Starting with DEI and Ethics - A New First-Year College Computer Science Introduction

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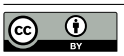
Abstract

Early exposure to ethical reasoning and diversity, equity, and inclusion (DEI) concepts is critical for preparing socially responsible computer scientists. To support this goal, we designed and implemented a required non-programming first-year undergraduate computer science course that is taken concurrently with an introductory programming course. This discussion-based course integrates DEI and ethics as foundational themes. The new course adopts a breadth-first structure delivered over a 10-week quarter, with 5 of the 18 sessions focused on DEI and ethics. Over three consecutive academic years, we collected pre- and post-course survey data from 451 students enrolled in the new course. Results show an increase in student's recognition of the importance of DEI and ethics and a substantial increase in understanding how these dimensions intersect with technical practice. In this experience report, we describe the course design, instructional methods, and survey instruments; present key findings; and reflect on lessons learned. This work contributes a model for embedding DEI and ethics into the early undergraduate computing curriculum.

CCS Concepts

• **Social and professional topics** → **Computer science education**; **Race and ethnicity**; **Code of Ethics**.



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Keywords

race and ethnicity; systemic oppression; CS education.

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1 Introduction

As computing continues to expand its influence across disciplines, industries, and socio-technical systems, critical questions emerge about who participates in its development and the values that guide this participation. Computing is no longer confined to advancing algorithmic efficiency or system performance; it increasingly shapes public institutions, economic opportunities, and civic life [1, 26, 36]. This expanded societal role requires a corresponding transformation in how computing professionals are educated and prepared to engage with the ethical and cultural contexts of their work.

Undergraduate CS education must prepare students to consider the social, ethical, and cultural consequences of the technologies they create [41]. Because design is inherently value-laden, technologies reflect their creators' assumptions and experiences, shaping equity, access, and inclusion at scale [40]. A socially responsive computing future therefore requires diversifying the field's workforce and research agenda, not just to improve design and outcomes, but as a matter of social justice [8]. The long-standing exclusion of minoritized groups from leadership and meaningful participation sustains structural inequities, making their inclusion a central goal for computer science education [31].

A growing body of literature has called for a more inclusive and critical approach to computer science education, one that goes beyond technical instruction to foreground identity, power, and systemic inequality [16, 23, 32]. These calls align with broader efforts to increase diversity [42] and belonging in computing [5], particularly for women, Black and LatinX students, first-generation college students, and other historically excluded groups. While significant work has addressed the K–12 pipeline; for example, through frameworks for culturally responsive computing [7], accessibility-centered design [15], and equity benchmarks for accountability [17]–entry into post-secondary computing programs remains a major barrier. For many students without prior K–12 access, college courses are their first exposure to computer science, making inclusive pedagogy essential for persistence and long-term success [6].

We present findings from a three-year implementation (2022–2024) of a restructured first-year computer science course that integrates ethics and DEI from the outset. Using pre- and post-course survey data ($N = 451$), we examine changes in students' attitudes, awareness, and sense of belonging. This analysis highlights the impact of embedding DEI and ethical reasoning within core content and adds to the growing literature on inclusive computing education. At the University of Denver, we redesigned our first-year sequence to position DEI and ethics not as supplements but as foundational lenses for engaging the discipline. In doing so, our work extends prior efforts to integrate ethics into introductory courses [11, 33] and contributes to broader movements to make computing education more representative, reflective, and responsible.

2 Background

What makes a computer scientist? Beyond programming, algorithms, applications, and systems knowledge the answer increasingly includes empathy, ethical reasoning, collaborative practice, and cultural awareness. As the field continues to shape and be shaped by society, CS education must evolve accordingly. A purely technical approach is no longer sufficient to prepare students for the complex, interdisciplinary challenges of the modern workforce. In response to this need, researchers have begun to consider the impact of the integration of DEI and ethics in CS education. A number of CS programs have integrated this content into their existing courses, while others utilized stand-alone courses or combined methods [10, 29]. Implementation strategies ranged from comprehensive frameworks such as GenderMag [10] to targeted pedagogical interventions, including deliberative dialogue [22] and peer-led ethics discussions [24].

Studies show that embedded approaches tend to yield stronger outcomes than isolated interventions. Integrated ethics and DEI content improved students' capabilities in inclusive design [10], ethical awareness [25], and professional preparedness [18]. However, the impact of stand-alone interventions was more variable, with some showing limited or mixed effects [2, 35]. Key implementation challenges included limited efficacy with international students [9], difficulties in fostering empathy [24], and barriers to applying concepts in project contexts [12].

The most effective programs shared several characteristics: ethics and DEI content was integrated throughout the curriculum rather than confined to single modules; pedagogy emphasized participation and dialogue; materials were tailored to student demographics; and institutional support was strong. While some studies were limited by small sample sizes or incomplete reporting, the overall evidence supports the importance of sustained, mandatory coursework in these areas [18, 25]. Comprehensive, long-term implementations consistently outperformed superficial or one-off efforts in cultivating both awareness and professional competence [14, 39]. Other works that suggested approaches to weave DEI into undergraduate computer science education have informed our curriculum revision. Lewis created and distributed "Microagressions: The Game!" to practice responding to microagressions [20, 38]. Many other excellent resources for promoting inclusion can be found at the csteachingtips.org [37]. Washington advocated for creating a course specifically on gender, race, and computing [43]. We strongly support this recommendation in addition to our approach of integrating DEI and ethics issues in required courses.

3 Course Details and Goals

Our "Introduction To Computer Science I" course serves as an entry point to the field, emphasizing that becoming a computer scientist involves more than learning to program. Designed to introduce students to the intellectual breadth and societal relevance of the discipline, the course covers foundational topics such as the history of computing, algorithms, time complexity, hardware, the internet, cybersecurity, AI/ML, HCI, and ethical considerations, while also highlighting computation as a tool for inquiry and understanding. Almost all of our incoming first-year majors take this course concurrently with our program's "Introduction to Programming I" course. Together, these courses ground students in both the conceptual and practical dimensions of computing as they begin their academic journey within the broader Computer Science program at the University of Denver. In this work we focus on the content and impact of "Introduction To Computer Science I" .

Key goals of the course are to:

- provide a larger picture of computing beyond programming, including applications, HCI, AI and high-level algorithms (11 lectures);
- introduce computing DEI issues (3 lectures);
- introduce and use ethical decision making frameworks (2 lectures); and
- explore computing careers including working with our university career center (2 lectures).

Although we refer to them as "lectures,"each 50-minute class combined a brief lecture with small-group work, class discussion, and individual reflections. Only reflections were graded, with full credit for any cogent response. Three sessions focused on DEI. In the first, student groups designed an auto-loan decision system using compound Boolean logic or pseudocode if/else statements. They could include zipcode default rates, leading to a class discussion on redlining and how such criteria can embed systemic oppression in software.

In the second, students engaged in an interactive theater exercise (Year 1) or watched a recorded version (Years 2–3), followed by discussion and reflection. The scenario depicted common gendered tropes: a man talking over a woman, a woman's idea being ignored

until repeated by a man, and men assigning the least challenging tasks to a woman. Further details are in [19, 30]. After a class discussion students are asked to enter a reflection answering:

> "1) How did this make you feel?; 2) What two (or more) things were "wrong" in this scenario? 3) If you were a fourth person in the group, what could you say/do to improve the situation for two or more things you identified as wrong?"

In the third DEI-focused lecture students are introduced to bias in AI/ML. Students watched Dr. Joy Boulamwini's TedX Algorithmic Justice talk [3] followed by a class discussion. Students are then asked to individually answer the following questions:

> "1) Which best describes your reaction to watching the Algorithmic Justice Talk by Joy Boulwaini: a) Nothing new to me; b) I was somewhat aware; or c) New to me, I was unaware. 2) What do you think were likely the problems with the training data set for the face recognition software used by Ms. Boulamwini. 3) How valuable to YOU was today's class on decision trees and Ms. Boulamwini's video?. 4) Regardless of whether today's class on decision trees and Ms. Boulamwini's video was valuable to you personally, in your opinion how IMPORTANT is it to cover the topic in this class?"

Two lectures introduced an ethical decision-making process in computing using a subset of "A Framework For Making Ethical Decisions" from Brown University's Program in Science, Technology, and Society [4]. We focused on the Consequentialist Common Good, Duty-Based, Rights-Based, Divine Command, and an adapted "agent-centered (feminist/marginalized group)" approach to include broader critical perspectives. The first lecture covered the framework and the common good model, followed by small-group discussions (2–3 students), whole-class debriefs, and individual reflections. A condensed version of the prompt is:

> "Your group was put in a time machine and sent back in time to make the decision on whether to add the apple watch cycle tracking app or not. You are asked: should we add this app to the watch? Using the framework of the consequentialist common good approach, what arguments do you have for saying "yes" and what arguments do you have for saying "no". Discuss in your group and then enter a summary of your discussion in the textbox of today's assignment."

For the second lecture we introduced the Duty Based, Rights Based, Divine Command Based, and Agent-Centered models. We again formed small discussion groups, shared to the class, and finally assigned a personal reflections as follows:

> "'Pick one of the following scenarios: 1.We are building a system to automate college admission decision making. 2.We are building a system to monitor people entering/leaving a building to help with contact tracing. 3.We are building a system to track diabetes to help government provide better services. Agree upon one of the following ethical frameworks to use: Duty Based, Rights Based, Divine Command Based, and Agent-Center Feminist/Marginalized Approach then answer these two questions: 1. Should you proceed? Why or why not according to your ethical framework? 2. Assuming you are to proceed what is your list of concerns that must be met in the final product?"

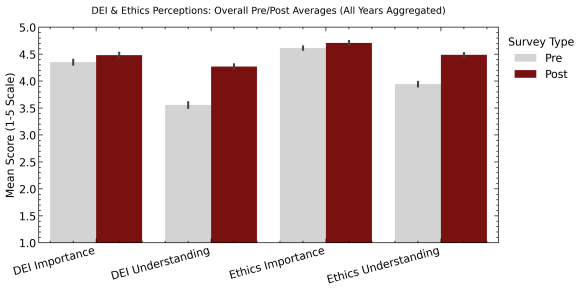

Figure 1: Mean of Responses to Q1–Q4

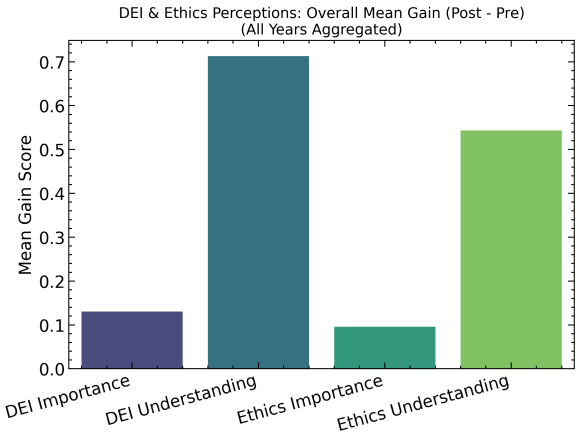

Figure 2: Pre- vs. Post-course Responses for Q1–Q4

4 Survey and Survey Results

Students were asked to complete a survey on the first and last class days. All 18 first day questions were multiple choice. Of the 29 last day question, 24 were multiple choice and 5 were open-ended text response questions. Here we only present the questions most salient to this paper. A full list of our survey questions can be found at FirstYearCS.cs.du.edu. The survey was anonymous, and inclusion in the research study was optional. The survey was part of a larger research project and covered under approved University of Denver Institutional Review Board Protocol # 1076764-16. Of the 501 students who took the pre-class survey, 451 agreed to have their answers included in this study; of the 441 who took the post-class survey, 371 agreed to have their answers included. Due to the anonymisation protocol, pre and post responses are not paired.

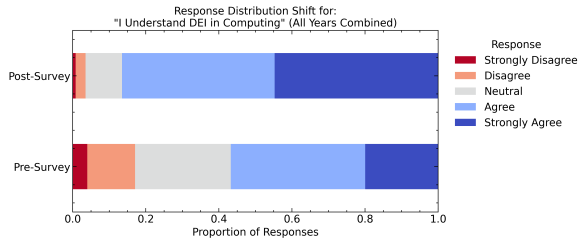

Figure 3: Response Distributions post-course to pre-course responses to Question Q2: "I have a good understanding of how DEI is related to computing"

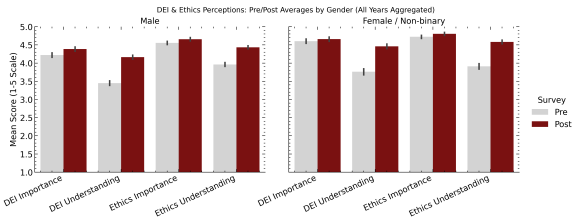

Figure 4: Gender Groupings of Mean Responses To Q1–Q4

4.1 Descriptive Results

We begin by presenting gender [1] demographics collected through student surveys (Table 1). To protect anonymity, we report disaggregated data in broader groupings, categorizing gender as either "male"or "female & non-binary."We present overall results and, where relevant, subgroup findings. Analyses by race/ethnicity showed no substantial differences, so we omit those demographics in line with recent recommendations [28].

Table 1: Generalized Survey Gender Data for Each Year

Category	2022	2023	2024
Pre-Course: Male	88	105	103
Pre-Course: Female & Non-binary	42	59	54
Post-Course: Male	78	79	82
Post-Course: Female & Non-binary	38	46	48

4.2 Student Perspectives

We first consider the following questions that appeared exactly the same in both the pre and post-surveys:

- Q1: Do you agree with this statement: DEI (Diversity, Equity, and Inclusion) is important to computing.
- Q2: Do you agree with this statement: I have a good understanding of how DEI (Diversity, Equity, and Inclusion) is related to computing.

[1]Students self-reported gender on their anonymous surveys, and were provided with options to select one of the following: (A) Male, (B) Female, (C) Non-binary / third gender / agender / gender fluid / two spirit / other, or (D) Prefer not to say. We recognize that these classifications are both reductive and imperfect, conflating language around gender and biological sex, and that they do not follow current best practices for gender self-reporting [34]. However, to ensure consistency across the three years of the study, we elected to keep the language constant each year. The results presented below adhere to the language participants used to self-identify.

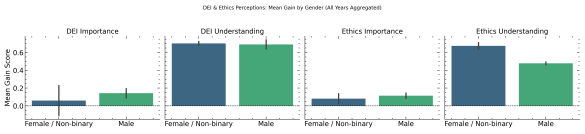

Figure 5: Gender groupings of pre- and post-course responses to Q1–Q4

- Q3: Do you agree with this statement: Ethics is important to computing.
- Q4: Do you agree with this statement: I have a good understanding of how ethical decision making can be used in computing.
- Q5: Do you agree with this statement: Computing is being used to make society more inclusive and equitable.
- Q6: Do you agree with this statement: Computing could be used to improve our environment and mitigate climate change.

For each of the six questions students responded with one of the following five answers: (5) Strongly agree; (4) Somewhat agree; (3) Neither agree nor disagree; (2) Somewhat disagree; (1) Strongly disagree. In Figure 1 we show the average numeric response for questions Q1 - Q4 averaged over all three years. In Figure 2 we show the numeric gain in the post-course survey compared to the pre-course survey for the fours questions. The results indicate that students already agreed that DEI ($M = 4.35, SD = 0.93$) and Ethics ($M = 4.61, SD = 0.68$) are important to computing, and at the end of the course there was an increase in importance.

Further, at the start, students did not agree as strongly that they understood how DEI relates to computing ($M = 3.56, SD = 1.07$) nor how ethical decision making can be used in computing ($M = 3.94, SD = 0.91$), but at the end there was an increase of understanding for both (to $M = 4.27, SD = 0.79$ and $M = 4.49, SD = 0.63$, respectively). In Figure 3 we plot the answer distribution shift for question Q2 from pre-course to post-course. The distribution for question Q4 was similar. In Figure 4 we show the average numeric responses grouped by gender and in Figure 5 we show the numeric gains grouped by gender. The female & non-binary group numbers are higher for all four questions (e.g., for post-course understanding of DEI, males $M = 4.16, SD = 0.83$ vs. female & non-binary $M = 4.46, SD = 0.71$). Both males and female & non-binary show comparable gains for questions Q1, Q2, Q3 while the female & non-binary groups has a higher gain for question Q4 (a gain of +0.67 vs. +0.47 for males). We also explored these results for questions Q1, Q2, Q3 and Q4 by race/ethnicity and did not see any significant differences for large groupings.

In Figure 6 we show the average numeric responses and in Figure 7 we show the numeric gain for all students over all years for questions Q5 and Q6. We see that at the end of the course students view that computing IS being used to make society more equitable decreased (from $M = 3.65, SD = 0.89$ to $M = 3.56, SD = 0.90$) and at the same time the view than computing COULD be used to make society more equitable increased (from $M = 4.41, SD = 0.76$ to $M = 4.49, SD = 0.72$). We note that for males there was a larger drop in agreeing that "computing IS being used to make society more equitable" (a drop of -0.12 vs. -0.04 for female & non-binary

students). We conjecture that exposure to some of the challenges presented in our DEI and Ethics lectures led students to decrease their feeling that computing is being used to make society more equitable, and, we are encouraged that students stated an increase in feeling computing COULD do so.

Our end of course survey added questions to explore the success of delivering on some of our learning goals:

- Q7: One of the learning outcome goals of this course was to introduce students to a broader view of computer science than "just programming". How successful do you think the course was in delivering on this learning outcome?
- Q8: One of the learning outcome goals of this course was to begin building an ethical framework in regards to computing. How successful do you think the course was in delivering on this learning outcome?
- Q9: One of the learning outcome goals of this course was to begin building an "equity and inclusion mindset" in regards to computing. How successful do you think the course was in delivering on this learning outcome?
- Q10: One of the goals for this course was to encourage students to want to continue on with a major or minor. How much impact did this course have on you wanting to continue on with a major or minor?

For each of questions Q7, Q8, and Q9 students responded with one of the following five answers: (5) Very Successful; (4) Successful ; (3) Somewhat successful; (2) Not very successful; (1) Not at all successful. For question Q10 students responded with one of the following five answers: (5) Significant impact to continue; (4) Some impact to continue; (3) No impact, neither encouraged nor discouraged; (2) Some impact to NOT continue; (1) Significant impact to NOT continue. Most students perceived that the course was effective in delivering each of these learning goals (see Figure 8).

On both the pre- and post-survey we asked these three questions assessing whether students feel they belong in and will be included in computing:

- Q11: Do you agree with this statement: I am concerned I may not feel welcomed and fully included by most of the other computing students during my undergraduate studies.
- Q12: Do you agree with this statement: I am concerned I may not feel welcomed and fully included by most of my co-workers in my computing jobs after graduation.
- Q13: Do you agree with this statement: I feel I belong in computing.

Students responded to each of the three questions on a five-point Likert scale ranging from (5) Strongly agree to (1) Strongly disagree. Figure 9 shows responses by gender. Over their first quarter, female and non-binary students reported a slight decline in sense of belonging ($M = 3.51, SD = 1.06$ to $M = 3.46, SD = 1.01$) and greater concern about inclusion among both college peers ($M = 2.79, SD = 1.14$ to $M = 3.05, SD = 1.14$) and future workforce peers ($M = 3.09, SD = 1.10$ to $M = 3.36, SD = 1.12$). While it is unclear whether these changes stem from this course, the concurrent programming course, or both, the findings highlight the need for tools that better empower minoritized students—a focus we intend to expand in future offerings.

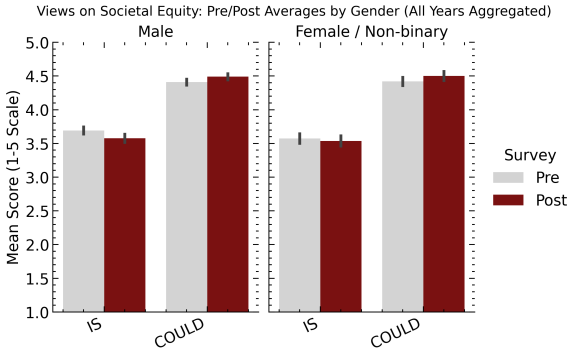

Figure 6: Computing IS/Could Be Used To Make Society Inclusive/Equitable by Gender

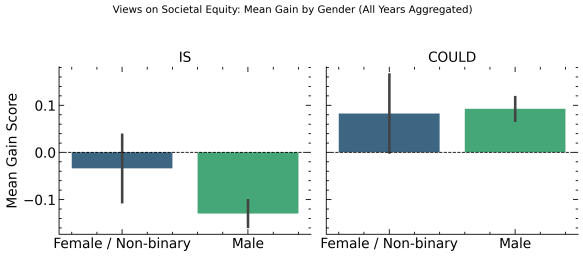

Figure 7: Society Inclusive/Equitable Gain/Drop in Numeric Responses by Gender

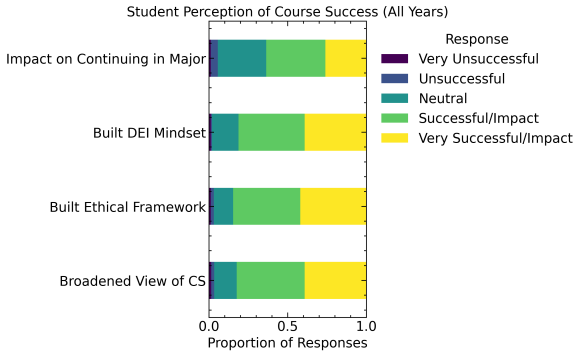

Figure 8: Post Survey Success Results

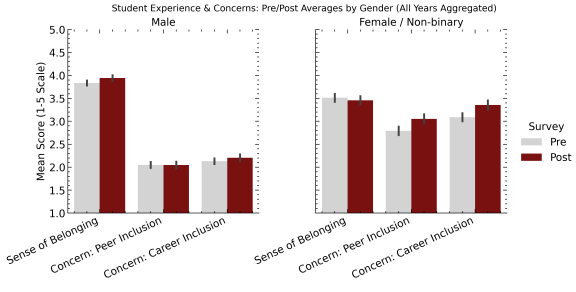

Figure 9: Personal Inclusion Concerns Gain By Gender

5 Instructor Reflections

Designing and teaching a required first-year course on the intersection of computing, DEI, and ethics can feel fraught or uncomfortable, depending on educators' backgrounds and lived experiences. To reflect on this, we each respond to the question: "Based on your experience teaching or developing this course, what do you feel are the biggest challenges and opportunities in this course for developing students' DEI and Ethics Mindsets?"

Author A: "I feel the biggest challenge is feeling comfortable teaching DEI topics. While I feel secure in being viewed as an "expert" in computer science education and technical CS topics, I was not trained in DEI nor Ethics. As a white, cisgender, heterosexual male I am lacking in shared lived experiences. At the same time, I feel social justice is too important to let my discomfort stop me teaching these topics."

Author B: "One of the biggest hurdles I faced in teaching this course was helping students feel empowered to engage with DEI and ethics issues in current systems. While students recognized the harms of biased and inequitable technology, they initially expressed a sense of helplessness, feeling unable to challenge or articulate the issues embedded within the system. As the course progressed however, students began using the ethical vocabulary to point out their concerns with greater clarity and conviction. This shift demonstrated that with right tools and language, students can move from passive awareness to active, thoughtful engagement with DEI and ethical challenges in computing."

Author C: "In teaching this course I had to learn how to facilitate class-wide conversations that were sometimes emotionally or politically charged, especially ones in which my own life experiences were less relevant than students'. These kinds of conversations are not something that teaching normal Computer Science courses prepared me for in almost any way - not just in the subject matter, but in the style of discourse. It ended up feeling valuable to me to have large parts of the conversations in the class be as student-led as possible, and my impression was that they got more out of those moments in class than listening to me lecture."

Author D: "I sometimes struggled to get students to take the course content seriously. From prior work, we know that CS students without prior experience discussing systemic oppression tend to devalue the importance of ethical content (c.f. [21, 27]). I found that using real-world examples helped illustrate direct impacts in a way that some students related to. However, others viewed the class as a "waste of time" (a quote directly from my student evaluations) compared to their other, more "technical" CS courses. I tried to connect course ideas to examples from my own lived experiences with minoritized identity hoping that it might help students contextualize our discussions. However, I had to balance my own disclosure against the fact that educators with visible minoritized traits are perceived as less competent [13]. It's difficult to know how all this interacted to influence students' mindsets."

Author E: "In approaching this work, I am guided by a belief that student motivation, a sense of value in the material, and a culture of persistence are essential to inclusive and effective computer science education. I view first-year courses not just as introductions to content, but as pivotal moments in students' educational journeys, moments that require psychologically safe environments where students can explore, make mistakes, and grow. As an instructor and researcher it is my responsibility to help create these spaces, not only through curriculum design but also through classroom culture. I recognize that this work is ongoing, and that meaningful inclusion requires reflection on how I show up for students, how I frame success, and how I support their development both academically and personally. I see these two avenues, supporting motivation and persistence, and intentionally cultivating psychologically safe learning environments, as critical directions for the continued development of the COMP 1201 course."

Author F: "Teaching this course reaffirmed my belief that DEI and ethics are not peripheral but foundational to CS education. A challenge was addressing student expectations, as many initially viewed CS as purely technical and were skeptical of equity and power structures. One of the most impactful moments came during our applied social simulation, where a workplace group project scenario was enacted and analyzed. These interactive theater experiences prompted deep reflections on power dynamics and everyday team interactions. Such exercises are essential for preparing students to navigate real-world situations where ethical reasoning and inclusive practices are critical. CS education must move beyond algorithms and syntax to equip students with the awareness and tools to design systems that responsibly serve diverse communities. This course was an opportunity to begin that transformation."

6 Conclusion

To promote equitable and socially aware computing education, we created a required, non-programming introductory course that paired with the programming sequence and framed core computing concepts through ethics and equity. Across three years and 451 students, survey data showed gains in understanding social and ethical dimensions of computing and shifts in how students saw their professional roles. Yet, female and non-binary students reported a decline in belonging, suggesting that raising awareness of systemic issues without tools for action may have unintended effects. This underscores a key implication for curriculum design: inclusive pedagogy must not only reveal structural problems but also equip students, especially those from marginalized groups, with the agency and confidence to enact change.

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