The Intersection of Being Black and Being a Woman: Examining the Effect of Social Computing Relationships on Computer Science Career Choice

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Computer science (CS) has been identified as one of the fastest-growing professions, with demand for CS professionals far outpacing the supply of CS graduates. The necessity for a trained CS workforce has compelled industry and academia to evaluate strategies for broadening participation in CS. The current literature in CS education emphasizes the importance of social relationships and supports for individuals from underrepresented groups. Unfortunately, this literature has largely been limited to either the exploration of issues of women or that of underrepresented racial/ethnic groups. These limited views generalize characteristics of specific underrepresented groups without considering intersections between these groups. This quantitative study (n = 3,206) addressed that shortcoming by leveraging inferential statistical methods to examine (i) the similarities and differences between the social CS-related experiences of Black women, Black men, and non-Black women in the United States; (ii) the relationship between these experiences and CS career choices; and (iii) the activities during which significant social experiences might occur. The results indicate that Black women's social experiences are often different from the experiences of both Black men and non-Black women. In particular, both Black men and non-Black women had more CS friends than Black women, whereas having these friends was more significant for the CS career choice for Black women. Introductions to CS in school, before college, were negatively related to career choice for all groups, whereas home support was positive for both Black women and men. This work suggests that considering intersectionality is important to understanding the needs of different individuals, as well as the importance of social supports for persistence in CS.

CCS Concepts: • **Social and professional topics** → **Professional topics**; **Computing education**; **Computing education programs**; **Computer science education**;

Additional Key Words and Phrases: Race, ethnicity, gender, intersectionality

ACM Reference format:
Monique Ross, Zahra Hazari, Gerhard Sonnert, and Philip Sadler. 2020. The Intersection of Being Black and Being a Woman: Examining the Effect of Social Computing Relationships on Computer Science Career Choice. *ACM Trans. Comput. Educ.* 20, 2, Article 9 (February 2020), 15 pages.
https://doi.org/10.1145/3377426

This material is based on work supported by the National Science Foundation under grant #1339200. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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1946-6226/2020/02-ART9 $15.00
https://doi.org/10.1145/3377426

1 INTRODUCTION

Engineering and computer science (CS) have long been identified as the highest-paying careers that only require a 4-year degree or bachelor's degree [12]. CS has been predicted to be one of the fastest-growing fields in the United states for the next 10 years [4]. When it comes to pay equity, fields like CS and engineering have a smaller pay gap by gender than most other fields [1]. The argument for broadening participation is often centered on market needs, but gender parity in computing is also a social justice issue, especially in the case of women of color [24, 25]. Women of color are most likely among American women to be the breadwinners in their immediate families and vital contributors to their extended families [27]. A pathway to and through CS could be life altering for many families of color in the United States.

With market demands at the forefront, the CS community has begun to investigate the interest, participation, retention, and graduation rates of women in computing [5, 8, 17, 29]. There have been great strides and success in some CS programs in the United States, which have seen an increase in enrollment to 40% to 50% women in their computing programs [1, 11, 21, 22]. Unfortunately, these efforts appear to have done little to influence the participation of women of color. Prior research indicates that White women pursue CS and engineering primarily because of familial influence [15]. These women are introduced to the field of computing both formally (e.g., camps, school curriculum, after-school programs) and informally (e.g., seeing a parent as a role model in that field, conversations with family) [11]. The connection between White women's interest in computing and their being influenced by male family members is consistent with the numbers, as White males make up 54% of computer, engineering, and science jobs. Conversely, Blacks and Hispanics comprise 4% and 7%, respectively, of computer, engineering, and science jobs [26]. If women in CS typically refer to their male role models as an influence in their choice to pursue CS as an occupation, how does this disparity in representation of minority men in CS impact the pathways for Black and Hispanic women?

This quantitative study was designed to better understand the social influences on occupational pursuits in CS for Black women. Drawing on data from a large survey of students in introductory computing courses, this study examines the social experiences that influence young Black women in their choice of CS as a potential career path.

2 LITERATURE REVIEW

2.1 Women

The underrepresentation of women in CS is a topic that has begun to garner attention in both popular culture and scholarly works because of increasing U.S. concerns over remaining competitive in a global economy. Universities and programs are scrambling to attract and retain women in computing fields to keep pace with industry demands for computing professionals. This necessity to increase women's participation in CS has resulted in a wealth of literature about the influences and factors that attract women to or repel them from CS. Some results point to the omission of women from the historical recounting of CS and the branding of CS as being masculine [29]. Other researchers have highlighted the climate and culture of CS as being unwelcoming to women [28]. This includes the ambient cues so prominent in CS departments [5]. Meanwhile, other scholars focus on lack of access, role models, and encouragement as factors that diminish the career interests of women [10]. These elements, coupled with stereotypes and the lack of a sense of belonging [2], and confidence [19, 20] lessen the attractiveness of a CS career.

However, not all research related to women in computing has found negative impacts. Some research has focused on the initiatives, programs, and factors that positively influence women's perceptions of CS as an occupation [2, 9, 29]. These include Girl Scout programs, Girls Who Code,

and other informal learning experiences that expose women to computing [13]. Other work has examined the positive influence family has on young women's pursuit of CS [19, 20] and the impact of encouragement on student interests and occupational pursuits [10]. Early exposure has been found to be critical to inspiring young women to consider computing as a field of study [14]. Other impactful initiatives have focused on providing a supportive environment and deliberate messaging that CS is an interdisciplinary, socially relevant career option [25]. Although these efforts provide room for optimism, there continues to be a dearth of women participating and a need to better understand social features and practices that best engage women in the field of computing.

In addition, these approaches make assumptions about all women. They assume that the experiences and pathways to and through CS are the same. Malcom et al. [18] warned researchers about the unintended consequences of such a broad understanding of women when they published their work in science around the intersections of race and gender. In short, they unveiled the complexities associated with the intersections of race and gender. This insight has prompted some researchers, while studying women, to no longer ignore the differences in experiences between White women and Black women or Hispanic women.

2.2 Women of Color

Research that narrowed the scope to women of color found that women of color fared even worse than White women in degree attainment in computing on every level (e.g., bachelor's, master's, and Ph.D.) [23]. Some attribute this to the tension between the demands of rigorous CS programs and external familial pressure to contribute to the family income [23]. Coupling this familial demand with what some call the *digital divide* or the underexposure to technology and basic computer skills due to socioeconomic inequity further amplifies the "lack of access" mentioned among *all* women [23]. This lack of access to computing classes and technology contributes to the continuing racial and gender disparity in K-12 CS education, according to a nationwide survey conducted by the Gallup organization for Google [16]. Black students are less likely than White students to have CS classes in high school (47% vs. 58%, respectively). Likewise, Black and Hispanic students are less likely than White students to use a computer at home [16].

2.3 Black Women

Further narrowing the scope, research on Black women suggests that African American girls have just as much interest in STEM as White girls, but they have less exposure to STEM, less adult support for pursuing STEM fields, lower academic achievement, and greater awareness of gender barriers in STEM professions [13]. Their confidence and observed ability to overcome obstacles, however, are high [13]. Research conducted by Zarrett and Malanchuk [31] reported that parents' educational attainment predicted Black females' pursuit of an information technology (IT) career in the opposite direction to that found for Black males: the lower the educational attainment of the parents, the greater the commitment was among Black females to pursue an IT career. In addition, Black females' decisions were predicted by the encouragement received from others. These findings suggest that receiving a great deal of advice and encouragement is particularly important for Black females to pursue IT aspirations. Whereas this study highlights the similarities between Black women and Black men, there are also differences worth further exploration.

3 THEORETICAL FRAMEWORKS

To provide some insight specifically into Black women's career interests in computing, the research for this secondary data analysis was guided by three theoretical frameworks: social influence,

standpoint theory, and intersectionality. An operationalization of each framework is presented in the following, as well as an explanation of its relevance to the study.

3.1 Social Influence

In the race to meet computing occupational demands, universities and college programs have begun to investigate factors that influence retention [39]. One such factor is social influence [38]. Scholars in education have leveraged frameworks such as Tinto's theory of student departure [40, 41], Astin's analysis of the level of student involvement [42], Sedlacek's noncognitive assessment model of students of color [43], social integration [44], and various identity frameworks [45] to better understand the effects of social interaction, engagement, and involvement on retention. The argument has been made that students' social integration into a disciplinary community can predict their success or persistence [46, 47]. Such integration largely depends on students' involvement within the community. Although academic preparation and success are important and strong indicators of persistence, noncognitive aspects of a student's collegiate experience can outweigh these factors [10]. The theory of student departure by Tinto [40], which is anchored in social integration, defined a student's personal affiliations to peers, faculty, and staff as indicators of academic success. This suggests that friendships and other supportive relationships are critical to continued academic engagement. This scholarly attention to peer relationships or friendships on engagement and persistence formed the basis for the selection of the questions analyzed for this study.

3.2 Standpoint Theory and Intersectionality

To unpack the differences that exist on the basis of race and gender, this research study was designed to give deliberate attention to Black women. Although the literature review demonstrates a growth in research around the representation of women in CS, these studies provide an incomplete and perhaps inaccurate generalization of women [28]. Drawing on feminist theory, we leveraged standpoint theory and intersectionality to frame this work. Standpoint theory pushes researchers to consider the notion that knowledge is anchored in experiences, and because men and women experience life differently, they might also have different knowledge and ways of knowing. Likewise, intersectionality extends this further by pointing out that standpoint theory often represents women monolithically, implying that all women experience life the same [48]. The shortcomings of standpoint theory are addressed by attention to the intersections of multiple identities (e.g., race, class, ethnicity, sexual orientation, nationality) [49]. As such, this study uses an intersectional approach with a focus on the intersection of race and gender. Intersectionality is a framework that is rooted in critical race theory (CRT)—a paradigm that was established initially by legal scholars who recognized and acknowledged the systemic existence of racism in the U.S. legal system and has since expanded into a body of literature that spans from education, cultural studies, English, sociology, political science, history, and anthropology [7]. Race/ethnicity and gender have become popular topics within education research; however, most studies have examined these identities separately rather than at the intersection [23]. Intersectionality recognizes that a person simultaneously has two or more social categories or social statuses (e.g., race, gender, class, sexual orientation) and examines the unique oppression that results from that combination. The term *intersectionality* was established by Crenshaw [6] when she critiqued the "single-axis framework that is dominant in antidiscrimination law" (p. 383). Drawing on the works of Crenshaw, and others who have followed, we have designed a study that explores Black women as they relate to non-Black women, as well as Black women as they relate to Black men [6, 50]. This study was designed as a deliberate approach to compare Black women to the social categories with which they are most often classified. Standpoint theory and intersectionality explain why this study does

Fig. 1. Map of sample institutions.

not provide a comparison with White males, but instead an exploration of the similarities and differences with respect to "near peers" to Black women: women and Black people. The point is not to overshadow their experiences by the dominant narrative [3, 6, 48, 50].

Although the survey was not designed with intersectionality as the guiding framework, the research team saw the opportunity to leverage a large dataset to explore Black women at the intersection of race and gender. When constructing an argument for exploring Black women, the dominant counterarguments are typically centered on the lack of numbers for statistical significance and Black women's integration with their near peers—people of color and women. The use of the secondary data source of Factors Influencing College Success in Information Technology (FICSIT) provided unique access to large numbers of women, people of color, and Black women, and thus offered an opportunity to identify ways in which Black women were similar to and differed from their near peers [32].

This study is guided by the following research questions:

Among students in introductory CS courses,

Q1: How are social influences and CS career aspirations similar and different for Black women as compared to non-Black women and Black men?

Q2: What effect do social influences have on the CS career aspirations of women and individuals who identify their race as Black? Are these effects different for Black women?

Q3: In what context are Black women most likely to experience important social influences?

4 METHODS

The FICSIT project was a national survey study administered to students in introductory college CS courses in the fall of 2014 (NSF #1339200). The 118 participating colleges and universities were selected from a random sample of 2- and 4-year institutions in the United States. The survey was designed to capture various types of student information, including their demographics, background, experiences with computing, attitudes toward CS, and CS aspirations. In total, the FICSIT project collected data from 10,203 students at these 118 universities. Figure 1 shows the location of the 118 institutions. As a result of the institutions being randomly sampled, the distribution reflects the population density of institutions (and subsequently people) in the United States.

The sample was composed of 71% males and 26% females, and 3% did not report a gender. The racial affiliations of the students were 54% White, 7% Black, 23% Asian, 2% Pacific Islander, 1% American Indian or Alaskan Native, and 8% other or multiracial, and the remaining 6% did not respond. In terms of ethnicity, 13% reported being Hispanic, 83% reported being non-Hispanic, and 4% did not respond to the ethnicity question.

The FICSIT survey was developed by the project team, which included education researchers, as well as advising computer scientists and CS educators. Preliminary surveys to key stakeholders, including students, teachers, and professors, provided feedback, which helped inform the survey and establish face and content validity. The advising computer scientists and CS educators also assisted in refining the survey. To gauge stability (reliability), a test-retest study was conducted with 49 college students who took the survey over two administrations separated by 2 weeks. Questions with a binary answer were analyzed with response agreement measures (e.g., Cohen's kappa). Questions that were answered with anchored Likert-type scales were analyzed with Pearson's correlations. The average reliability for the binary response items was 0.7, and the correlations also averaged to a reliability of 0.7. This level of consistency across administrations met required reliability thresholds [27, 28].

In this study, we focused on the dependent variable of CS and/or IT career intentions. Thus, students who did not report their career intentions were omitted from the analysis (4%). Of the remaining 9,791 respondents, 4,983 (50.9%) students reported that they did not want a CS/IT career, and 4,808 (49.1%) students said that they did. This national survey study was also able to capture a relatively large number of students from diverse backgrounds. Capitalizing on this diversity, our key independent variable focuses on an understudied subpopulation in computing—Black women—comparing their social influences and their CS career aspirations with those of Black men and non-Black women. There were 239 (2.3%) Black women who responded to the survey, 609 (6.0%) Black men, and 2,358 (23.1%) non-Black women. In this study, non-Black women consisted of 1.2% identifying as American Indian or Alaskan Native, 38.0% as Asian, 1.1% as Pacific Islander, 58.3% as White, and 6.0% as Other. In addition, 11.1% of the non-Black women identified themselves as Hispanic.

The first research question was addressed by comparing the prior experience and social influences, as well as career intentions, of Black women to those of the other two groups. Nonparametric Kruskal-Wallis analysis of variance tests were performed to compare the groups (non-Black females, Black females, Black males). To address the second question, logistic regression modeling was used to examine how prior experiences predicted the CS career intentions of women, focusing on whether there were differential effects for Black women. Similarly, logistic regression modeling was used to examine how prior experiences predicted the CS career intentions for Black identified individuals, focusing on whether there were differential effects for Black women. When building the models, we began by controlling for the education of the mother and father, ethnicity, and undergraduate enrollment (full time or part time) and found that none of these factors had a statistically significant impact on career intentions. We then constructed a model taking into consideration social interactions (e.g., family, friends, school, after-school opportunities). Finally, the last question was addressed by examining the correlations between predictive social experiences and contexts in which they may have occurred. All data analyses were run with the R statistical computing software.

4.1 Positionality

This work is based on a secondary data analysis [32] that draws on survey development from several earlier studies in mathematics and science education with diverse teams including people of color and women [33–36]. The FICSIT project had a similarly diverse team, which included

women, men, and people of color. The objective of the original work was to identify factors that predict success in introductory CS courses. However, a separate analysis team was convened for this work, which grew out of discussions about the differences in experiences across race and gender. The research team that carried out the secondary data analysis included Hazari, a woman of color and science education researcher, and Ross, a Black woman and CS education researcher. Discussions of the need to examine the experiences of women who possessed multiple underrepresented identities drove the research questions and subsequent analysis. Prior work in the space of intersectionality [37] helped frame this work and provided an analytical lens. The analytical team for this study, both women of color, has been cognizant of the need to disaggregate data on the basis of race and gender and at the intersections of both to capture the nuances in the experience of women of varying backgrounds.

5 RESULTS

Research question 1. How are the social influences and CS career aspirations similar and different for Black women as compared to non-Black women and Black men?

As an initial step in our intersectional approach, we compared experiences of Black women, non-Black women, and Black men to better understand how the experiences of Black women are similar to and different from the larger groups in CS with which they share gender/race identities (others who identify as women, others who identify as Black). In particular, we focused on comparing the groups on social experiences (how they were first introduced to CS, having CS friends, and home environment support) and CS aspirations (why they are taking a CS course, CS/IT career choice). The results (summarized in Table 1) indicate that Black women are considerably different from both non-Black women and Black men in terms of how they were first introduced to CS. Specifically, a smaller percentage of Black women reported being introduced to CS by a family member or a friend (17% and 3%, respectively) than was the case for non-Black women (24% and 10%, respectively) and Black men (21% and 9%, respectively). At the outset, this immediately highlights that the experiences of Black women are not an average of the experience of being a woman and being Black, but unique in themselves. Furthermore, a higher percentage of Black women reported being introduced to CS in school (48%) than was reported by both non-Black women and Black men (40% and 31%, respectively). Black women (28%) were more in line with non-Black women (23%) when asked if they were introduced to or explored CS on their own than they were with Black men (37%). There was no statistically significant difference between Black women, non-Black women, and Black men when asked about after-school or summer school programs or a supportive home environment. It is interesting, however, to note the very low participation rates for these programs across all groups (2%–3%).

Our analysis of questions related to motivations for taking the CS course also resulted in differences between participants based on race and gender. Black women were more aligned with non-Black women for a course selection based on intended major (34% and 28%, respectively) compared to Black men (52%). They were also more aligned with non-Black women when reporting that they were taking the course because it was required for their non-CS major (44% and 39%, respectively) compared to Black men (25%). However, Black women (11%) were better aligned with Black men (7%) and non-Black women (16%) with regard to the perceived usefulness of CS with a statistically significant difference existing between non-Black women and the other two groups. There was no statistically significant difference between Black women, non-Black women, and Black men when asked if they elected to take the course because they "may intend" to major in CS, were taking the course based on a recommendation, or simply took the course for fun. It is interesting to note the small number of responses reporting taking the course based on recommendation or fun (3% across the board). Comparison of CS or IT as a career choice was the only variable on which Black

Table 1. Comparisons of Non-Black Women, Black Women, and Black Men on Social CS Experiences and CS Career Aspirations (Kruskal-Wallis Tests)

	Non-Black Women (n-BW)	Black Women (BW)	Black Men (BM)	Kruskal-Wallis χ^2	Significance	Group Differences
First Introduction to CS						
Family member	24%	17%	21%	7.2	*	n-BW > BW*
After-school or summer school program	3%	2%	3%	0.7	ns	
A friend	10%	3%	9%	10.1	**	n-BW > BW** BM > BW*
On my own	23%	28%	37%	45.9	***	BM > BW* BM > n-BW***
In school	40%	48%	31%	25.1	***	n-BW < BW* BM < n-BW*** BM < BW***
Have Any CS Friend	53%	44%	58%	14.7	***	n-BW > BW** BM > BW*** BM > n-BW*
Supportive Home Environment (0 = Not at all, 5 = Very supportive)	Mean 3.23 sd 1.60	Mean 3.31 sd 1.78	Mean 3.20 sd 1.72	1.8	ns	
Why Are You Taking This College Computer Science Class?						
Intend to major	28%	34%	52%	112.4	***	BM > BW*** BM > n-BW***
Useful	16%	11%	7%	32.5	***	n-BW > BW* n-BW > BM***
May want to major (perhaps)	11%	6%	10%	4.8	ns	
Recommended	3%	3%	3%	0.03	ns	
Required (non-CS major)	39%	44%	25%	41.8	***	BW > BM*** n-BW > BM***
Fun	3%	3%	3%	0.1	ns	
CS/IT Career Choice	33%	41%	57%	109.3	***	BW > n-BW* BM > BW*** BM > n-BW***

ns, not significant.
*$p < .05$, **$p < .01$, ***$p < .001$.

women (41%) were positioned between non-Black women (33%) and Black men (57%) while being statistically different from both.

Research question 2. What effect do social influences have on the CS career aspirations of women and individuals who identify their race as Black? Are these effects different for Black women?

Addressing the previous research question, our descriptive statistics indicated several significant differences between Black women and non-Black women, as well as between Black women and Black men. We next turned to model building to examine how these experiences relate to the

Table 2. Logistic Regression Predicting CS/IT Career Choice for Women (with Interactions for Race, Specifically Being Black)

	Estimate	Std. Error	Significance	Odds Ratio
Intercept	−0.11	0.07	ns	0.90
Black (0 = No, 1 = Yes)	0.08	0.20	ns	1.08
Introduction in School (0 = No, 1 = Yes)	−1.17	0.10	***	0.31
CS Friends (0 = No, 1 = Yes)	−0.34	0.09	***	0.71
Interaction Between Being Black and CS Friends	0.88	0.30	**	2.42

ns, not significant.
$^{**}p < .01$, $^{***}p < .001$.

Table 3. Logistic Regression Predicting CS/IT Career Choice for Black People (with Interactions for Gender, Specifically Being a Woman)

	Estimate	Std. Error	Significance	Odds Ratio
Intercept	−1.08	0.27	***	0.34
Gender (0 = Female, 1 = Male)	0.83	0.26	**	2.30
Introduction in School (0 = No, 1 = Yes)	−1.31	0.17	***	0.27
Home Support (0 = Not supportive, 5 = Very supportive)	0.34	0.05	***	1.40
CS Friends (0 = No, 1 = Yes)	0.42	0.31	ns	1.52
Interaction Between Gender and CS Friends	−0.60	0.36	+	0.55

ns – not significant.
$+p < .1$, $^{**}p < .01$, $^{***}p < .001$.

CS career choices of women (Table 2), focusing on interactions with being racially Black (i.e., if certain experiences had a different effect for Black women). We then examined how the experiences relate to the CS career choices of individuals who identify as racially Black (Table 3), focusing on interactions with gender (i.e., if certain experiences had a different effect for women).

A logistic regression model examining the effect of social experiences on women's CS career intentions in the sample (Table 2) revealed that being introduced to CS in school was a negative predictor of CS career choice ($p < .001$). This is noteworthy because it suggests that this exposure may not have been effective in attracting these women to CS careers, while at the same time a higher proportion of women in CS college courses were initially exposed to CS in school. Specifically, the odds ratio (0.31) indicates that if women were introduced to CS in school, they were 69% less likely to pursue a CS career than those who were not introduced to CS in school. Surprisingly, having CS friends was a negative predictor for women's choice of CS career ($p < .001$) but positive for Black women ($p < .01$). This interaction effect is displayed in Figure 2, with the y-axis representing the probability of intending a CS/IT career (predicted probabilities are based on regression estimates and were calculated using the "predict" function for general linear models in R). Although the probability of intending a CS career was similar for Black and non-Black women without CS friends (38% and 36%, respectively), Black women with CS friends had a significantly higher probability of pursuing CS careers than non-Black women with CS friends (51% and 28%, respectively). The pseudo R^2 (McFadden) for the model is 0.10. Note that this small amount of variance explained was expected since there are many other factors that contribute to a student's CS/IT career choice beyond the social experiences examined in this article.

The second logistic regression model examined the effect of social experiences for individuals who identified as Black (Table 3). The results indicate that Black male students were more likely to plan CS/IT careers than Black females ($p < .01$) with 2.3 times higher odds of having these plans.

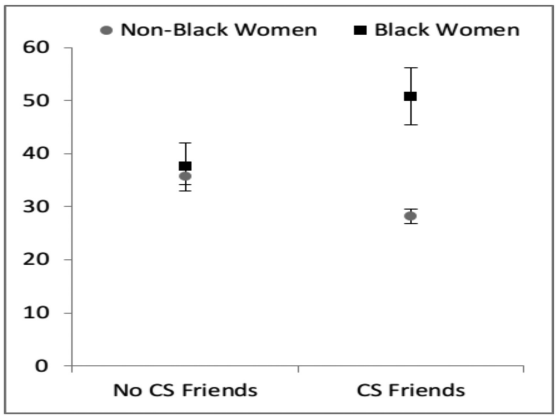

Fig. 2. Predicted probabilities for CS/IT career choice with and without CS friends for Black and non-Black women.

For the students in this model, being introduced to CS in school was a negative predictor of CS career intentions ($p < .001$) with an odds ratio of 0.27. This translates to an odds ratio of 1:0.27 or, reversely, 3.70:1. Thus, those not introduced in school were 3.70 times more likely to intend on CS/IT careers than those introduced in school. Home environment support for CS was a positive predictor ($p < .001$) with an odds ratio of 1.40. This means that a 1-point increase in the home support variable corresponds to 1.40 times higher odds of choosing a CS career. The pseudo R^2 (McFadden) for the model is 0.19, which is considerably better than for the model for women.

Although the CS friends predictor was included in the model with a gender interaction, its main effect was nonsignificant at the $p < .05$ level. However, the interaction effect yielded a p-value of .099, which is approaching the threshold. Thus, we considered the likelihood of this predictor being nonsignificant due to type II error. To examine this, we calculated how much the R^2 improved by including CS friends and the interaction of CS friends to the model. The R^2 improved by 0.01. This corresponds to an f^2 effect size of 0.01 ($f^2 = R^2/(1 - R^2)$). Using this effect size, 2 as the number of coefficients (degrees of freedom added), a significance cutoff of 0.05, and a power of 0.8 (80% likelihood of detecting an effect), a power analysis revealed that the minimum sample size for detecting an effect would be $n = 964$. This is greater than our model sample size of $n = 766$ (82 observations deleted due to missingness), although not by a considerable amount, which explains why the result may be approaching the significance threshold in the current model. Thus, it is likely that there may be a difference between Black women and men for the effect of CS friends on their CS/IT career choice.

The interaction effect is displayed in Figure 3, with the y-axis representing the probability of intending on a CS/IT career. Whereas Black men without CS friends had a much higher probability (59%) of intending on a CS career than Black women without CS friends (39%), the gap is narrowed for Black men and Black women who had CS friends (55% and 49%, respectively). This effect indicates that CS friends may have a positive effect for Black women, which is not the case for Black men.

Research question 3. In what context are Black women most likely to experience important social influences?

To address this question, we tried to identify contexts in which Black women were likely to make friends in CS. This was explored by calculating Spearman nonparametric correlations for Black women between having CS friends and activities they reported (Table 4). The social interactions

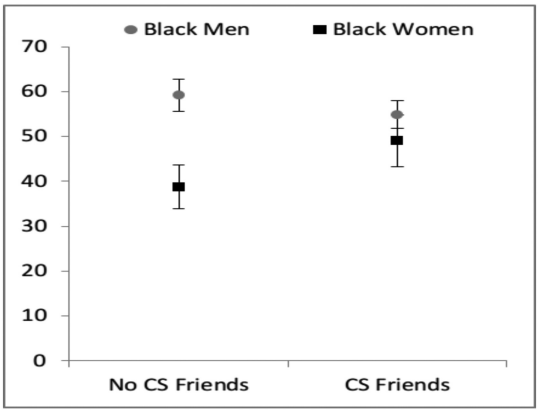

Fig. 3. Predicted probabilities for CS/IT career choice with and without CS friends for Black men and Black women.

Table 4. Likely Venues for Black Women ($N = 239$) to Make CS Friends

	Correlation (Spearman's Rho)	Significance
Computer Club	0.13	*
Robotics Competition	0.15	*
High School CS Class	0.14	*

*$p < .05$.

that were identified as being statistically significant were participation in computer clubs, robotics competition, and high school CS classes.

6 DISCUSSION

This quantitative study was designed to examine (i) the similarities and differences between the social CS-related experiences of Black women, Black men, and non-Black women in the United States; (ii) the relationship between these experiences and CS career choices; and (iii) the activities during which significant social experiences might occur. The findings suggest that although Black women's CS career aspirations and experiences at times fall between the averages for Black men and non-Black women (sometimes closer to one group than the other), their social experiences are often unique. For example, although Black women fall between non-Black women and Black men in their likelihood of first being exposed to CS by themselves, they are less likely than both groups to be exposed through friends and family and more likely to be exposed in school. These findings are problematic because the regression models revealed that CS friends may be more important for the CS career choices of Black women than non-Black women and possibly Black men. Unfortunately, the data also suggest that an introduction to CS in high school had a negative effect on Black students' CS career intentions. Thus, because Black women were more likely to be introduced to CS in school than the other two groups, this may also have become the most likely place to have repelled them from the field, even with the potentially mitigating effect of finding CS friends in CS high school classes.

In alignment with previous work, home environment support was a significant predictor of CS/IT occupational intention for Black participants [31]. Although there was no significant difference in the reporting of home environment support for the three groups being studied, Black women in our sample had the lowest percentages with respect to being introduced to CS by family

or friends. This finding is in contrast with the literature suggesting that women are most likely to pursue CS because of familial influence [11]. These results together point to the likely inadequacy of social support that Black women receive in CS compared to other students with whom they share identities. Since friendships in CS had a larger effect on the CS/IT career intentions of Black women, we also explored the contexts in which Black women may have established these relationships. Results indicate that computer clubs, robotics competitions, and high school CS classes were the most likely venues—at least in terms of venues reported on the survey. This, however, was undercut by the low initial introduction to CS through informal learning settings for all groups studied (2%–3%), as well as low participation in clubs and robotics for Black women in particular (5% participation). High school CS courses appeared to be by far the most likely place for Black women to make CS friends while also negatively affecting their likelihood to intend on CS careers after friendships were accounted for.

7 CONCLUSION

When designing this study, we were interested in determining if there were differences between Black women, Black men, and non-Black women in the discipline of CS. The literature often groups Black women together with either Black/underrepresented groups or women, often omitting, disregarding, or overlooking the unique experiences situated at the intersection of race and gender [23]. Indeed, if the research had only focused on students' interests in CS, a conclusion may have been drawn that Black women fall between being female and being Black since their interests in CS careers fall in the middle. However, their experiences in several cases differ from both women and others who identify as Black. Black women, although they share many characteristics of their categorical partners (Blacks and women), have unique social experiences in CS. For example, they are less likely to be introduced to CS by their family, unlike other women, and they have fewer friends in CS than both other women and Black men. An alarming finding is that although Black women are most likely to be introduced to CS in school, this introduction has a negative effect on their CS/IT career intentions. In addition, a social mechanism that may be critical to their prolonged engagement is the establishment of friendships within the CS community, but they are less likely to have such friendships. Results such as these paint a bleak outlook for Black women in CS and should be viewed as a call to the community to further investigate populations that are muted in the margins. No longer can we, as a community, ignore these populations because they are numerically insufficient. More quantitative and qualitative exploration is necessary to understand the needs of individuals and the way in which they may be socially deprived and marginalized in the system of CS education. This insight is critical in determining the most appropriate ways to support these individuals in CS. The CS field needs to heed the call to begin to disaggregate the data surrounding those underrepresented in CS to better understand the barriers against, and structures conducive to, diversifying computing.

In terms of the expansion of research in CS education *theoretically*, this study was executed to aid in the development of an argument for studying Black women exclusively. We compared Black women to their near peers in an attempt to demonstrate that prior work that categorizes Black women as Black or women does not adequately reflect the experiences and influences of Black women; however, scholars in other disciplines have long made the argument that a comparative group is not always necessary [51]. The voices and experiences of any one group can and should be presented on its own terms and not contextualized on the basis of women or White people or in relation to these groups [3, 49, 50]. Future work in CS education research should continue to expand, intentionally, into critical theory to design and analyze data related to other marginalized or intersectional identities in CS. Intersectionality is a powerful analytical lens that allows the researcher to disaggregate the "undifferentiated mass," to explain "how social divisions of race,

gender, age, . . . among others, positions people differently in the world" [49, p. 13]. Intersectionality can be leveraged in both qualitative and quantitative research designs to seek knowledge to grow and diversify our CS population. Just as in this work, comparative research does, however, continue to play a role in building an argument for the expansion of research designed around disaggregated data. Intersectionality coupled with comparative research also aids in highlighting the disparities that exist between dominant groups and those least represented in computing. Given the complex problems that we face in computing, we need many different approaches to inquiry (theoretical framing and methodology) to unpack and understand the landscape of computing for those least represented in computing. We have a responsibility as a community to continue to expand and explore these methods and more.

ACKNOWLEDGMENTS

Without the extraordinary contributions of many people, the FICSIT project would not have been possible. We thank the members of the FICSIT team: Wendy Berland, Hal Coyle, Annette Trenga, and Bruce Ward. We would also like to thank several STEM educators and researchers who provided advice or counsel: Lecia Barker (chair of the Advisory Committee), Randy Battat, Joanne Cohoon, Maria Litvin, Clayton Lewis, Irene Porro, Kelly Powers, Lucy Sanders, Susanne Steiger–Escoba, Jane Stout, Charles Alcock, and Janice Cuny. Last but not least, we are grateful to the many college CS professors and their students who gave up a portion of a class to provide data.

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Received March 2018; revised November 2019; accepted December 2019