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Admissions, Organization, Culture, and Policy: Understanding the Postsecondary Structures that Shape Women's Entry into Computing Bachelor's Programs

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Despite the growing popularity of computing bachelor's programs, women remain vastly underrepresented in these fields. Using Social Cognitive Career Theory and intersectionality as guiding theories, this qualitative study explores how postsecondary institutions shape women's experiences choosing and entering computing bachelor's programs. Twenty-eight of 40 participants entered their institutions with plans to study computing, while 12 developed a new (or renewed) interest in computing as postsecondary students. Findings outline four postsecondary structures that shaped women's entry into computing majors, including university-level admissions and participant perceptions of financial and cultural accessibility; academic college-level organization and admissions processes; institutional computing cultures, namely introductory course experiences and social environments; and major declaration policies. Findings also show how these structures differentially shaped participant experiences based on intersecting social identities. Overall, findings illustrate the precarious relationship between computing interest development, major intent, and major enrollment for undergraduate women in computing.

Keywords: *Computer science, computing, decision-making, diversity, engineering education, equity, gender, higher education, postsecondary education, qualitative research, race/ethnicity, science education, women's issues*

Computing[1] majors are among the fastest growing bachelor's programs in the United States (National Center for Education Statistics [NCES], 2022). In particular, student demand for computer science (CS) majors has outpaced capacity at many U.S. institutions, contributing to strained resources and exclusionary practices (National Academies of Sciences, Engineering, & Medicine [NASEM], 2018). While women's proportional participation in computing bachelor's programs has also grown over the last decade—thus reversing a long-term pattern of decline—men still outnumber women in computing (National Science Foundation [NSF], 2023). In 2022, women comprised just 22.6% of U.S. bachelor's graduates in computer and information sciences and support (NCES, 2023a, 2023b). Women of Color are even more underrepresented in computing fields, composing just 11.7% of 2022 bachelor's graduates in computer and information sciences and support (for more information, see Supplemental Table A1; NCES, 2023a, 2023b).

Prior research has identified many explanations for the underrepresentation of girls and women in computing, including gendered gaps in early computing experiences and computing self-efficacy, and masculine computing cultures (Cheryan et al., 2017; Sax et al., 2017). While researchers have also called attention to the importance of colleges and universities in shaping women's participation (Perez-Felkner et al., 2024; Singh et al., 2007), most studies explore single institutions (e.g., Bares et al., 2018; Redmond et al., 2013; Smith & Lapan, 2023; Wright et al., 2019), or larger field patterns with limited attention to varied postsecondary structures (e.g., Lehman et al., 2020; Sax et al., 2018). In the interest of exploring how institutions of higher education can promote gender equity[2] in computing, this study asks two research questions: How do institutional structures shape women's experiences entering computing bachelor's programs? How do these structures shape women's experiences based on intersecting social identities?

Overview of the Literature

Understanding the role of colleges and universities in women's entry into computing majors is complex, as institutions and academic programs vary by organization, discipline, admissions practices, curricula, cocurricular resources, diversity and representation, and more. This section provides a brief overview of previous research on women's precollege experiences in science, technology, engineering, and math (STEM), and entry into computing majors.

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Pre-College Experiences in STEM

Secondary school experiences in STEM have important implications for student attitudes and interest in STEM bachelor's programs. For example, using the Education Longitudinal Study of 2002 (ELS:02), Wang (2013) found that exposure to math and science courses, 12th grade math achievement, and math self-efficacy all predicted secondary students' intent to pursue a STEM college major. STEM major intent was also the strongest predictor of STEM major entry (Wang, 2013). Using the High School Longitudinal Study of 2009 (HSLS:09), Zhao and Perez-Felkner (2022) similarly found that high school students' interest and perceived ability in math and science were both associated with entering STEM college majors.

Researchers have also found differences in secondary students' STEM experiences by gender. Using the ELS:02, Perez-Felkner et al. (2017) found that high school girls had a lower perceived ability in math and science than boys, a finding supported by Zhao and Perez-Felkner (2022). As a result, girls were less likely than boys to enroll in advanced high school science courses and pursue STEM college majors (Perez-Felkner et al., 2017). Other studies illustrate the importance of supportive environments and programs for middle and high school girls in STEM. For example, using data from the National Education Longitudinal Study, Legewie and DiPrete (2014) found that girls who attended high schools with strong math and science curricula and with less gender segregation in extracurricular activities were more likely to pursue STEM college majors than girls in other schools. Further, in a systematic review of published research on the experiences of middle and high school girls in STEM, A. Kim et al. (2018) found that initiatives designed to promote girls' interest and attitudes in STEM consistently achieved these outcomes, including STEM major entry.

Entry into Computing

While secondary STEM experiences foster STEM college major interest and entry, there is reason to believe that entry into bachelor's programs in computing may be unique. Computing differs from other STEM subjects in its uneven presence in U.S. K–12 education, unique labor market opportunity, high student demand (and resulting practices across postsecondary institutions), and severe gender and racial gaps. The following subsections explore these ideas.

Pre-College Computing Experiences. Despite evidence that high school STEM experiences may predict entry into STEM college majors, these variables do not always predict entry into computing majors. For example, using HSLS:09, Chen et al. (2023) found that math attainment values in high school and taking advanced science courses predicted student entry into STEM majors, but not entry into computing majors. One important predictor, however, was participation in high school computing courses. Indeed, the more CS credits students took, the more likely they were to enter computing majors (Chen et al., 2023). Both Chen et al. and Wyatt et al. (2020) also found that high school participation in CS was a stronger predictor of computing major entry for women than men. While girls composed just 32% of students who took Advanced Placement (AP) CS Principles in 2019, girls in these courses were proportionally more likely than boys in these courses to continue into CS college majors (Wyatt et al., 2020).

Unfortunately, access to computing is not equal in secondary schools. As of 2023, 57.5% of U.S. public high schools offered foundational CS courses, with courses less available in rural, urban, and small schools (Code.org et al., 2023). Still, participation is low even where CS courses are available. Across 35 states with available data, only 5.8% of high school students took CS in 2023 (Code.org et al., 2023). Compared to their representation in the U.S. population, girls, Hispanic/Latinx students, low-income students, multilingual students, and students with disabilities were all underrepresented among students taking CS in high school (Code.org et al., 2023).

Career Opportunity. Another dynamic unique to computing is the labor market opportunity in these fields. According to the U.S. Bureau of Labor Statistics (BLS, n.d.), employment in computer and IT occupations is projected to grow "much faster" than the average for all occupations from 2022 to 2032. Computing occupations also have a median wage of more than double the median across all occupations ($104,420 as of May 2023, compared to $48,060; BLS, n.d.).

Consistently, research shows that career opportunity in computing is an important draw to the field. Qualitative studies have shown that students who start college in other majors may switch into computing or add computing as a second major to enhance their career prospects (Smith & Lapan, 2023; Wu & Uttal, 2020). This idea is consistent with research showing that students commonly enter computing majors without clear professional goals (Kapoor & Gardner-McCune, 2019)—a pattern that may be more prevalent among women (Lehman et al., 2016).

Parents and other important social connections may also encourage students to pursue computing due to perceptions of career opportunity (Barrett et al., 2024; Smith & Lapan, 2023). Career-related values may be especially impactful to first-generation college students and students from immigrant families, groups that often seek majors aligned with specific careers and lucrative jobs (e.g., George Mwangi, 2019; E. Kim, 2014; Ma et al., 2014; Polenova et al., 2018; Poon, 2016; Smith, 2023). Indeed, one study found that parent education and postsecondary students' interest in computing careers were inversely related; students whose parents had less education were more interested in computing careers (George et al., 2022).

Computing in U.S. Higher Education. Unlike many other STEM disciplines, computing academic programs do not have a fixed place in U.S. colleges and universities. Computing academic departments and programs may be located in colleges of engineering, arts and sciences, and/or with other disciplines (Camp, 1997). Some institutions, like UNC Charlotte (2022), Drexel University (n.d.), and Massachusetts Institution of Technology (n.d.) have even created computing-specific colleges.

The inconsistent location of computing academic programs within the organization of U.S. institutions—and related curricular differences—contributes to the complexity of understanding student entry into computing majors. For example, while computing courses may be required in some academic colleges and departments, especially in engineering colleges (e.g., Smith & Lapan, 2023), computing courses may be taken as electives in others. Thus, participation in computing courses and majors often skews toward students with prior interest and experience in these fields (Lehman et al., 2020)—a group that is disproportionately men. Indeed, one multi-institutional study found that 74.6% of men in introductory CS were computing majors, compared to only 50.9% of women (Sax et al., 2018). Another study found that women were overrepresented among students who take introductory CS courses in their third year or later, often "too late" to newly enter a computing major without elongating their overall time to graduation (Lehman et al., 2020).

In recent years, unprecedented student demand for CS courses and programs has strained postsecondary resources, with demand outpacing capacity at many institutions (Computing Research Association [CRA], 2017; NASEM, 2018). In response, some computing departments and academic programs have implemented "competitive enrollment" policies requiring students to complete prerequisite courses before they become eligible to apply to their preferred academic majors. Through these policies, institutions limit program access based on academic performance, often perpetuating existing participation gaps (NASEM, 2018). In 2020, Nguyen and Lewis published a study based on 80 CS departments, finding that 30% of these departments had competitive enrollment. Such policies were negatively associated with first-year students' perception of the department as welcoming, their sense of belonging, and their self-efficacy in computing (Nguyen & Lewis, 2020).

Overall, both individual and institutional experiences and characteristics can shape students' interest and entry into computing bachelor's programs. For example, students who enter college without prior experience in computing are less likely to feel a sense of belonging in computing courses than their peers (Sax et al., 2018), with sense of belonging associated with major interest (Moudgalya et al., 2021). In effort to promote feelings of belonging among diverse students, some institutions have implemented interventions such as creating computing courses for true beginners (Huangs et al., 2012; Nguyen & Lewis, 2020) or restructuring curricula to emphasize interdisciplinarity and social relevance (Alvarado et al., 2012; Bares et al., 2018; Butterfield & Crews, 2012). Cocurricular spaces that offer supportive environments for women and other minoritized groups, such as identity-based student organizations and living-learning communities in computing may also promote computing interest and feelings of belonging (George et al., 2022) and major entry (Wright et al., 2019).

Representation and Bias in Computing. Finally, across STEM, computing disciplines have some of the largest gender and racial disparities (NSF, 2023). As educational disparities in STEM often begin before college, it can be difficult for women and other minoritized groups to "catch up" in computing experience, self-efficacy, and attainment at the postsecondary level. Several studies illustrate that college women have lower self-efficacy and confidence in computing than men, with adverse implications for women's interest, course taking, and performance in computing courses and majors (Bernuy et al., 2022; Beyer, 2014; Blaney & Stout, 2017). College women also report a lower sense of belonging in computing compared to men (Salguero et al., 2021; Sax et al., 2018), a dynamic exacerbated by the relatively low representation of women and pervasive gender bias in these environments (Barrett et al., 2024; Robnett, 2016).

Racialized disparities also put Women of Color (WOC) at higher risk of exclusion and bias in computing settings. In the United States, white women have historically composed the largest proportion of women bachelor's students in CS (except in 1991 when Black women were the largest group; Lunn et al., 2021). Black women's proportional enrollment has declined since 1991, with the proportion of Asian, Hispanic, and Native American women in CS all remaining low over time (Lunn et al., 2021). Notably, while white students far outnumber all other groups in computing, Asian students are typically not considered minoritized in computing due to higher representation compared to their representation in the U.S. population (Lunn et al., 2021). The number of Asian women in computing has also grown over the last decade (Lunn et al., 2021).

Unfortunately, research confirms that WOC and other students with multiple minoritized identities in computing frequently encounter exclusionary cultures and bias. Quantitative studies show that racially minoritized women in computing, including Black, Hispanic, and Indigenous women, are less likely to feel a sense of belonging than other groups (Blaney & Stout, 2017; George et al., 2022). Qualitative studies attribute these experiences to being excluded, subordinated, and subject to sexism and racism (Charleston et al., 2014; Rankin & Thomas, 2020; Rankin et al., 2021; Thomas et al., 2018). Importantly, Asian women are also subject to racialized bias and exclusion in computing, with these experiences further shaped by gender, immigration status, nationality, socioeconomic status, and other intersecting identities (Tari et al., 2021). In a similar vein, minoritized identities beyond race/ethnicity and gender may also be associated with experiences of low sense of belonging in computing, such as being a first-generation college student (Blaney & Stout, 2017) and identifying as LGBTQ+ (Stout & Wright, 2016).

Theoretical Framework

This study uses two theories to investigate how postsecondary structures shape women's entry into computing majors: Social Cognitive Career Theory (SCCT) and Intersectionality.

Social Cognitive Career Theory

SCCT (Lent et al., 1994) is a career model that illustrates how a person's background, experiences, social cognition, and environmental dynamics shape academic and career interest development, goals, and actions. In this study, SCCT illustrates how postsecondary structures influence the relationship between computing interest development, goal development (i.e., intent to study computing), and action (i.e., computing major enrollment).

SCCT is derived from Bandura's (1986) Social Cognitive Theory, which explains how learning experiences and social cognition, particularly a person's appraisal of their own performance and their environments, guide behavior (Lent et al., 2002). SCCT is also based on Krumboltz's (1979) Social Learning Theory (namely, the idea that learning experiences shape interests, values, and choice), and Hackett and Betz's (1981) research on how self-efficacy shapes women's career development. According to Hackett and Betz, girls and women have less opportunity to engage in learning experiences that are stereotyped for boys, leading to gender bias in self-efficacy development and gendered socialization, including in STEM.

Building on these ideas, SCCT posits that person inputs (e.g., gender, race/ethnicity) and background contextual variables (e.g., socioeconomic status, parent education) shape participation in various learning experiences (Lent et al., 1994). In turn, learning experiences serve as potential sources of self-efficacy and outcome expectations for related future tasks. In SCCT, learning experiences that facilitate self-efficacy and positive outcome expectations lead to academic and career interests. Academic and career interests may develop into related goals and actions, but only under optimal proximal contextual conditions.

Contextual conditions are an important part of SCCT, as proximal environmental dynamics—both real and perceived—can support or impede a person's progression from developing academic and career interests to taking related actions (Lent et al., 2000). This relationship may be direct (e.g., contextual conditions moderate goals and actions) or indirect (e.g., contextual conditions shape self-efficacy and outcome expectations; Lent & Brown, 2019). Notably, in a meta-analysis exploring the role of contextual conditions in research using SCCT, S. D. Brown et al. (2018) found that contextual supports may have a greater impact on career outcomes than contextual barriers.

Overall, SCCT has been widely used in research about the participation of women and racially minoritized groups in STEM (Clarke et al., 2023; Fouad & Santana, 2017; Gayles & Smith, 2019). Additionally, although SCCT is a theory built and supported by quantitative analysis—including research on computing interest and entry (George et al., 2022; Lent et al., 2008), qualitative researchers have also applied SCCT to examine student experiences in STEM (e.g., Alshahrani et al., 2018; Charleston & Leon, 2016; Marco-Bujosa et al., 2021), sometimes alongside intersectionality (e.g., Marco-Bujosa et al., 2024).

Intersectionality

Despite the utility of SCCT in explaining career behaviors and contextual moderators, SCCT falls short in identifying structural conditions that uniquely marginalize women, WOC, and other minoritized groups in STEM (Gayles & Smith, 2019). To better understand field disparities, computing education researchers have called for research using intersectionality as a framework for identifying dynamics that uniquely oppress groups with multiple minoritized identities (e.g., Bruning et al., 2015; Rankin et al., 2024; Rodriguez & Lehman, 2017). In response, this study uses intersectionality as a second guiding framework.

Intersectionality stems from Black Feminist scholarship (Collins, 2019) and reflects how WOC are uniquely situated between two subordinated groups, white women and Men of Color (Crenshaw, 1991). As a result of this social location, WOC are oppressed structurally, politically, and representationally, with U.S. social structures, political agendas, and popular media all perpetuating this subordination (Crenshaw, 1991).

Computing education researchers have used intersectionality to examine the experiences of multiply marginalized groups in computing, especially Black women. For example, in a qualitative study using intersectionality, Rankin et al. (2021) identified predominantly white institutions as one of three "saturated sites of epistemic violence" (p. 33) that perpetuated negative stereotypes, microaggressions, and the exclusion and hypervisibility of Black women in computing. In another study of Black women in computing, Yamaguchi and Burge (2019) used intersectionality to show how initiatives designed to support women and "underrepresented minorities" in computing fell short in serving Black women's unique needs.

Intersectionality can also be used to identify opportunities for structural change. As an example, Erete et al.'s (2021) autoethnography used intersectionality to identify transformative approaches to supporting the participation and success of Black and Latina girls in computing. Specifically, authors identified the importance of addressing local histories of injustice, countering negative stereotypes to create inclusive and safe spaces, and building sustainable computational capacity in Black and Latinx communities.

In this study, SCCT explains the relationship between computing interest development, goals (i.e., major intent), and behaviors (i.e., major entry), with attention to postsecondary structures serving as proximal contextual supports and barriers. In addition, intersectionality helps to illustrate how these structures and related systems of power differentially shape participants' experiences based on their multiple social identities.

Research Design

This study uses an interpretive qualitative design, which is a pragmatic and flexible approach to qualitative research relying on tools from a range of methodological traditions (Caelli et al., 2003; Thorne, 2008). This study centers women's experiences to identify structures that support and impede their entry into computing bachelor's programs in effort to address the "theory-practice divide" (Kahlke, 2014, p. 13).

Positionality

I approached this research interested in understanding postsecondary computing structures that minoritize women so as to affect change. In interpretive research, researchers must "indicate the position from which they speak about the research and the approach" (Caelli et al., 2003, p. 5), a value also critical within intersectional research (Rankin et al., 2024). As a woman, I share a gender identity with participants. However, I also hold social, professional, and disciplinary identities that are distinct from most or all participants, including my white racial identity, my identity as a faculty member, and my disciplinary training in education. I designed this study with the hopes of uplifting women's voices and experiences, selecting a qualitative multiphase design and open-ended data collection tools to build rapport and provide space for women to express what they deemed most important to their experiences.

Participants

Participants were recruited in Spring 2022 using purposeful criterion sampling to identify "information-rich cases" (Patton, 2002, p. 230). This study is part of a larger study on women's career development and internship experiences in computing. In line with the original study, participants were eligible if they were age 18+, self-identified as women, were enrolled in a U.S. computing[3] bachelor's program, and had accepted a summer computing internship. Study information was emailed to Association for Computing Machinery-Women[4] (ACM-W) campus chapters with public contact information.

Prospective participants completed an electronic demographic survey to indicate interest. Participants include 40 women from 16 U.S. institutions, 35 of whom entered CS majors. All participants are ages 18–24, most are third-year students ($n = 27$). Most participants identify as Asian/Asian American ($n = 24$), five are white, four are Hispanic/Latina, three are Black/African American, two are Hispanic/Latina and white, one is Asian/Asian American and white, and one is Middle Eastern/North African. Participants were invited to select their own pseudonyms, which are used in this report. For more information on each participant and the de-identified institutions represented within the sample, see Tables A2 and A3 in the Supplemental Materials.

Data Collection

Data collection occurred in three phases: a one-hour semi-structured virtual interview, electronic journal entries, and a second one-hour interview. The career development focus of the original study informed the multiphase design, including interview questions about pre-college and college learning experiences in computing, and participants' development of computing interests, goals, and actions. Most of the data relevant to this study were collected in first interviews where participants were asked when and how they first developed an interest in computing, how they decided to pursue a computing major, how they picked their institutions, and how their college computing experiences compared to their original expectations.

Intersectionality was selected as a framework after data collection, although participants were also asked to reflect on how their gender has shaped their computing experiences, if at all. Participants were also asked how "any other social identities [they] hold, such as race/ethnicity, age, ability/disability, or anything else that comes to mind" shaped their computing experiences, if at all. While this phrasing elicited varied responses, it provided the opportunity for participants to describe the identities most salient to their lived experiences. Participants responded by discussing their experiences related to race/ethnicity, being a first-generation college student, being from an immigrant family, being from a small town, having a disability, and more.

In the second phase, participants were asked to submit five electronic journal entries during summer internships on topics of their choice. Journal submissions mostly focused on participant internship experiences, although participants occasionally reflected on college experiences and their fit in the field. Second interviews followed up on ideas and experiences introduced in the first two phases and focused mostly on participants' summer internship experiences and on their short- and longer-term plans in the field, including post-graduate career plans. Thirty-four participants completed all phases. For an illustration of the data collection process, see Supplemental Figure A1.

Data Analysis

I used Dedoose for analysis, beginning with a line-by-line review to identify all data relevant to the research questions. I then conducted initial coding of these data using a combination of deductive and inductive codes (Saldaña, 2016). Deductive codes were based on literature and theory (e.g., pre-college computing experience, curricular requirements, key learning experiences, gender, race/ethnicity). Inductive codes were derived directly from the data. In line with research on proximal contextual conditions in SCCT (S. D. Brown et al., 2018), I also used subcodes to indicate positive and negative structural influences on computing entry. See Supplemental Table A4 for first-cycle codes and example participant excerpts.

During coding, it became clear that students navigated postsecondary structures in systematic ways, although processes and timelines differed based on each participant's unique experiences and contexts. To identify participant progression from computing major interest to related goals and actions (i.e., major intent and entry) following SCCT, I mapped out each participant's interest-goal-action path into computing, separating pre-college and postsecondary experiences (for a visual, see Supplemental Figure A2 and Table A3). Throughout coding and mapping processes, I recorded analytic memos on these insights, especially reflecting on how participant social identities shaped their experiences.

Finally, I reviewed codes, maps, and memos to conduct pattern coding, or grouping data into larger categories of meaning (Saldaña, 2016). Here, I identified three structural levels that shaped participants' entry into computing bachelor's programs: university, college, and program. Mapping participant paths also helped me recognize how institutional structures facilitated participants' computing interest and goals, and how contexts differentially shaped participant experiences. Ultimately, I identified four themes, two of which have two subthemes, organized by institutional level and chronology. For a visual of code and theme organization, see Supplemental Table A5.

Findings

Through analysis, I found that postsecondary systems had two roles in supporting women's entry into computing majors: (1) Enabling women to actualize pre-college interests and goals in computing; and (2) Inspiring new or renewed computing interests and goals and providing support to enable computing major entry. Within this sample, most participants (n = 28) had decided to pursue computing majors prior to enrolling in college. Notably, some of these participants had never taken a formal computing course. For the other 12 participants, postsecondary contexts were critical in inspiring new or renewed computing interests and goals.

Regardless of their starting points, all participants had to navigate at least one, if not multiple levels of postsecondary admissions to actualize their goals of entering computing bachelor's programs. Yet, processes and experiences varied by institutional context and by participant characteristics and identities. Overall, four themes illustrated how postsecondary structures shaped women's entry into computing majors: (a) University admission experiences shaped perceptions of institutional accessibility, (b) Academic college admissions and organization shaped computing accessibility and commitment, (c) Institutional computing culture shaped field interest, and (d) Major declaration policies shape computing program access. For the purposes of contextualizing participants' experiences alongside their social identities, participant race/ethnicity is listed when participants are first mentioned in the findings text. Institutional sector and enrollment size categories are also included when institutions are first mentioned, with more details about institutions and participants available in Supplemental Tables A2 and A3.

University Admission Experiences Shaped Perceptions of Institutional Accessibility

To enter a computing bachelor's program, participants first had to gain access to an institution of higher education. This theme includes participant experiences identifying institutions, applying, gaining admission, and choosing an institution. This theme includes two subthemes: perceptions of institutional financial accessibility and diversity and cultural fit.

Perceptions of Financial Accessibility. Across the sample, nearly every participant mentioned the importance of college affordability in pursuing their educational goals. Many participants only applied to institutions they perceived to be affordable, especially public in-state institutions. As Lucia (Hispanic/Latina and white) described, "Going out of state is too expensive and too far from family." Anticipated costs and perceptions of affordability were also a common top priority when selecting and enrolling in an institution. Tia (Asian/Asian American) applied to institutions across the United States but chose Institution 9, a large public, after realizing that out-of-state institutions were "way, way outside of [her] budget." Participants like Zoe (Asian/Asian American), Purple Spark (Black/African American), and Kirby (Hispanic/Latina) received full scholarships from their respective institutions, which "really helped tip it [institutional choice] over the edge" (Zoe).

Several participants also prioritized institutional selectivity and perceptions of prestige in selecting their institutions, sometimes weighing these facets alongside or against affordability. Katie, an Asian international student, initially applied to institutions based on their rankings in the *U.S. News & World Report* for CS, but chose Institution 5, a large public, as it "gave [her] the highest scholarship." Wen (Asian/Asian American) directly contrasted prestige and affordability, sharing: "I figured that my options were either to go to an extremely prestigious school or to go to [a public institution] for free." Wen selected Institution 1, a large private and highly selective institution.

Some participants discussed the importance of college affordability by referencing their own social identities and family dynamics, especially family income, first-generation college student, and immigrant identities. As Nayelli (Hispanic/Latina) shared: "I come from a lower-income household, so I understood very early on that I needed to get a full ride if I wanted to go to college." Sarah (Asian/Asian American) similarly described: "I come from a first-generation immigrant background and only my mom works … I would have wanted to go to a different institution, but I don't think [Institution 16] puts me back [financially]." To save money, Sarah selected Institution 16, a mid-size local public institution that allowed her to live with family and commute to college.

Importantly, participants' perceptions of affordable college options did not always align with their actual experiences. For example, several participants who described themselves as first-generation and low-income were surprised to learn that they were eligible for robust financial aid at private institutions. Kirby, who is Hispanic/Latina and a first-generation student, originally planned to attend a public institution due to concerns about affordability but was later "shocked" to learn she was eligible for full financial aid at Institution 1. As Kirby described, "Nobody else did that, so I was like, 'Well, okay. That's it.'" Dawn Potter and Frances, both Asian/Asian American and first-generation students, had similar experiences—both were invited to a "fly-in" program for low-income students at Institution 3, a small private institution. Even though neither woman had heard of Institution 3 prior to receiving these invitations, both participated in these visits and later enrolled at the institution after receiving strong financial aid packages.

Perceptions of Diversity and Cultural Fit. Perceptions of campus culture, diversity, and institutional fit were also important to participants' application and enrollment decisions. Similar to the subtheme above, participants often based their decisions on perceptions—ideas that were sometimes updated with more information, especially campus visits. Tinker Bell, a Black/African American woman, for example, worried about attending her state's large public flagship institution, explaining: "[Institution 10] doesn't have the best reputation when it comes to diversity and inclusion . . . I didn't want to be in a place where I was uncomfortable." Tinker Bell was especially concerned about the lack of diversity she had seen on Institution 10's social media posts. However, Tinker Bell chose Institution 10 after visiting the campus and talking with her cousin (a student at the institution), both of which helped her get a better sense of the campus culture.

Hope, a Black/African American woman, was similarly drawn to her institution after a campus visit. Although she originally planned to attend a highly selective technical institution, Hope was impressed by two types of interactions she had with Institution 1 as a prospective student: welcome emails she had received from the campus's student organizations for women and for racially minoritized students in computing (which Hope described as "really heartwarming, because it showed that there was already a sense of community"), and her campus visit. Specifically, Hope (who is Nigerian American) was impressed to learn about Institution 1's living-learning communities for Black and Hispanic students and its African language courses, which helped Hope to feel like she could "still study [her] culture even when [she] wasn't near home."

Similar to Tinker Bell and Hope, other participants also worried about how their identities and background experiences, such as parent education and high school quality, including access to AP computing courses, would affect their fit into specific institutional contexts. Mary (white), was excited to attend Institution 9, which is "big and so popular in [U.S. state]," but she also wondered how her experience would differ from her peers: "Typically, [Institution 9] is a family thing, your parents went there, and then everyone else ends up going there. But, for me, I'm the first in my family to come here."

Nayelli also worried about fit in various institutional contexts. Even though she was her high school's valedictorian and was interested in studying engineering, Nayelli felt too "intimidated" to apply to engineering colleges at most institutions. Thus, Nayelli applied to different academic majors at different institutions, including in varied STEM and non-STEM fields. Nayelli had only applied to engineering at Institution 9, sharing that engineering "felt more accessible" at this institution. Nayelli explained, "I come from a lower-income district, so I didn't get as many educational opportunities, and I was aware of where I stood nationally." Amy March (Asian/Asian American and white) expressed a similar sentiment in choosing Institution 13 (mid-size public), a smaller, more affordable institution compared to the large public institution with "a lot of resources" within her state. Although Institution 13's CS program "isn't the most well-praised," Amy March worried that a CS bachelor's program would be too "demanding" at the larger institution, as well as "very, very expensive."

Overall, competitive postsecondary admissions and financial aid processes perpetuated a status quo that marginalized and excluded first-generation, low income, and racially minoritized students. These structures therefore serve as potential barriers in women's paths to entering computing bachelor's programs, especially for multiply marginalized women. As participant experiences illustrate, university admissions structures may sort out prospective students who do not feel that they belong, whether based on perceptions or real information (e.g., costs). At the same time, some participants were surprised to find that selective and costly institutions were financially or culturally accessible, illustrating a potential gap between postsecondary practice and student perceptions of opportunity and fit.

Academic College Admissions and Organization Shaped Computing Accessibility and Commitment

A second dynamic that shaped women's access and entry into computing bachelor's programs was academic college-level admissions and organization. At larger institutions, participants typically had to apply to both the institution and to a specific academic college as prospective students. While individual processes and experiences varied, choosing the "right" academic college (and gaining acceptance) were essential to participants' ability to enter computing bachelor's programs.

For some, the location of engineering and computing academic units within larger institutional structures shaped participant perceptions of these fields and programs, and their resulting behaviors. As a common example, participants with limited pre-college computing experience were often hesitant to apply to colleges of engineering. For participants like Regan (Asian/Asian American) and Hermione (white) who entered college planning to study CS but had no prior computing experience, these decisions felt high stakes. Hermione applied to the college of arts and sciences at Institution 2 (mid-size private) because "[she] wasn't super sure about CS," and because this decision afforded "a lot more flexibility to switch [her] major." Julia (Asian/Asian American) made the opposite choice but for the same reason, as she was deciding between two computing majors: CS and computer engineering. As Julia described, "At [one institution], CS is a part of the science college, and not the engineering college. If I ever wanted to switch [to computer engineering], it would be a lot harder . . . so I just picked [Institution 9]."

For Lucia, college-level admissions served as a real barrier when it came to entering a CS major. Lucia applied to engineering colleges within two large public institutions, her state's flagship and Institution 9. Lucia had a strong preference for the flagship institution, explaining "[Institution 9] has a reputation of being a lot more conservative and less diverse. That wasn't something that I wanted . . . I don't even know where I would fit in." While Lucia was admitted to both institutions, she was only admitted into the engineering college at Institution 9. Thus, rather than enrolling at the flagship institution in liberal arts and attempting to switch into the engineering college at a later time, Lucia "picked [her] major over the school" and enrolled in Institution 9 despite her concerns about diversity at the institution and her fit within this environment.

Generally, computing programs located outside of colleges of engineering had more flexible curricula and were therefore easier for participants to enter, whether during the initial university application process or after they were already enrolled. While most participants did not switch academic colleges, Sarah switched from a college of business into a college of science, and Melina (Asian/Asian American) switched from a college of engineering into a college of arts and science, although described that she later regretted this decision. For Frances, Gloria, Wen, Alex, and Alice (all Asian/Asian American women), initial entry into their respective institutions' colleges of arts and sciences in non-computing STEM majors allowed each participant to stay within these colleges and switch into computing majors, or to easily add computing as a second major.

Overall, this theme illustrates how the organization of academic colleges and college-level processes may shape women's perceptions of the accessibility of computing majors, and women's actual experiences entering these programs. For some participants, especially those applying to large institutions, college-level admissions added an extra structural barrier. Similar to university-level admissions, competitive college-level admissions perpetuate the status quo, and are likely to disproportionately exclude students with multiple marginalized identities. Additionally, the organization of computing majors within academic colleges shaped participant interest and application behaviors, especially when participants had limited prior computing experience. Overall, academic colleges without separate admissions processes and with more flexible curricula helped to facilitate women's entry into computing, especially among participants who initially entered college in other academic disciplines.

Institutional Computing Cultures Shaped Field Interest

While 28 participants entered higher education intending to study computing (see Supplemental Figure A2), others entered their institutions in other, non-computing majors or as undeclared students. For these 12 participants, postsecondary structures and experiences were critical to newly inspiring or (re)confirming computing interests and goals. This theme includes two subthemes: computing course experiences and social cultures in computing.

Computing Course Experiences. For some participants, college-level computing courses critically inspired interests and goals in computing. In other cases, computing course experiences made participants question their plans to major in computing fields.

For some participants, college courses provided a first point of exposure to computing. Mary, Nayelli, and Maggie (Hispanic/Latina and white) all entered their institutions' engineering colleges unsure of their major or planning to study other engineering fields. Yet, all three were drawn to CS based on their initial course experiences. Each of these three participants described their introductory CS courses as difficult and compared their relative lack of computing experience with more experienced peers. However, all three participants were also drawn to the problem-solving nature of CS and enjoyed the opportunity to build and create using code. Both Maggie and Nayelli also described how CS courses made them look at the world in a new way. As Maggie described, "there are programs for everything . . . none of our technology would exist without CS." Nayelli summed, "[CS] gave me a new set of eyes."

In several cases, direct faculty encouragement in introductory computing courses helped participants form interests and make plans to join computing majors. Mary entered college as a materials engineering major and recalled feeling "scared" of her required introductory CS course, as coding was "unfamiliar" and her only prior exposure to CS had come from popular television shows. Despite her initial concerns, Mary did well in the introductory course and the professor even encouraged her to consider majoring in CS. Without this encouragement, Mary explained that she probably would have never considered pursuing a computing major.

Faculty encouragement was also important for Jodie's entry into computing. Jodie (Asian/Asian American) is a unique participant within the sample, as she had already earned a bachelor's degree in communications and was pursuing an MBA from Institution 12 (mid-size public) when she was first exposed to computing. During her MBA program, Jodie took a data science elective, a course she described as "electrifying." At the end of the course, Jodie's ("excellent") professor "encouraged [her] to pursue a career in data science." After completing her MBA, Jodie studied data science independently for one year before re-enrolling in Institution 12 to pursue a second bachelor's degree in CS.

Other participants entered college with prior computing experience and took computing courses as electives even though they planned to major in other disciplines. For these participants, postsecondary computing courses often provided a new perspective on the field, leading to renewed interests and goals in computing. Sarah had taken CS in high school but "backed off" from pursuing CS in college after hearing that CS majors are "math-heavy" and "very hard." Sarah entered Institution 16 as a business major, but still took CS as an elective and participated in a hackathon in her first year. After enjoying these experiences, Sarah felt more confident and switched academic colleges and majors to enter CS. Frances, Wen, and Gloria also initially entered college in non-computing STEM majors, yet each added CS as a second major after their CS elective course experiences. As Frances explained, "the first class I took in college was data structures and algorithms and, honestly, I really enjoyed that class even more than my AP CS class."

Participants who had taken high school computing courses generally appreciated how these pre-college experiences helped to prepare them for postsecondary academic experiences, although some felt that the quality of their high school courses lagged behind their peers' experiences. For Gloria, pre-college computing courses, including AP CS, enabled her to skip introductory CS in college. Although Gloria was initially intimidated as the only first-year student in a 200-level CS course, Gloria described how the course and institutional environment helped her succeed: "I am in an all-girl's college, and we all have this supportive life around us. I fit in almost immediately after a few classes and [did] not feel that imposter syndrome anymore." Gloria also shared that her CS class was "very small," which allowed her to have a "personal connection" with the professor. Although she entered college as a math major, Gloria added CS as a second major as a result of her advanced start and positive course experiences.

From the examples above, it is clear that supportive academic environments and resources were critical to facilitating interest in computing majors. Like Gloria, other participants at small and mid-sized institutions similarly described the benefit of small classes and faculty relationships. Even more common across institutional types, however, was participants' gratitude for academic support resources such as office hours and teaching assistants (TAs). Indeed, many participants described going to office hours for "hours and hours on end" (Hana, Middle Eastern/North African), and "every single time I had a question" (Tinker Bell). As Hermione shared,

> I had never coded before, and there were some students in the room who took AP CS in high school and had a serious amount of experience. I felt a little down at first . . . but the TAs really made my experience great, and they were very supportive and always available . . . the community aspect of it and the support really kept me going.

Overall, it was common for participants to feel behind their peers in introductory computing courses, especially if they were new to the field. Sometimes these experiences were demotivating, amplifying concerns about fit. Colette (white), for example, had a "terrible" experience in her first CS course, which she attributed to "one of the worst [professors she] had ever had" and (men) classmates using unnecessarily complex words, which made Colette "panic that [she] wasn't in the right spot." In some cases, even participants with prior experience discussed the difficulty of their introductory courses, which sometimes made them question their goals in the field. Although Hope had taken AP CS in high school, she was surprised by the pace of her introductory CS course in college: "The intensity actually made me doubt whether I actually wanted to do CS . . . I didn't expect such a fast-paced curriculum." Although Hope earned an A in the course, she did not take CS in her second semester. Instead, participating in an institutional summer program designed to prepare racially minoritized and first-generation students for advanced-level CS courses helped Hope to reaffirm her interest and commitment to the field.

Social Cultures in Computing. Beyond course experiences, campus social cultures in computing were also critical to shaping participants' interests and goals in computing. In some cases, social cultures were informal, with peers serving as sources of social encouragement in computing. For example, although Dawn Potter had taken CS before college, she described her high school CS class as "very basic" and "lackluster." Thus, although she entered college interested in CS, Dawn Potter credited her college peers with her decision to pursue a CS major:

> The curriculum didn't attract me as much as the community . . . I befriended some upperclassmen who were CS majors. Watching them do the things they do in their internships and hearing them talk about job prospects right after graduation was so cool to me that I just decided that this was the community that I wanted to be a part of.

Like Dawn Potter, Wen's college peers were also an important influence. Although Wen had taken AP CS, she entered Institution 1 in biology. Wen later added CS as a second major, explaining that her college friends were "really into CS" and encouraged her to join. As Wen shared, "I just interacted with them as friends, but the CS leached out." In addition to the social culture, Wen was also attracted to the career opportunity she associated with CS.

Formal cocurricular activities and organizations also inspired and reinforced computing interests and goals for participants. Participants like Adriana and Samantha, both Hispanic/Latina and first-generation college students, participated in pre-college summer bridge programs designed to prepare minoritized students for engineering majors. Through the bridge program, Adriana connected to the Society of Hispanic Professional Engineers, where she met her closest college friends. Many other participants similarly joined identity-based student organizations, especially organizations for women or racially minoritized groups in engineering or computing. For most participants, these groups provided welcoming environments and access to academic support and career resources.

Some participants also participated in hackathons for field beginners, with both Tia and Sarah mentioning these experiences in their decisions to pursue CS majors. Tia described,

> One of the main reasons why I was locked into CS was because I attended a hackathon my first semester . . . they were advertising it during our open house week with all the student orgs . . . I showed up and I had a blast. I loved the environment. I loved the people, and I really fell in love with just how much I could get done in 24 hours when I'm coding.

As this theme illustrates, postsecondary computing experiences like introductory courses and formal and informal social cultures and encouragement critically inspired some participants' interests and goals in computing. These structures were particularly influential among participants who were interested in computing or who had prior experience in the field, but who had entered college planning to study other disciplines. Formal structures also helped participants connect with peers and classmates with shared social identities, especially gender and race/ethnicity.

Major Declaration Policies Shape Computing Program Access

The final theme describes the structural barriers that some women encountered in declaring a computing major, often the final step in officially entering computing bachelor's programs. Across the sample, major declaration policies and processes varied. For most, the process of enrolling in computing majors was straightforward; participants applied to their institutions as computing majors, were accepted, and never changed paths. Other participants entered college without a major (sometimes due to institutional policies preventing students from choosing a major before enrolling) or enrolled in a non-computing major and entered computing once they solidified their interest in the field. For others, however, competitive admissions and enrollment practices made this process far more complex. In the cases of computing programs with competitive enrollment, participants had to complete prerequisite courses, meet performance criteria, apply, and receive major-level acceptance in order to enter these programs.

Competitive enrollment policies served as barriers for both Leah (Asian/Asian American) and Lucia in entering computing. Both participants enrolled in their respective institutions' colleges of engineering with plans to declare CS majors once they were eligible to do so. Yet, both participants struggled to meet the required GPA threshold for their colleges' respective CS programs. Leah applied to the CS major after completing prerequisite courses but was not accepted. Fortunately, in Leah's second year, Institution 7's (large public) CS program changed its major eligibility criteria to be “more holistic,” and Leah was accepted when she reapplied.

Lucia also benefited from an unexpected policy change. Even though Lucia had selected Institution 9 specifically because she had been accepted into its engineering college, college-level competitive enrollment policies required that she complete pre-requisite coursework before applying for a major. In this college, students were only guaranteed admission to their top-choice engineering major if they had a 3.5 GPA due to high demand in disciplines like CS. As Lucia shared, “It felt like a repeat of where I was senior year . . . the whole reason I came to this school was because I was going to study CS.” Fortunately, Lucia leveraged pass-fail grading policies implemented during the COVID-19 pandemic to earn a 3.5 GPA and enroll in CS.

As these examples show, competitive enrollment policies put pressure on participants from the very start of college and had very real implications for shaping participants’ access to computing, and their corresponding actions. Zara (Asian/Asian American), for example, chose to pursue an interdisciplinary engineering degree in cybersecurity instead of a traditional CS major, in part to avoid Institution 9’s competitive enrollment in CS. As Mary described, “in other programs, you’re just worried about your GPA for graduation, but with this, the freshman year GPA really matters.” Overall, the fewer steps there were in declaring a computing major, the more accessible these programs were. Similarly, competitive enrollment and major declaration policies created precarity in the entry process for certain computing majors, even among students who were already accepted and enrolled in corresponding academic colleges, and committed to computing. Indeed, some participants faced difficulty entering the very same academic programs that brought them to these institutions in the first place.

Discussion

For undergraduate students, major choice is an important decision with implications for job opportunity, earnings, and more (Altonji et al., 2016; Kinsler & Pavan, 2015; Monaghan & Jang 2017). Despite the career opportunity and earnings associated with computing majors (BLS, n.d.; Carnevale et al., 2021), women—and especially Women of Color—remain vastly underrepresented in computing bachelor’s programs. Using SCCT, with specific attention to proximal contextual influences (S. D. Brown et al., 2018; Lent et al., 1994), and intersectionality (Crenshaw, 1991) as guiding frameworks, this study explored how postsecondary structures shaped 40 women’s entry into computing bachelor’s programs. Specifically, analysis revealed varied patterns in participants’ experiences and timelines developing computing interests, setting goals (i.e., computing major intent), and taking related action (i.e., entering computing majors) across pre-college and college contexts. Four themes also showed how higher education structures and contexts shaped participants’ entry into computing majors: university admissions, academic college-level admissions and organization, institutional computing cultures, and major declaration policies. Findings further demonstrated how these structures perpetuated gender-, race-, and class-based disparities in computing.

Regardless of field preferences, the first steps to entering a bachelor’s program include identifying, applying, gaining acceptance, and selecting an institution. While these institution-level structures are often overlooked in discussions of computing participation, findings illustrate how these processes shaped women’s experiences, including participants’ overall perceptions of the accessibility of engineering and computing bachelor’s degrees and programs. Specifically, study participants built institutional choice sets, selected institutions, and adjusted their academic goals based on institutional financial, cultural, and academic accessibility—whether real or perceived. Across the sample, participants consistently valued affordability. Other institutional characteristics and priorities varied across participants. For example, Black and Hispanic participants often sought institutions that were racially diverse, while lower-income participants sought institutions where they felt they would be able to succeed academically, especially within engineering and computing contexts.

Findings related to perceptions of cost and affordability align with previous research indicating that low-income and racially minoritized students are less likely to apply to more selective institutions and institutions they perceive as financially inaccessible, even if these assumptions are incorrect (e.g., Black et al., 2020; Dynarski et al., 2021). As most participants were deeply concerned about college costs, many limited their options to in-state, public institutions. However, large public institutions represented within the sample were also likely to have multiple levels of admissions processes, including competitive major enrollment. At the same time, some participants were surprised to learn that (well resourced) private institutions provided robust or full financial aid, and these institutions had comparatively fewer levels of exclusionary structural barriers in entering computing majors, especially CS.

When examined through the lens of SCCT, these findings begin to show how university, college, and program level practices may either reinforce or weaken the relationship between computing interest and computing entry among current and prospective students. Overall, findings support prior research showing the importance of K–12 computing experiences in promoting computing major interest, especially among women (Chen et al., 2023; A. Kim et al., 2018; Wyatt et al., 2020). Using SCCT, however, this study extends prior work by illustrating how postsecondary systems may critically influence the relationship between computing interest and computing bachelor’s entry. Even though most study participants ($n = 28$, 70% of the sample) planned to pursue computing majors even before they entered college, their actual entry into computing bachelor's programs was shaped—whether supported or precluded—by postsecondary systems, often starting with college search and application processes.

In their study of research on contextual conditions in SCCT, S. D. Brown et al. (2018) found that contextual supports may be more important to career outcomes than contextual barriers. While this study is unable to weigh experiential facets, findings illustrated the importance of institutional support structures, both formal and informal, in facilitating computing entry for postsecondary women. While support structures like office hours, TAs, encouraging faculty, and cocurricular engagement opportunities were important for many, they were perhaps most important for participants who were unsure of their major and for those with limited prior computing experience. While negative postsecondary experiences also made some participants question their commitment to computing majors, both academic and social support structures proved to be powerful forces in major recruitment and retention, especially when they encompassed both realms, as in the case of encouraging faculty and TAs.

Applying intersectionality as a framework, these same insights also reveal how postsecondary systems perpetuate and amplify social inequities in computing education at multiple levels and in multiple ways. In the United States, participation in computing education is stratified by gender, race, and social class, even at elementary and secondary levels (Cheryan et al., 2017; Code.org et al., 2023; A. Kim et al., 2018). These patterns reproduce over time, making it difficult for students who do not have prior experiences—disproportionately women, Students of Color, and low-income students—to "catch up" with more experienced peers. As study findings illustrate, the social and political systems and norms that define U.S. higher education, including selective admissions processes and high costs, perpetuate the exclusion of multiply marginalized students from these systems, and from specific academic programs like computing. Criteria for competitive admission and enrollment structures reflect unequal systems of power, privileging experience and knowledge disproportionately available to students with majoritized social identities. Overall, participants with multiple marginalized identities were most vulnerable to being screened out through one or more of these exclusionary structural mechanisms.

As findings begin to show, institutions of higher education serve as social and political systems that uphold white, westernized, and patriarchal norms of competition, with metrics of success constructed and defined by (inequitable) educational systems. How can access to computing bachelor's programs be equal if K–12 and postsecondary access to computing is unequal, and if computing environments across educational levels are systemically biased against women and other marginalized groups in the field? As a key premise of intersectionality is the rejection of social inequality and the importance of social justice (Collins, 2019), the following section outlines ideas for change.

Recommendations for Practice

Colleges and universities have the potential to transform computing cultures on their campuses and create larger change in the field. These changes should start with recruitment and admissions, as women and other minoritized students in computing cannot enter computing majors if they cannot access the institutions that offer these programs. Findings showed how student perceptions shape institutional accessibility, as well as the malleability of perceptions. Funding campus visits for prospective minoritized students in computing may be one strategy to increasing interest among diverse students, and in reducing gaps between perception and reality—although these efforts must be coupled with structural support, including robust financial aid and connections to communities of students with shared social identities. Reducing college costs is an important step in achieving equitable access in computing.

Researchers must begin to bring seemingly disparate topics together, recognizing the connections between disparities in college access and computing enrollment. Administrators must find ways to reduce costs or amplify financial aid, perhaps asking corporations invested in building a diverse computing workforce to fund scholarships, or via political advocacy to increase local, state, and federal support for higher education. Institutional agents such as faculty and administrators may also use their platforms to advocate for resources to support K–12 computing education, especially in low-income and predominantly Black, Hispanic, and Indigenous schools and communities to provide enhanced opportunities for early interest development (Erete et al., 2021).

Creating supportive postsecondary computing environments is also critical. Introductory courses for true beginners are a start (e.g., Huangs et al., 2012), but not all students will choose to take elective computing courses. Computing departments may partner with other disciplines to expand exposure and capacity in other ways, perhaps through interdisciplinary courses or by incorporating computing into required curricula. Educating students about varied computing disciplines and degree options may also help to expand capacity and avoid reliance on harmful competitive enrollment policies that limit access to only the most academically successful students—mostly those who have prior computing experience (NASEM, 2018).

Academic support structures like office hours were critical to participants' computing intent and entry. To standardize access among computing beginners, institutions could consider corequisite models, or supplementing traditional courses with additional instruction for students with less experience, as is common in developmental education (e.g., Boatman et al., 2022). Institutional investment into any program or resource targeting students without prior computing experience (or even those with limited experience) will support computing interest development, intent, and entry among more women and other minoritized groups in these fields.

Limitations and Future Research

This study has several limitations that offer opportunity for future research. First, sampling procedures excluded women who may have been interested in computing but who did not enroll, whether due to structural barriers or personal choice. Additionally, as recruitment targeted women with internships and those enrolled at institutions with ACM-W chapters, the study sample is likely skewed toward women who are more engaged in the field, especially through formal cocurricular activities such as campus and professional organizations. Additionally, although the sample is primarily comprised of Women of Color, most sample members are Asian/Asian American, a group not typically considered minoritized in computing (NSF, 2023). However, Asian and Asian American women still experience gendered and racialized environments and dynamics, including bias, within engineering and computing contexts (e.g., Smith et al., 2023; Tari et al., 2021). Future research may begin with intersectionality as a framework that guides study design to explore these dynamics more intentionally, whether among Asian women or other minoritized subgroups, including Black, Hispanic/Latina, and Indigenous women. Additionally, future research may also focus on background characteristics and social identities beyond gender and race/ethnicity, such as family income, generational status, immigrant status, etc. to continue to understand intersectional experiences and opportunities to create change.

Finally, future research on postsecondary structures and contexts may continue to include multiple institutions while focusing on specific institutional types or characteristics (including selectivity), institutional structures (e.g., colleges of engineering vs. other models), or specific computing disciplines to further explore study findings. Overall, additional research is critical to reducing barriers, enhancing supports, and to achieving gendered equity and justice in computing fields.

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Open Practices

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Notes

1. "Computing" includes computer engineering, computer science, cybersecurity, information systems, information technology, software engineering, and data science (Association for Computing Machinery & Institute of Electrical and Electronics Engineers Computer Society, 2020).
2. Gender equity is conceptualized as equitable opportunity for all students regardless of gender identity or expression. However, this study focuses on students who self-identify as women.
3. Initial criteria required that participants be CS majors, but eligibility was expanded to reach study capacity.
4. ACM-W is a worldwide organization with 70,000+ professional and student chapters that aims to "celebrate, inform, and support women in computing" (Association for Computing Machinery, n.d.-a, n.d.-b).

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