CS2023 Paper

Improving Computer Science Education with Help From DEI

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Overview

Undergraduate computer science (CS) demographics are troubling. For example, women earned 57.4% of bachelor's degrees and 60% of associate degrees granted to US citizens in 2019, but in the computing sciences they earned only 20.6% of bachelor's degrees and 20.0% of associate degrees.[1] See figure 1. In the USA, the demographics of most CS classrooms do not mirror those of their institutions as a whole, and, even more concerning, they underperform those of other STEM disciplines despite efforts to address the lack of diversity through inclusion, participation, and exposure programs. The lack of diversity is not isolated to undergraduate education but is echoed in K-12 education and the computing industry[2]. While the advent of the CS Principles Advanced Placement (AP) test significantly increased the number of students starting college with a CS AP, the College Board's two CS AP tests are taken primarily by white males[3] and opportunities to take high school CS classes are disproportionately offered by urban and well-funded school districts.[4] These statistics highlight the lack of diversity in the USA with respect to race and gender, but diversity may look different in your classroom. The strategies and resources offered below are also relevant to the gamut of diversity factors. CS2023's curricular guidelines include topics and illustrative learning outcomes regarding accessibility, diversity, equity, and inclusion in the undergraduate classroom. To effectively address these issues, students and faculty must begin with an understanding that diversity is important ethically, required legally in some countries, and valued and sought by industry because it is good for business.

Per the National Science Foundation's Science and Engineering Indicators (2022)[1], since 2011, the share of S&E (science and engineering) bachelor's degrees awarded annually to Hispanic students rose from 10% to 16%, while the share awarded to Black students declined slightly. The share awarded to Asians increased, and the share awarded to American Indians or Alaska Natives dropped. While the number of S&E bachelor's degrees earned by White students increased from 2011 to 2019, their overall share declined.

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[1] https://ncses.nsf.gov/pubs/nsb20223/demographic-attributes-of-s-e-degree-recipients
[2] https://www.bls.gov/opub/reports/womens-earnings/2021/home.htm
[3] https://code.org/promote/ap
[4] https://advocacy.code.org/2020_state_of_cs.pdf

Despite more focus on changing CS inclusion and "participation and exposure programs", little progress or systemic change has resulted. While we can point to ample studies to demonstrate this, we offer a visualization based on S&E Indicators Report (2022). Figure 1 provides a visualization of CS relative to other S&E fields. While the Indicators report offers percentages and absolute values, Figure 1 offers a depiction of proportional views of gender (inner circle) with women (in purple) and men (in blue). The outer ring captures representation within gender at the intersection of race/ethnicity in the U.S. White and Asian men and women represent the largest number of bachelor's degrees awarded in CS.

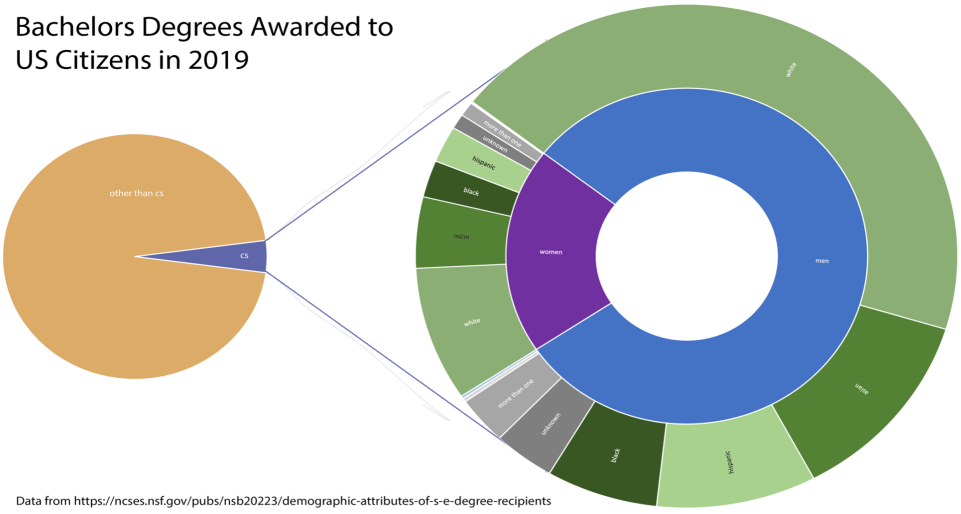

Figure 1: Visualization of CS Bachelor's Degrees Awarded to US Citizens in 2019

Strategies – Room from Transformative Approaches to CS Education

While the strategies may be many, there are commonalities across the CS education scholarship to better enable equitable inclusion. These include:

1) Universal design for learning
2) Cultural relevancy that embraces diverse experiences and cultures
3) Provision for student agency and interest in the learning process
4) Understanding the historical context of students and their diverse backgrounds
5) Understanding the value of collectivism to cultivate community approaches
6) Use of inclusive language within curricula, pedagogy, and classroom/lab experiences
7) Review of departmental policies, processes, procedures, and cultures that can amplify deficit-thinking and biases of underserved and/or minoritized students and faculty
8) Reviewing data pertaining to gateway courses, pedagogy, and learning environment to inform outcomes and course revisions

Conclusion

The strategies referenced above work towards achieving a computer science classroom that is inclusive, diverse, and equitable. Students, like each of us, crave a sense of belonging—to feel that their intersectional identities are not at odds with the learning environment. As faculty, we have a duty to educate all students in our classes, and, to that end, we can help foster a sense of belonging for our students through cultural awareness. Introducing students to computer scientists who share their identities and communities can be empowering and impactful. If possible, have peer mentors that share the identities of all your students. Take time to contextualize your grades; computer science grades may be lower than those in other disciplines. The C a student earns from you may be their first C. Students should not be surprised by a final grade. Communicating early and often with struggling students allows them to be connected with appropriate remediation resources or to adjust their work habits for better success. High impact educational practices that nurture a sense of community work for everyone: mentoring and peer-mentoring foster human relationships and provide support and opportunities for a holistic understanding of students. Undergraduate research, internships, and thoughtfully chosen real-world projects expose students to academic and industry work, nurture professional relationships, and connect our classrooms to the outside world. Lastly, we offer a list of readings for those interested in the CS Education domain and note that this is merely a partial curation of the many works that are available on this topic.

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