provided the space and place to share, engage with, and learn from others; think critically about the topics in the context of their positionality, and interrogate the impacts of these topics on both their identities and others'.

Course implementation

The course was piloted in the fall 2020 semester and was offered in the subsequent spring 2021 and fall 2021 semesters. While initially planned as an in-person course, university restrictions due to the COVID-19 pandemic resulted in fully remote implementations in the first two semesters (2020-2021 academic year). Creating a remote course required several considerations. First, class lectures were held via Zoom. However, the university Zoom license did not include closed captioning in the 2020-2021 academic year, which meant that students needing it were dependent on provisions from the university office of accessibility. To address this issue, the instructor used Web Captioner as a free, third-party app for captioning.

Next, creating a "safe" environment via Zoom required intention. Zoom links for the course were restricted to those with university email addresses and a waiting room was created to eliminate Zoom bombing. In addition, course links were only provided through the learning management software. Students were also not required to keep cameras on during lectures. Finally, students were required to record/submit their final presentations (with a specified time limit) for playback in the final week of class. While the original purpose was to ensure all presentations could be viewed in the allotted time, the recorded presentations provided additional benefits. As with class discussions, there was no pressure for students to speak in front of the entire class. Second, recorded presentations allowed for more creativity, including creation of game/talk shows, video blogs, and narrated, time-lapsed portrait creations that expressed their course experience.

The fall 2021 semester was the first time that the course was implemented in person. The recorded presentation requirement was maintained.

Course assessment

In addition to the standard, university course evaluation, a custom, instructor-created survey that collected quantitative and qualitative data on student experiences was distributed in the last two weeks of the semester. Table 1 includes the custom survey items.

Table 1. End-of-semester course survey.

1. Prior to enrolling in this course, how many full courses dedicated to diversity, equity, and/or inclusion in computing had you completed?
2. Prior to enrolling in this course, how many workshops/course modules dedicated to diversity, equity, and/or inclusion in computing had you completed?
3. Before this class began, I was comfortable discussing the topics covered.
4. After completing this course, I am comfortable discussing the topics covered.
5. The instructor created a brave space for learning.
6. My classmates created a brave space for learning.
7. This course was structured in a way that helped me learn the material.
8. I'd like to see more classes like this in the computing department.
9. I'd like to see more topics like those discussed in this class infused throughout other computing courses.
10. Is there anything you think should be included or discussed in more detail?

11. Is there anything you think should be removed or discussed less?
12. Are there any strengths of the class to highlight?
13. Are there any weaknesses of the class to highlight?
14. Do you have any advice for future students who are beginning/considering the course?
15. Is there anything else you'd like to share?

Responses to items 1 and 2 collected open-ended responses in the range of 0 to N (where N is a positive integer). Items 3-9 collected five-point, Likert scale responses. Items 10-15 collected open-ended responses.

Results

A total of 16, 20, and 42 students completed the course in the fall 2020, spring 2021, and fall 2021 semesters, respectively. The total survey responses were 8, 12, and 31 in these same semesters, corresponding to a 50%, 60%, and 74% response rate, respectively.

Course enrollment represented more diversity than that of the department and university (a predominately white institution), as well as the greater computing discipline. For example, only 3% of all Duke CS undergraduates identify as Black, which is below the university representation of 9%, as well as the national representation [1]. Table 2 presents racial and gender information on participants completing the course per semester.

Table 2. Course demographics, by race, ethnicity, and gender.

	Black	**White**	**Asian**	**Latine**	**Middle Eastern, Northern African**	**Multi-racial**	**Men**	**Women**	**Non-binary**
F20	44%	31%	25%				44%	56%	
S21	22%	22%	39%	4%		13%	25%	75%	
F21	14%	31%	28%	17%	3%	7%	46%	46%	7%

Table 3 presents the mean and standard deviation of the responses to items 1-9 (by semester). Responses were coded as Strongly agree (5), Somewhat agree (4), Neither agree nor disagree (3), Somewhat disagree (2), and Strongly disagree (1).

Table 3. Responses to quantitative survey items (1-9), by semester.

Item	**F20**		**S21**		**F21**		**Total**	
	μ	**σ**	**μ**	**σ**	**μ**	**σ**	**μ**	**σ**
Prior to enrolling in this "Race, Gender, Class, & Computing how many full courses dedicated to diversity, equity, and/or inclusion in computing had you completed?	0	0	0	0	0.194	0.467	0.118	0.378

Prior to enrolling in "Race, Gender, Class, & Computing," how many workshops/course modules dedicated to diversity, equity, and/or inclusion in computing had you completed?	2.375	1.218	1.833	1.675	0.742	1.244	1.255	1.506
Before this class began, I was comfortable discussing the topics covered.	3.875	1.166	3.917	0.493	3.613	0.973	3.725	0.930
After completing this course, I am comfortable discussing the topics covered.	5	0	4.833	0.373	4.516	0.666	4.667	0.583
The instructor created a brave space for learning.	5	0	4.833	0.373	4.548	0.498	4.686	0.464
My classmates created a brave space for learning.	5	0	4.75	0.433	4.452	0.559	4.608	0.527
This course was structured in a way that helped me learn the material.	4.875	0.331	4.667	0.624	4.645	0.698	4.686	0.641
I'd like to see more classes like this in the computing department.	5	0	4.667	0.850	4.806	0.470	4.804	0.561
I'd like to see more topics like those discussed in this class infused throughout other computing courses.	5	0	4.75	0.595	4.710	0.579	4.765	0.546

Qualitative results

Open-ended responses from items 10-15 in Table 1 were coded using NVivo to identify three course components that significantly impacted students' experiences: intentional structuring of course content, class discussions and participation, and physical classroom configurations. In addition, themes related to the need for these courses to help students with not only their own identity development, but also their cultural competence began to emerge. Below discusses the course components impacting student experiences, followed by emerging themes.

Structure of course content

Students noted the intentional structuring of the course (including centering the voices of people from minoritized groups) was helpful in grounding their discussions and understanding topics that are not often taught/discussed in traditional computing courses:

"I love the way the class was structured (how we first spent time defining identities and placing historical context and then zooming into computing specifically). I also enjoyed the way we learned materials (podcasts, movies, Ted talks and short articles). They were very interesting and formats made me more eager to learn."

"I really enjoyed starting with a focus on different types of identities and getting that baseline before moving into issues of DEI in tech."

"I also really liked the structure of the class: going identity by identity and talking about them one by one, then going into how they are related to computing."

"All of the review material is very informative and helpful. I like how it was a mixture of podcasts, articles, and videos."

Students also noted more even distributions of pre-lecture material, adjusting the focus of some topics, and course logistics updates as areas of improvement:

"There was a bit of a disparity between the weeks in terms of amount of prep material. Some weeks there would be 5+ hours of podcasts, videos, readings, etc. and other weeks there would be like 3 2 page articles. I think spreading out this load more would help students process things more consistently."

"It (felt) like facial recognition/AI lasted really long"

"I think it could be interesting to shift the weight of the class more to the first half where we learned about identities and history more generally. Although learning about algorithmic bias was very interesting, I think the last couple weeks of class had somewhat repetitive topics."

<u>*Class discussion and participation*</u>

Students noted the impact of the in-class discussions, as well as an open and inclusive environment for having these discussions:

"How conversational and inclusive the class environment was (even though it was online)!"

"Discussions & open, inclusive environment."

"I liked how we were able to contribute our own opinions to the class discussions often and it didn't just feel like we were being lectured to the whole time."

"The in-class discussions were the best part of the course to me."

"I think the discussion in this class is definitely a highlight and facilitates some of the most profound learning moments."

"safe space to talk"

"Good energy -- was excited to come to class everyday and didn't feel stressed about the work"

Given there was no participation requirement, students noted this helped to facilitate more organic discussions, while also presenting challenges when only a few people consistently spoke:

"No one was pressured to speak and no one was judged when they did speak."

"I also think that not requiring participation is a great class policy for a class of this type - sometimes requiring participation leads to less productive discussion on sensitive or difficult topics."

"I would have liked more engagement from other students."

"I'm not sure how to fix this, but sometimes I am afraid to say certain things because I am afraid of saying something wrong or offensive. Making sure people know it's okay to make mistakes and it doesn't make you a terrible person would be helpful, but again, I am not sure how to effectively make this known."

Physical classroom configuration

While the course was in-person for only one semester (fall 2021) of the initial three, the impact of the classroom configuration (and campus COVID-19 protocols) emerged as a significant barrier for many students in that semester.

"being in a lecture hall and how hard it is to see everyone's faces."

"A weakness of the class was it being in a lecture hall as I never got to see everyone's face at one time."

"Lecture style, would love to see it be more conversational with for credit or built-in discussion sections that shift throughout the semester."

Emerging themes: Student shifts in Perceptions of identity and computing

There are several emerging themes related to shifting student perceptions of identity, computing, and their relationship and importance that are of interest. Most of these emerged from responses to Question #14 in Table 1: "Do you have any advice for future students who are beginning/considering the course?"

"Be willing to share idea and think deeply about these topics. There is no stupid question and the only way to learn and grow is to recognize where you need room for improvement. You get so much more out of the class by actively participating in discussions."

"Before this class, I only ever knew what it was like to be me."

"Come in with an open mind and don't think the stuff in this course doesn't apply to you!"

"If it's your first time discussing DEI in any setting but specifically a class setting, come in with an open mind. listen listen listen"

"GO TO CLASS!!!!! I can't imagine this class without attending lectures and learning from my peers."

"Engage in difficult conversations! It's the best way to learn."

"Definitely take this class, particularly as a computer science major. Super important"

"Absolutely take this class, you will learn so much about others and yourself"

"Take it seriously! The work is very manageable and honestly probably no one would know if you did the readings, but the low-pressure environment is perfect to actually do the readings and learn from them. This isn't a class you take for the grade, but rather a class you take to genuinely learn."

"TAKE IT! This class will really challenge the way you view the tech field"

Discussion

This course was the first computer science course at Duke that centered identity-inclusive topics, as well as the first time that many students had completed such a course. Students overall reported completing less than 0.2 identity-related courses (with fall 2020 and spring 2021 semesters reporting 0) and approximately 1.25 workshops prior to enrollment. Subsequently, the favorable responses to more courses (4.804) and topics infused throughout other computing courses (4.765) indicate identity-inclusive computing is of significant interest to students.

The responses to open-ended questions support student interest in the content, discussions, and ability to share with/hear from peers about their experiences (which served as important learning opportunities in the course). Across all three semesters, students reported an approximately 20% increase in comfort discussing the topics covered in the course. This was attributed to the inclusive environment that was reported via open-ended responses. While one student reported concerns with being wrong/offensive as a reason for not participating more, there were also concerns about whose voices dominated the conversation. However, students were informed at the beginning of the course that they would not be asked to speak unless they raised their hand. Throughout each lecture period, all students were provided the opportunity to speak. Given the importance of not requiring participation and unexpectedly asking students to speak for their

identity (especially those from minoritized groups), it is important that students be reminded of this throughout. To address this for future semesters, students will be reminded at the beginning of every lecture period of the importance of using their voice [32].

Finally, the COVID-19 pandemic presented a significant challenge for the in-person implementation in the fall 2021 semester. Given this was the first return to campus since course implementation, a classroom was assigned that would allow for proper social distancing among students. The classroom capacity (150) versus the maximum enrollment (50) meant that students were not always seated close together. This (as well as indoor mask mandates) made it more difficult to not only hear, but also engage with others. Determining the proper balance between classroom layout and enrollment during the pandemic is an ongoing challenge. For example, a smaller classroom was assigned for the spring 2022 semester (capacity: 73). However, the enrollment also increased (65).

Emerging themes related to student perceptions of identity and computing indicate a growing interest in understanding and discussing their own identities as well as others'. Students indicated the course allowed them to further reflect on their own identities and how that relates to not only interpersonal communication, but also how they experience computing environments (as creators) as well as technologies (as consumers). Coupled with other responses that noted the value of the course structure (i.e., beginning with definitions of identity, historical context, and then connecting what happened historically in society with what is currently happening in society and computing), respondents note a value in the course is gaining a firmer sense of their own identity, reducing knowledge gaps related to identities they don't hold, and what they've done outside of class to continue this. This is important, given the class demographics per semester (Table 2) and global events that were happening concurrently.

As previously noted, the enrollment demographics did not always align with national trends in terms of race, ethnicity, and gender. The fall 2020 semester followed the summer-long Black Lives Matter protests globally (following the murder of George Floyd) as well as the COVID-19 pandemic, subsequent attacks on the Asian community, and the 2020 U.S. presidential election. The spring 2021 semester began immediately following the January 6 insurrection attempt and included the murders of six Asian women at an Atlanta spa. The fall 2021 semester included ongoing issues related to the pandemic, white supremacy, attacks on trans rights, and misinformation campaigns on social media. Given these events, many students with minoritized identities appeared to seek courses that provided opportunities to explore these topics in the context of their experiences as college students and computing majors.

In addition, many students noted in final presentations that ability was the identity they knew the least about prior to enrolling in the course. Following the discussions of ability (including the inaccessibility of Duke's campus), they've become more cognizant of barriers and how the COVID-19 pandemic has exacerbated problems for people based on this identity and others. These and other responses indicate a growing need for computing departments to move beyond traditional computing curricula that focuses on theory and incorporate more courses into their curricula that focus on the human aspects, especially as areas such as human-computer interaction, user experience/user interface (UX/UI) design, and more explode. In addition, more computing students are actively seeking avenues to combine their social justice interests with

their computing majors. Courses such as this provide a great introduction to these topics, as indicated by three respondents:

"For those who are interested in equity and activism but aren't sure where to start, this is a good introductory course because it covers a broad range of important topics. Even people who aren't necessarily interested should try out the class, and the atmosphere is generally welcoming."

"Absolutely take this class, it's a must for anyone planning to enter the tech space."

"TAKE IT! This class will really challenge the way you view the tech field"

These emerging themes also indicate that requiring similar courses for graduation from the major would help prepare more graduates to enter tech companies with an understanding of these topics from the context of the developer as well as the user. Given recent issues with companies like DoorDash (where developers complained about monthly requirements to serve as a driver as part of their WeDash program), requiring students to complete such courses before graduating and entering companies would eliminate the assumption that a developer does not need to intimately understand the user's experience to develop a product, especially when these beliefs are rooted in classism and other forms of oppression [38].

This requirement was first posited by the author in [15]. While this position paper noted the limitations of computing departments (due to ABET requirements), the author contacted ABET in the spring 2020 semester to understand the process for requesting such changes to general and program criteria and was subsequently invited to serve on the Computing Sciences Accreditation Board's DEI Committee, which was tasked by ABET (along with all other commissions) to update general/program criteria to better incorporate DEI [39]. This work is currently ongoing, with the first round of public review completing in June 2022, and updated criteria scheduled for the 2023-2024 academic year. As this work progresses, exploring these emerging themes across more semesters is important.

Course scaling and replication

The course was initially created as a special topics course in the fall 2020 semester, with a capacity of 25 students. However, given the department's size (approximately 1000 undergraduates, the largest Duke undergraduate major), this enrollment cap is insufficient to impact a significant number of students before graduation. In 2021, over 360 undergraduate degrees were awarded in computer science, with approximately 53% of all Duke graduates completing at least one CS course. This meant less than 10% of all Duke computer science graduates would have the opportunity to complete the course before graduation. Enrollment was increased to 50 in the fall 2021 semester (to understand the impact of the switch to in-person implementation on course design) and 70 in the spring 2022 semester. The course is also listed in the fall 2022 offerings with an initial enrollment of 100 and maximum capacity of 120 (to account for waitlisted students) (reaching at least 33% of any graduating class).

In the fall 2020 semester, computing faculty from other institutions expressed interest in using the course material to create similar courses at their institutions. However, the course required

self-reflection, accountability, and changes (where necessary); intentionality in design and implementation; understanding of topics and current events; and comfort/self-efficacy leading discussions with students from diverse identities. In addition, the course's fluidity and the importance of not following traditional postsecondary computing pedagogical practices meant that instructors could cause harm if they have not taken the proper time to (un)learn, then apply this knowledge in innovative and inclusive ways.

The Cultural Competence in Computing (3C) Fellows Program was created in the fall 2020 semester to address this (and scale the number of undergraduate computing students completing similar courses outside of Duke University). This two-year, virtual, cohort-based, professional development program helps participants (computing faculty, staff, postdoctoral researchers, and graduate students) define identity; identify how academic/professional computing environments are impacted by identity; interpret how experiences within computing environments differ based on identity; relate these experiences to historical/cultural events that impacted people from minoritized identities; select and advocate for personal/departmental policies and practices that are more inclusive of identity; and design/implement computing deliverables (courses, modules, and other outputs) at their home institutions [40]. This program ensures that the developed projects are not simply "replications" of the original "Race, Gender, Class, & Computing" course, where instructors have not invested the necessary time to understanding/developing the material. It also ensures that instructors (many of whom have limited, if any, understanding of these topics due to their exclusion from traditional undergraduate/graduate computing programs) are able to (un)learn, as well as gain self-efficacy implementing and sustaining these deliverables in their home computing departments, by providing the important and necessary "setting for folks to voice fears, to talk about what they are doing, how they are doing it, and why"[32].

Cohort 1 of the 3C Fellows Program (approximately 100 participants) included participants from the U.S., Canada, Austria, and Nigeria. Seven new courses and 3 modules in existing courses were implemented in the fall 2021 semester. Eleven new courses and 9 modules in existing courses were implemented in the spring 2022 semester. This work continues to grow each academic year, as Cohort 2 (approximately 100 participants) is completing Y1 professional development and Cohort 3 applications are under review.

Conclusion and future work

The rapid rate of technology development means computing graduates must be prepared to address not only the challenges with current and future technologies, but also think critically about the challenges within their personal, academic, and professional environments. Until recently, university computing departments have not taken an identity-inclusive approach to defining what constitutes computing fundamentals, how it is taught, and who is impacted. This work presents "Race, Gender, Class, & Computing," a novel, three-credit-hour computing course for Duke University undergraduates that focuses on understanding how identity impacts and is impacted by computing. The course intentionally centers the experiences and voices of people from minoritized groups based on race, gender, socioeconomic class, ability, and sexuality. Through a mixture of content and activities, the course is shown to improve student knowledge of and self-efficacy discussing these topics. Results also indicate these topics are potential areas

of significant interest for computing undergraduates and should be infused throughout the curricula.

Future work includes understanding the impact of increasing course enrollment (to reach as many undergraduates before graduation as possible), assignment revisions (to better incorporate prior assignments with future ones), and other course adjustments (to allow for more discussions on certain topics, based on student feedback) on student experiences. Future work will also further explore the emerging themes related to identity and cultural competence. This work will also explore the impact of non-Duke courses on student experiences by distributing the custom end-of-semester survey used in this study across all courses led by 3C Fellows. This will allow for assessing the impact of these courses across different institutions.

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