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Work in Progress: A Novel Professional Development Program for Addressing Systemic Barriers to Computing Participation

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1. Introduction

Technology's pervasiveness, its impact, and the economic mobility of its creators demand that all people drive the future of computing. Nonetheless, computing is dominated by white and Asian, able-bodied, middle-to-upper-class, cisgender men. Even with recent enrollment increases in undergraduate computing departments (i.e., computer science, computer engineering, etc.) in the United States, participation of Black, Indigenous, Latine/Hispanic, Native Hawaiian/Pacific Islander, women, LGBTQ+, disabled, and economically disadvantaged groups remains low [1]–[3].

The effects of this lack of diversity are evident in academic and workplace cultures as well as in biased/harmful technologies (e.g., facial recognition, predictive policing, public services, healthcare, and financial software) that negatively impact and exclude non-dominant identities [2], [4]–[10]. Identity-inclusive computing (IIC) explores how identity impacts and is impacted by computing [11]. This growing area of research blends social science with computer science to infuse topics related to identity (i.e., race, ethnicity, gender, sexuality, ability, and class), discrimination, and intersectionality throughout the discipline, with the goal of creating more inclusive and equitable academic/professional environments (and ultimately, less biased/harmful technologies).

To date, most efforts to increase diversity have centered on marginalized students, without fully acknowledging or addressing the people, practices, and policies that systemically make persistence difficult (if not impossible). This paper introduces a novel, virtual, cohort-based, professional development (PD) program that helps computing administrators, faculty, staff, postdoctoral researchers, and graduate students to identify and address systemic barriers impacting students and faculty with marginalized identities in computing classrooms and departments. The programmatic objectives are: (1) to increase participant knowledge of identity-related topics, (2) to increase participant self-efficacy to lead initiatives based on an understanding of these topics, and (3) to increase the number of departments implementing more identity-inclusive courses, modules, and other activities.

The program was piloted in the 2020–2021 academic year with over 100 participants from the United States, Canada, Austria, and Nigeria. Data collection included both formative and summative feedback. Likert-scale and open-ended responses were analyzed via descriptive and inferential statistics and thematic analysis. The preliminary results indicate an increase in participant knowledge of identity-inclusive topics, enhanced effort and self-efficacy with respect to designing/implementing identity-inclusive initiatives, and the creation of 67 courses/modules targeting both students and faculty.

2. Motivation

Despite recent enrollment increases in undergraduate computing departments in the United States, representation of historically excluded groups (i.e., Black, Indigenous, Latine/Hispanic,

Native Hawaiian/Pacific Islander, women, LGBTQ+, disabled, and economically disadvantaged) remains low. The 2020 Taulbee Survey reported that 12.6% of students enrolled in undergraduate computing programs identify as Latine/Hispanic, 5.6% identify as Black, 0.2% identify as Native American/Alaska Native, 0.1% identify as Native Hawaiian/Pacific Islander, and 20.6% identify as women [1]. Similar trends appear among computing educators, where only 2.6% of computing faculty identify as Latine/Hispanic, 2% as Black, 0.3% as Indigenous/Alaska Native, and 10% as women. Intersectionality further highlights the lack of representation [12], [13]. For example, Black women earn less than 3% of undergraduate degrees and represent less than 1% of computing faculty [1]. There is insufficient data on people with disabilities and queer identities to assess representation properly [2].

There have been many efforts to broaden participation in computing at the postsecondary level. However, these have primarily centered on students from minoritized groups through activities such as active recruitment, mentoring and role model programs, out-of-school activities, bridge programs, and affinity groups [14]–[17]. These interventions are rooted in the belief that students from minoritized groups have a perceived deficit and must develop more "grit" and academic abilities to complete computing courses and degrees successfully [18], [19].

Mostly absent from discussions are complementary interventions to address the people (i.e., students, faculty, and staff from dominant identities), policies (e.g., entrance exams and advanced placement course expectations), and practices (e.g., inaccessible material, campus policing, and other discrimination) that significantly impact student sense of belonging, retention, and degree completion. hooks notes the importance of considering educator fears with respect to shifting paradigms [20]. Thus, programs that provide them the space to express these concerns while learning to create/lead identity-inclusive activities are a necessary part of institutional transformation.

The PD program in this paper employs an identity-inclusive approach that targets administrators, faculty, staff, and other departmental constituents who are in positions to influence change for minoritized students, faculty, and staff. The program pushes discussions beyond climate and culturally relevant practices, and instead it uses a holistic view of identity to examine the impact of changes at the individual, group, classroom, and department levels.

3. Program description

The program was piloted in the 2020–2021 academic year, with Cohort 1 beginning September 2020. Year-1 activities began with completion of a prep packet (September–January), to ensure all participants began PD sessions with a baseline understanding of key topics. This prep packet consisted of two films, eight books, and three podcasts that centered on minoritized experts (e.g., *Why Are All the Black Kids Sitting Together in the Cafeteria*, *Sister Outsider*, *The Privileged Poor*, and *13th*) [21]–[24]. Brief check-in surveys in November, December, and January gauged participant progress towards completing the prep packet. Participants not completing these check-ins were removed from the program.

Ten PD sessions began in February and continued twice per month through June 2021. These virtual sessions allowed for deeper exploration into identity-related topics (e.g., race/ethnicity,

gender, sexuality, class, ability, intersectionality, white supremacy, racism, homophobia, transphobia, classism, ableism, advising/mentoring/supporting students and faculty, and teaching contentious issues). Program expectations were established early and included community guidelines adapted from Dr. Amrah Solomón such as "throw sunlight, not shade," "be open to being challenged on your ideas and expectations," and "no gas lighting" [25]. Prior to each PD session, participants were required to complete a pre-work assignment, which included a small collection of videos and podcast episodes related to the upcoming session topic.

Each 2-hour session included guest speaker(s) in the first hour who were experts on the session topics (e.g., Dr. Ruha Benjamin, Dr. Safiya Noble, and Dr. Ebony McGee). The second hour was dedicated to breakout and larger group discussions that built upon the pre-work and guest speaker(s) in the context of personal/professional experiences. The first six PD sessions focused on participants understanding their positionality in the context of the session topics, identifying similarities to/differences with students and colleagues from minoritized identities, and recognizing personal actions and organizational policies/practices that impact their academic/professional success. High-level designs of the required project began as pre-work assignments for Sessions 7 and 8 and continued as presentations/discussions for feedback in Sessions 9 and 10. A shared document of all projects [including institution and leader(s)] was maintained as a reference for all participants. Implementation of the identity-inclusive project was required no later than the spring semester of Year 2. In total, 67 projects were developed across 67 organizations. Of these, six projects were first implemented before the end of Year 1, with the remaining scheduled for the 2021–2022 academic year.

To facilitate community engagement around interesting news; implementation questions, challenges, and lessons learned; prep material; and job opportunities, a Slack workspace was created.

4. Methods

4.1. Research design

The purpose of this study was to answer the question, "*To what extent and in what ways does the program help participants to identify and address systemic barriers impacting marginalized students in computing classrooms and departments?"* The study design incorporated a mixed methods approach to provide a comprehensive analysis of the research question and improve the overall strength of the findings. Mixed-methods design is a well-established approach for collecting and analyzing both quantitative and qualitative data to understand the research problem better. This analysis enabled a general understanding of participants while also allowing for a nuanced view of specific concepts of interest [26].

4.2. Participants

Applicants for Cohort 1 were solicited through computing email listservs, social media, and word of mouth between August and September 2020. All computing faculty, graduate students, and staff who applied for the program were accepted, pending commitment to complete the program requirements discussed below. While the program targeted postsecondary participants, a small number of high-school staff and educators joined the program. A total of 138 participants

began the program, 123 of whom completed Year 1. Participants who did not complete the program left for a variety of reasons, including family challenges and work-related responsibilities. A total of 15 participants who missed multiple sessions were removed from the program. Demographics for initial participants are in Table 1.

Table 1. Participant demographics.

Variable		**Total**	**%**
Affiliation	Faculty	76	55
	Staff	25	18
	Graduate student	17	12
	Other (Secondary educatory/staff)	20	14
Gender identity	Male	50	36
	Female	84	61
	Non-binary/self-identify	4	2
Racial/ethnic identity	White	86	62
	Black	19	14
	Asian	16	12
	Latine/Hispanic	9	7
	Multiple	8	6

4.3. Data collection

Data collection procedures received IRB approval and participant consent for data reporting. Quantitative and qualitative data were collected throughout the first year via Qualtrics. Formative feedback was collected after each PD session via a session-specific survey containing one Likert-scale question and five open-ended questions related to the efficacy of the pre-work material, guest speaker(s), and breakout as well as larger group discussions. This feedback was used to refine subsequent PD sessions.

Pre- and post-work surveys assessed constructs of interest, including understanding of identity and self-efficacy implementing identity-inclusive projects. Additional pre-work survey questions collected information on prior diversity, equity, and inclusion (DEI) experiences (e.g., training and projects), as well as personal, department, and university strengths and challenges with respect to implementing change. Demographic information (i.e., race, ethnicity, gender, university type, and position) was also collected. In addition to questions assessing personal, department, and university strengths and challenges, the post-work survey collected data on the average hours per week participants spent completing the prep packet and pre-work for each PD session, as well as overall program strengths and areas of improvement.

4.4. Data analysis

Quantitative data from the pre-/post-work surveys were summarized through descriptive and inferential statistics. Due to unequal sample sizes (i.e., differing response rates), Welch's *t* test was used to compare the means and standard deviations with an alpha level of 0.01. Qualitative data from open-ended pre-/post-work survey responses were reviewed using inductive coding. A combination of descriptive, in-vivo, and values coding was initially performed, followed by line-by-line coding. Once patterns were identified, data were summarized using thematic analysis to identify common themes in responses. This process fostered a holistic representation of participant views by handling each response with equal importance and allowing ideas to present themselves organically.

Throughout data collection and analysis, the team (which consisted of the program leaders, who had a vested interest in the project's success) engaged in consensus building and exploring their positionalities to enhance the trustworthiness of the work [27]. Collectively, they identify as marginalized and equity-minded scholars who are all situated within computing departments and committed to advancing DEI in computing. Each has been engaged in a variety of departmental efforts to broaden participation and enhance inclusivity for marginalized students (K–16 and graduate students). Consensus was built by reviewing and discussing the data to determine the most salient themes across the study.

5. Preliminary findings

Prior to the first PD session, participants were invited to complete the pre-program assessment, and all 138 completed it. In June 2021 (immediately after the final PD session), the post-program assessment was sent to all participants successfully completing Year 1 activities. Of the 123 participants who completed the final PD session, 35 responded.

5.1. Quantitative analysis

The following null (H_0) and alternative (H_a) hypotheses were defined for this study:

- H_{01}: Participant knowledge of topics related to identity and DEI **do not** improve following completion of Year 1.
- H_{a1}: Participant knowledge of topics related to identity and DEI improve following completion of Year 1.
- H_{02}: Personal efforts to create inclusive/equitable environments **do not** improve following completion of Year 1.
- H_{a2}: Personal efforts to create inclusive/equitable environments improve following completion of Year 1.
- H_{03}: Department efforts to create inclusive/equitable environments **do not** improve following completion of Year 1.
- H_{a3}: Department efforts to create inclusive/equitable environments improve following completion of Year 1.
- H_{04}: University efforts to create inclusive/equitable environments **do not** improve following completion of Year 1.

H_{a4}: University efforts to create inclusive/equitable environments improve following completion of Year 1.
H_{05}: Participant self-efficacy **does not** improve following completion of Year 1.
H_{a5}: Participant self-efficacy improves following completion of Year 1.

Table 2 presents the sample mean (μ), standard deviation (σ), and statistical significance of responses to items assessing participants perceived level of knowledge, prior efforts, department/university efforts, and self-efficacy before (pre-) and after (post-) completion of Year 1 (1–min, 5–max).

Table 2. Participant self-efficacy, knowledge, and perception of efforts.

Survey Question	**Pre**		**Post**		***p*-value**
	μ	σ	μ	σ	
My knowledge of identity and how it is impacted in society.	3.3	0.9	4.3	0.6	< .001
My knowledge of identity and how it is impacted by computing.	3.1	1.0	4.3	0.6	< .001
My efforts to foster inclusive and equitable environments.	3.5	0.9	4.1	0.9	.001
My department efforts to foster inclusive and equitable environments.	2.7	0.9	3.3	0.9	< .001
My university's efforts to foster inclusive and equitable environments.	2.6	0.9	3.1	1.0	.03
Self-efficacy for leading identity-inclusive projects	2.8	1.1	3.9	0.9	< .001

Table 3 provides information on participant experience with prior identity-inclusive professional development as well as previous initiatives created and implemented.

Table 3. Prior identity-inclusive experience

Variable		**Total**	**%**
Prior identity-inclusive PD completed	None	40	29
	1–2	43	31
	3–5	33	24
	6+	22	16
Prior activities created/implemented	None	55	40
	1–2	48	35
	3–5	21	15
	6+	14	10

5.2. Qualitative analysis

Qualitative data enabled the researchers to make iterative improvements to the program and to identify emergent themes that were related to how the program supported participants' knowledge development with respect to identity-related topics as well as self-efficacy for implementing identity-inclusive projects.

Theme 1: Addressing lack of knowledge of and experience with contentious issues

Prior to program implementation, many participants felt they did not have enough understanding of how identity impacts and is impacted by computing. One participant noted both "my lack of knowledge of the challenges that other underserved populations in computing face [… and my] lack of background in how inequitable our products are." Many also expressed anxiety related facilitating contentious discussions. For example, "I need more education about how to have sensitive discussions. […] How to make sure everyone feels comfortable in the conversation and how to shut down anything that might be problematic." This lack of knowledge of and experience with addressing contentious issues led to challenges when describing efforts to address policies and practices in the classrooms and departments.

Participants also felt the program provided foundational knowledge of identity and identity-inclusive practices. They noted their increased knowledge, which they attributed to their self-efficacy to lead activities. This increased knowledge was, in part, due to the program materials (including books, podcasts, and videos). As one participant stated, "The materials from the program gave me a really good base for what to talk about in my class." Others cited being part of a community of practice—both inside and outside their institutions—that was dedicated to these topics and that increased their comfort implementing projects. Sample responses included "I have connections with others to help with the implementation and feel prepared to discuss the topics," and "My team is implementing things, so I am not alone."

Theme 2: Creating a safe space for grappling with tough content

Participants indicated that the facilitation of the program in terms of delivery and logistics was important to their experience. The delivery style of the facilitators created an environment that made participants feel comfortable engaging in the sessions. One participant stated, "I appreciate so much how patient and welcoming you all are." Participants noted relationship dynamics within breakout rooms as setting the tone for (non)productive conversations. For example, "not all the conversations in my breakout groups were productive. […] It was clear people were afraid/hesitant about dealing with the hard questions about race, gender, class, etc." Similarly, another stated "[I need] more time and structure to get to know the people in my breakouts. It is difficult to grapple with these subjects without any opportunity to get to know the people you are talking with." However, many participants experienced the breakout rooms as safe spaces to grapple with contentious issues. For example, another participant appreciated "being opened to questions and being comfortable with admitting that it is OK to not know certain things."

Theme 3: Providing rich content for varying levels of experience

Participants indicated that the quality of the speakers, their perspectives, and the content provided in the prep packet and pre-program work were valuable in their learning. In addition to the speaker topics being interesting and engaging, learning from experts in the field allowed

them to think critically about experiences outside of their own. One participant noted, "I really liked hearing from so many different voices about their lived experience."

Respondents requested more differentiation in material in the pre-session work based on their previous knowledge level; more advanced content for those who were already familiar with the session topics. Participants stated, "I felt like this week's pre-work material felt a bit rudimentary compared to the material we've already covered for our pre-course reading." and "I would maybe offer some extra content for people who feel more comfortable with these types of topics."

Some responses noted that engaging with the content individually and with others impacted their experience in the program. For example, "Excellent reading list [… and] connection to others through breakout sessions and Slack servers." The prep packet and session pre-work allowed them to reflect upon program topics personally before participating in discussion with others in breakout groups. However, the quality of breakout room discussions sometimes made it difficult to engage as deeply as they would have liked. Respondents noted that some conversations were not as rich as others due to varying group dynamics and willingness to share.

6. Discussion and limitations

Participants reported a statistically significant increase ($p < .001$) in knowledge of identity and how it impacts and is impacted by society. Therefore, we reject the null hypothesis (H_{01}) and accept the alternative that participant knowledge of topics related to identity and DEI improve following the completion of Year 1. Next, participants reported a perception of efforts to facilitate change both personally ($p = .001$) and within their own departments ($p < .001$), yet they reported that there was no change at the university level ($p = .03$). Therefore, we reject H_{02} and H_{03} but we cannot reject H_{04}. The statistical significance in personal effort is likely attributed to already high levels of effort in the DEI space (as indicated by 40% of participants having completed more than three identity-inclusive PD programs prior to the program). In addition, the time of pre-program survey distribution (after completing the prep packet and prior to beginning PD sessions) may have impacted responses. Nonetheless, although participants did not report a change in their departmental efforts to facilitate change, they did report increased personal self-efficacy for leading identity-inclusive projects ($p < .001$); thus, we reject the null hypothesis H_{05} and accept the alternative hypothesis H_{a5}.

As evidenced by the statistical results from the quantitative data and the thematic results of the qualitative data, participants experienced a noticeable improvement in self-efficacy following Year 1 of the program. Pre-program survey discussions of self-efficacy reflected initial feelings of apprehension and uncertainty around teaching. In contrast, feelings pertaining to self-efficacy in the post-program survey shifted to comfort in speaking out to address conflict.

The increase in self-efficacy is attributable to the knowledge gained from participation in the program and increased institutional and departmental buy-in. Initially, gaps in knowledge were stated as personal challenges to accomplishing participant goals. After completion of Year 1, participants recognized how much knowledge they gained and felt more prepared to lead their project implementation following engagement with the program content. Additionally, while pre-

program survey responses reflected a general interest but no sustained efforts in DEI at the university level, post-program survey responses recognized a unified commitment to improvement across faculty and leadership. Respondents felt more supported in their efforts through department prioritization of the work.

A key limitation of the reported results is the incongruity between the participant response rates across pre-program and post-program surveys, which were 100% and 28%, respectively. The higher proportion of participants completing the pre-program survey is likely due to the timing of the survey administration. Most computing faculty members are on summer break in June; thus, access to emails and other obligations likely limited response rates. Additionally, completing the post-program survey was not explicitly stated as a program requirement, so there was little incentive to complete it.

Another limitation of this work is that participants self-selected into the program. The program was piloted following the summer of 2020, which saw international support for Black Lives Matter protests and university as well as STEM faculty commitments to anti-racism [28]–[30]. Understanding how to attract computing faculty, staff, and graduate students who may not voluntarily participate in efforts to create more inclusive and equitable environments is an ongoing consideration. However, given that some departments participated collectively (with some department leadership purchasing all prep packet materials for faculty) served as examples of how collective approaches can lead to more personal and departmental accountability.

7. Conclusion and future work

While "the classroom remains the most radical space of possibility in the academy" [20], most prior efforts to broaden participation have centered on minoritized students by helping them to adapt to and survive in unwelcoming, toxic, and systemically oppressive environments. Instead, there is a need to center those from dominant identities through identity-inclusive computing courses, modules, and activities. This requires (future) faculty and staff who are knowledgeable of and comfortable leading such projects. Our preliminary results demonstrate that while a general increase in knowledge impacts confidence, an increase in knowledge of identity specifically impacts one's ability to create the right policies and to take the necessary steps to enact sustainable change.

The piloted program was designed to cultivate more inclusive and equitable environments for computing students, faculty, and staff from minoritized groups. To this extent, the 2-year model included: (1) a pre packet of books, documentaries, and podcast episodes (to understand historical trends that impact organizational cultures and technology development); (2) ten 2-hour, semimonthly PD sessions (which include guest speakers with expertise in social science and identity-inclusive computing, as well as breakout discussions on identifying, understanding, and addressing class, department, and institutional barriers); (3) design (Year 1) and implementation (Year 2) of identity-centered initiatives; and (4) two 1-hour, follow-up PD sessions (spring of Year 2).

The final post-program survey (June 2022) will include information on project completion (including enrollment, frequency, and, where applicable, end-of-course feedback). Year 2 of the

program is currently underway as participants are implementing the projects at their respective institutions. Preliminary Year 1 data provide insight into the impact of program participation thus far, including an increase in participant knowledge of identity-inclusive topics, as well as effort and self-efficacy with respect to designing/implementing identity-inclusive initiatives.

Future work will incorporate several lessons from this preliminary work, beginning with Cohort 2. First, participants desired less pre-program work prior to PD sessions. In response, we plan to make pre-program work optional, as well as providing time estimates for completion. To facilitate richer discussions, the time allocated to breakout groups will be increased, the number of participants per room will be reduced, and additional structure will be provided during breakouts to avoid silence when conversations are not flowing organically. Finally, the program will institute a strict one pre-approved absence policy to address challenges with participants missing multiple sessions.

To transform undergraduate computing departments, institutions must acknowledge and address the environments into which they bring a more diverse student body. This requires providing space and place for (future) faculty and staff to reflect, share, and (un)learn through a targeted program designed to address issues impacting both students and faculty from minoritized groups.

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