National Science Foundation Broadening Participation in Engineering CAREER project: Valuing the Social in Engineering and Computing (poster)

Computer Science and Engineering (CSE) is a discipline rapidly expanding into many domains of human experience. However, women's attrition in technical fields is significantly higher than men's, and women and nonbinary technologists are highly underrepresented in the computing workforce [1]. This National Science Foundation CAREER project 2409905, funded by the Engineering Education and Centers (EEC), aims to investigate how values, attitudes, and behaviors within CSE impact women and non-binary scholars' inclusion and how cultural elements either reinforce or challenge power inequities. There is uneven participation of women across CSE subfields, suggesting that subfield cultural values and norms vary. By comparing the cultural dynamics across subfields (Human Computer Interaction and Theory/Algorithms), the project seeks to broaden participation in computing by creating inclusive environments that offer equal opportunities, resources, and respect, ultimately enhancing women's and non-binary individuals' involvement and advancement in the field.

This project employs a grounded theory approach that values the lived experiences of technologists across the public and private sectors. Through conducting life history interviews and examining participants' lives in a holistic way, the project navigates how participants were drawn to computing, their challenges, and their engagement and experiences within the computing workforce. The interview protocol provided covered topics such as subfield culture, gender, race dynamics, and diversity (e.g., "Why did you choose your subfield?" and "Have you faced discrimination or bias?"). This protocol is available to other researchers upon contacting the PI. Other data collection methods used include participant observation, conducting semi-structured interviews, and content analysis of reputable literature and media. Using these methods, the project is action-oriented in nature, enhancing direct engagement with participants and amplifying the voices of underrepresented group members.

The *Valuing the Social in Computing* Lab is committed to providing research experience for undergraduates (REU). Over 35 undergraduates have gained skills and knowledge in qualitative data collection and analysis methods and strengthened their professional development on critical social issues related to computer technology. Through the lab, students have the unique opportunity to annotate cutting-edge literature, conduct qualitative analysis, and gain pedagogical experience all the while

learning from a carefully curated lab syllabus on lab processes and advanced research techniques. With these responsibilities, the principal investigator instills her research assistants with confidence in engaging with the many challenges in the computing workplace and creating theories and interventions that can broaden participation in this influential field.

Student self-governance is a fundamental value at the University of Virginia, and the *Valuing the Social in Computing* Lab embodies this central principle by fostering peer-mentoring, open dialogue, and consensus-based leadership opportunities. Through peer mentoring during the onboarding of new students and succession planning activities, students enhance the project's efficiencies and efficacies. Undergraduate researchers have designed the lab's operations to enhance communication, ethical data management, literature archiving and analysis and work hard to continually optimize these systems. As a result of their involvement in this project, many students have gained valuable research experience that has led to fully funded graduate school offers at prestigious universities, work in justice-oriented nonprofits, and research at high-tech companies.

Findings

This CAREER project has also contributed new knowledge to engineering education, STS and feminist anthropology, publishing in journals including; *Big Data and Society, Catalyst, Human Organization, Anthropology in Education Quarterly, and Science, Technology and Human Values*. Several of the papers were co-authored with undergraduate researchers.

One significant paper produced in this lab examined the phenomenon research participants called "majorism," or the preferential treatment of science and technology over the liberal arts in higher education. The methodology of this paper was unique in that data collection efforts were supported by undergraduate efforts at California Polytechnic State University, San Luis Obispo. Over 500 students across 42 majors conducted mini-ethnographies in the PI's classes, amassing over 15,000 pages of data that eight lab members analyzed. Findings revealed how majorism, perpetuated by universities' adoption of corporate "best practices" and their prioritization of profit-making over humanistic inquiry, stratified campus culture along lines of race, gender, sexuality and major field of study. Majorism impacted student's feelings of intrinsic worth, reinforced harmful stereotypes and instilled fear among liberal arts students about their future prospects as well [2].

Another paper published by this lab builds off the PI's experience with ethnographic methods to establish an innovative tool used to analyze engineering culture and foster inclusive change called Articulating a Succinct Description (AaSD). AaSD consists of four steps: 1) Conduct ethnographic fieldwork through semi-structured interviews, participant observation, and reflecting on personal experiences to explore engineering culture. 2) Analyze data using grounded theory to reveal power dynamics impacting underrepresented students. 3) Formulate case studies from real student experiences of bias, written as film scripts, to illustrate broader systemic issues. 4) Facilitate case studies as assessment and as a probe for collecting new data through classroom discussions. This process is an iterative loop that collects data at both the beginning and end of this cycle to examine how cases have transformed the culture being studied and verify the researchers' interpretations. Moreover, transforming ethnographic findings into case studies helps engineering students collectively confront biases, promote allyship and empathy, and uplift underrepresented students' experiences in engineering education [3], [4].

The *Valuing the Social in Computing* Lab has also contributed new knowledge on data science using feminist frameworks of consent and identifying techniques of invisibility used in computing worksites to obfuscate acts of coercion. These techniques refer to practices in data science that obscure power imbalances and perpetuate unaccountable behaviors. Examples of techniques proposed in this paper include epistemic injustice (silencing marginalized voices) and the Brotherhood (acts of exclusion and violence by dominant groups). Data science often relies on unrecognized labor and unchecked practices, leading to violations of consent and autonomy in both the production and distribution of algorithms. The PI and her undergraduate co-authors propose a call to action for public accountability, regulation and transparency in technoscience [5].

Finally, the PI also published a monograph last year with MIT Press documenting how feminist resistance to racialized gender violence in high-tech fields is leading a counterculture movement in the US to demystify computers and uncrown its most favored beneficiaries — Bros [6].

Development of Case Studies

The *Valuing Social in Computing* Lab also combines ethnography with the case study method to promote equity and inclusion in STEM. Undergraduate researchers work with the ethnographic data to create scenario-based learning modules that establish a collective framework for discussion and debate among engineers about the social challenges they face in labs and workplaces. Problem-solving with peers facilitates the sharing of best practices and strategies and helps catalyze institutional change.

Using the AaSD method, the PI and her student assistant developed case studies to engage students in critical discussion about diversity and inclusion in engineering. The first case, Resistance to Diversity, explores how four students react to the discussion of bias and microaggressions, with 88% of engineering participants reporting an enhanced understanding of bias and microaggressions, 86% gaining insight into strategies for supporting diversity, and 94% increasing their understanding of their peers (3). The Greg and Sara case study highlights exclusionary practices in group work, focusing on challenges underrepresented students face in engineering. The LGBTQIA Perspectives case features Jack and Emma, addressing homophobia and increasing awareness of the diversity within the LGBTQ community. Lastly, Lipstick portrays Sarah, a woman in electrical engineering facing sexism. The case shows how gender biases impact women engineers' educational experiences in painful ways. In developing these case studies, students have deepened their understanding of action-oriented ethnography and how to use it to promote cultural change in higher education. Over 2000 engineering students, from 2015-2023, participated in one of the *Valuing the Social in Computing* Lab's case facilitations [3].

Public Scholarship

All case study facilitation guides are available upon request at the *Valuing the Social in Computing* Lab website. In providing access to these ethnographically designed guides, the lab hopes to provide tools for other institutions to use these materials to facilitate problem-solving among peers, catalyzing cultural change in engineering education.

Also, the *Valuing the Social in Computing* Lab has amassed a media discourse scholarship archive of over 500 articles on the social dimensions of computing and made these tech journalism resources available on the lab's website. Articles are grouped into themes that reflect this project's ongoing analyses; to name a few, they include data privacy and surveillance, gender and sexual harassment,

racism in high-tech and tech worker resistance. Aside from increasing access to cutting-edge news articles, the lab provides a clearinghouse of peer-reviewed literature on sexual and gender harassment and labor issues in Big Tech to assist scholars who are pursuing similar research interests.

Contributions

The work produced by *Valuing the Social in Computing* Lab highlights the pervasiveness of cultural inequities in computing and engineering. Through amplifying marginalized voices and facilitating discussions on issues of representation and justice, our findings have contributed to a nuanced understanding of how increasing feminist values are vital for broadening participation in computing and engineering. In creating case studies and publishing interdisciplinary books and articles, this project paves the way for cultural change in various computer science and engineering sectors, including education and industry, with the goal of holding institutions of science and technology accountable to commonweal values and democratic oversight.

Acknowledgements

References

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