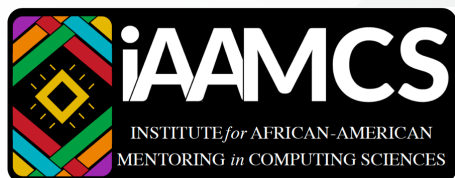


# The Role of Social Networks and Mentorship in Supporting Black and African American Computer Science Students Facilitate Culture Border Crossings

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## Introduction

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For a number of decades, there has been a national call to diversify the STEM workforce. While in some areas of STEM, the participation of African Americans has increased, in the field of computer science (CS), participation continues to be low. As of 2022, African Americans received only 2.1% of master's degrees and 1.7% of PhDs awarded in the field of CS (Zweben & Bizot, 2022). Access to quality CS experiences and opportunities is one barrier that specifically hinders the success of African-American students in earning degrees, especially terminal degrees in CS. But even when African Americans do have access, there are incongruencies between their home culture and the culture of CS. Aikenhead (1999, 2001) posits that the degree of cultural difference between students' home cultures and the cultures of science and higher education plays a key role in their success. Students who come from backgrounds that are culturally congruent with the field of CS are more likely to have "a smooth transition" (Costa, 1995) into the field.

Many minoritized students such as African Americans, whose cultures can be conceived of as being incongruent with the field of CS, are more likely to have a difficult transition into the field without the assistance of "cultural brokers," who can help them cross cultural borders between their home culture and the culture of CS. In this paper, the authors conceive of a mentor as a type of cultural broker who supports students as they traverse between their cultural norms and the norms of CS programs without having to fully assimilate (Aikenhead, 1999; Ferguson, 2021). Our paper draws from the literature on cultural border crossings to examine the ways in which social networks and mentorship support Black and African American students as they "cross" from their respective home cultures into the cultural context defined by institutions of higher education, more specifically, CS graduate programs. Our primary research questions are as follows:

1. How do students navigate incongruencies between their home culture and the cultures of their schools and programs?
2. What roles do social networks and mentorship play in helping students navigate these incongruencies?

## Sampling and Methods

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The purpose of our study was to understand how Black and African American students navigate the incongruencies, if any, between their culture and the culture of CS and the role that social networks and cultural brokers play in making these transitions. We used semistructured key

informant interview (KIs) as our primary method to collect data because they enabled both interviewers and interviewees to explore defined topics in an open-ended format that also provided the freedom to open up new lines of inquiry and probe topics of interest in a greater level of detail (Bernard, 2006). Since the study's research questions explored key concepts related to students' experiences navigating the cultures of their CS programs, we used KIs to probe students and mentors about their experiences, perceptions, and recollections regarding mentorship and social networks, which generated interview data that directly addressed these key areas of inquiry.

Since this research was conducted as part of a research partnership between the American Institutes for Research (AIR) and the Institute for African American Mentoring in Computing Sciences (IAAMCS), we worked with IAAMCS to guide the composition of the qualitative sample and identify sample participants. IAAMCS provided names of and contact information for students and mentors who had participated in past IAAMCS activities who we could potentially include in our sample. After determining the number of students we wanted to include in our sample and identifying the characteristics of the students, AIR conducted several rounds of outreach with these students and mentors and included those who responded affirmatively in the qualitative sample. In addition, AIR conducted outreach to CS undergraduate and graduate programs throughout the country to include students and mentors who had not had any contact with IAAMCS. By including both IAAMCS and non-IAAMCS students and mentors in the sample, researchers were able to draw comparisons between their respective experiences with mentorship over the course of their CS programs.

The sampling framework included variability along the following key demographic dimensions:

- gender
- respondent type (i.e., undergraduate student, master's student, PhD student, postgraduate student, and mentor)
- institution type (e.g., control [public or private status]); whether a college was a minority-serving institution [MSI], more specifically a Historically Black College or University [HBCU] or a predominately White institution [PWI]); note: institution type according to the respondent's current or recently attended educational institution)
- nationality (i.e., American or foreign national)
- region
- IAAMCS affiliation

All respondents identified themselves as racially Black and/or African American. In total, we included 30 respondents in our final qualitative sample—22 students, 1 recent graduate, and 7 mentors. Table 1 provides a snapshot summary of the qualitative sample by our key demographics.

**Table 1. Demographic Breakdown of Qualitative Sample (N = 30)**

Demographic variables	Count
<b>Gender</b>	
Male	12
Female	18
<b>Respondent type</b>	
Undergraduate	4
Master’s student	7
PhD student	11
Recent graduate	1
Mentor	7
<b>Institution type for current or recent students</b>	
Public PWIs	12
Private PWIs (3 non-profit, 1 for-profit)	4
Historically Black College or University (HBCU) or other minority-serving institution (MSI)	7
<b>Nationality</b>	
American	20
Foreign national	10
<b>Region</b>	
Midwest	5
South	17
West	2
Northeast	6
<b>IAAMCS affiliation</b>	
Affiliated with IAAMCS	24
Not affiliated with IAAMCS	6

After composing the sample, AIR researchers conducted 30 semistructured key informant interviews (KIIs) virtually over Zoom between June and September 2023.

Researchers developed five separate interview protocols tailored to each respondent type (undergraduate student, master’s student, PhD student, postgraduate student, and mentor). All the protocols, with the exception of the one developed for mentors, followed a similar semistructured template—asking interview respondents questions related to their journeys into their CS programs: initial exposure to CS, access to CS-related resources growing up, their social networks, their general sense of belonging in their programs, their experiences and attitudes toward mentorship, and their aspirations for the time after they completed their programs.

We took a slightly different approach with the mentors’ interviews. Rather than using the semistructured interview template that we used with the students and the recent graduate, we used a more open-ended interview format following an oral histories approach, a “highly inductive” method designed to understand the way mentors’ past experiences, memories, and career journeys shaped their approaches and perspectives to mentoring CS students (Leavy, 2011) (see Appendix A for the complete set of interview protocols). We used this approach for the mentors because we were interested in learning more about the ways in which they conceived of their role as mentors and the ways their own life experiences, that is, their histories, might have shaped those conceptions. Thus, we wanted a more open, free-flowing interview format that made room for mentors to share their life experiences and personal reflections on the ways their journeys shaped their approach to mentorship.

## Analysis

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Researchers transcribed the interview recordings, which were made with consent from the research participants, and those transcriptions were loaded onto the NVivo software to be coded. To guide the analysis, we developed two codebooks—one for students and the recent graduate and another for mentors (see Appendix B for the full codebooks, along with code definitions). The codebook for students and the recent graduate largely followed the structure of the interview protocols. We created thematic codes related to the following domains:

- background information
- journey leading to CS program
- social networks
- sense of belonging
- mentorship
- career aspirations
- career transitions (only applied to the postgraduate respondent)

The codebook developed for mentors contained thematic codes related to the following domains:

- background information
- early life
- education and career
- personal experiences with obstacles
- mentorship and cultural brokerage

Guided by this codebook, four AIR researchers coded two transcripts together to forge consensus on the way the remainder of the transcripts would be coded. Once the group reached consensus, the four researchers evenly split the remaining transcripts and coded their assigned transcripts so that all the remaining transcripts were coded once. Further, we anonymized all data by removing all personally identifiable information.

Once the interview data were organized by code, we conducted subgroup thematic analysis, which enabled us to compare key themes by the sample's demographic characteristics. Moreover, as part of the analysis, we used a student categorization scheme first developed by Costa (1995) and then elaborated on by Aikenhead (2001) to classify the students in our sample on the basis of the perceived congruency between their "home cultures" and the cultures they had had to navigate in their CS programs, as well as in their institutions of higher education. The five student categories that Costa (1995) developed were as follows:

1. **Potential Scientists**—Students whose transitions are smooth because the cultures they grew up around (their family and friends) are congruent with the cultures of both school and science. Potential scientists demonstrate both a deep familiarity with science and education, as well as an enthusiasm for gaining a deeper understanding of it. They grew up in a culture that not only encouraged their pursuit of science but modeled it, as well (e.g., students' parents were also scientists). Potential scientists' self-images and epistemological understanding of the world is compatible with that of Western science.
2. **Other Smart Kids**—Students whose transitions are manageable because their home cultures are congruent with the culture of school but inconsistent with the culture of science. In other words, these students may have grown up around family and friends who have attended or otherwise espoused the values of higher education but have little to no interest in pursuing science as a field. They may be motivated to excel in school but do not see science as being relevant in their lives.

3. **“I Don’t Know” Students**—Students whose transitions are hazardous because their home cultures are inconsistent with the cultures of both school and science. These students may have been generally encouraged to go to school, but perhaps the value of school and/or science, or the way to be successful in their pursuit, was never fully modeled for them. Nevertheless, these students have enough self-esteem as students to persevere in school, but science does not fit within the way they identify themselves, their upbringing, or their lifestyle. Typically, these students would have a superficial, but passable understanding of science.
4. **Outsiders**—Students whose transitions are impossible because their home cultures are discordant with that of both school and science. The cultures of school and science were not modeled for them growing up, and these students typically expressed no interest in either school or science. As a result, these students tend to drop out of school to pursue other interests and opportunities that align more with their worldview and abilities.
5. **Inside Outsiders**—Students whose transitions are very difficult or nearly impossible because, while they are personally interested in learning science, their home cultures are irreconcilable with the cultures of school and higher education. For these students, institutional discrimination, a hostile cultural context full of microaggressions, and imposter syndrome are typical barriers they would have to overcome to pursue a degree in sciences.  
  
Building on these five categories, Aikenhead (2001) developed a sixth category to differentiate a type of student whose transitions are hazardous in the same way as “I Don’t Know” students’ transitions.
6. **“I Want to Know” Students**—Similar to “I Don’t Know” students, these students experience hazardous border crossings because their home cultures are inconsistent with the cultures of science and schools. However, these students are more predisposed to learning science than “I Don’t Know” students because their self-images and interests align and are congruent with the world of science, although these students still may find the concepts underlying the field to be challenging to grasp. On the basis of their motivation alone, they generally attain a modest yet effective understanding of science.

Further, Table 2 provides a matrix summary of this conceptual framework, along with Costa (1995) and Aikenhead’s (2001) student categorizations.



**Table 2. Student Categorizations of their Schools and Science Cultures Relative to Their Home Cultures**

	Home Culture				
<b>School culture</b>	Congruent	Congruent	Inconsistent	Discordant	Irreconcilable
<b>Science culture</b>	Congruent	Inconsistent	Inconsistent	Discordant	Compatible
<b>Student category</b> (Costa,1995; Aikenhead, 2001)	Potential scientist	Other smart kids	“I don’t know” students or “I want to know” students	Outsiders	Inside outsiders

On the basis of our analysis, we assigned each of the student respondents to one of four of the student categories: (1) *potential scientist*, (2) “*I want to know*” students, (3) “*I don’t know*” students, and (4) *inside outsiders*. Our team assigned students to one of these categories according to respondents’ descriptions of their home cultures and the extent to which their experiences with their CS programs and higher education institutions aligned or were compatible with the way they grew up. We did not include the categories for “other smart kids” or “outsiders” because these categories describe students who had no interest in the sciences. Because all the student respondents in our sample demonstrated a strong interest in CS, these two categories were not relevant to our analysis.

Although these student categories were not meant to be prescriptive, Costa (1995) and Aikenhead (2001) observed that they generally correlated with certain outcomes related to a student’s experience of transitioning into the culture of a college and/or science program. Because they conceptualized students as crossing a “cultural boundary” when moving from home cultures to the cultures of colleges and sciences programs, these researchers used the term “border crossings” to describe that movement. For example, Costa and Aikenhead observed that students who fit the description of a *potential scientist* tended to experience smooth border crossings. *I don’t know* and *I want to know* students tended to experience hazardous border crossings and *inside outsiders* tended to experience very difficult border crossings.

Building on this border crossing literature and the analysis of our data, we developed four types of transition experiences (defined below) and assigned each of the student respondents to one of these experiences. These assignments were based not on the way students were categorized in Table 2, above, but on the way respondents described their own experiences transitioning into their respective CS programs described below:

1. **Smooth border crossing:** Respondents reported that they had no trouble transitioning into their CS graduate programs. Their home cultures tended to be consistent with the cultures of CS in undergraduate and/or graduate education. Respondents felt well supported in their graduate school environment.
2. **Manageable border crossing:** Respondents stated that they were managing to adjust to their CS programs despite some minor challenges, which they felt generally equipped to overcome. Their home cultures were largely consistent with the cultures of CS and/or graduate education, but they had to adjust to some aspect of the culture of their CS programs.
3. **Difficult border crossing:** Respondents shared having had a difficult time adjusting to the culture of their CS programs. While some aspects of their home culture had given them some familiarity with CS and/or higher education, they still had trouble adjusting to the culture of their CS programs.
4. **Hazardous border crossing:** Respondents' home cultures were at odds with the dominant culture of their CS programs. Respondents conveyed having had trouble adjusting to the culture and having lacked adequate support to navigate this dissonance. There was a sense of "going it alone" with minimal support from peers and/or mentors.

The student categories and transition outcomes were loaded into NVivo as case classifications, which were assigned to each of the 23 students in our qualitative sample. Researchers then ran matrix queries across these case classifications to identify patterns and themes related to the key topics that made up this report's guiding questions—namely, key factors that had shaped students' decisions to pursue CS graduate degrees; issues related to students' national, racial, and gender identities; and the role of social networks and mentorship in helping students navigate the cultural transition into their CS graduate programs. Moreover, the interview data with mentors were analyzed through the lens of an oral histories approach; we were interested in understanding the ways in which mentors conceived of their roles, and the ways this conception affected their approach to mentoring students.

## Findings

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Through the lens of the cultural border crossing framework, our findings provide insights on how students navigate incongruencies between their home cultures and the cultures of their colleges and CS programs. At a high-level, our data analysis revealed that the student respondents in our sample did not fully align with the expected patterns that Costa (1995) and Aikenhead (2001) observed. For example, Table 3 (which summarizes the way we coded the 23

students in our sample according to their categorizations and transition experiences) shows how several “I don’t know” and “I want to know” students experienced reasonably manageable border crossings into their CS programs (8 respondents). This observation contrasts what was documented in the literature—that is, “I don’t know” and “I want to know” students were expected to experience more hazardous crossings due to the incongruencies between their home and school cultures.

**Table 3. Summary of Student Categories and Transition Experiences (N = 23)**

	Smooth	Manageable	Difficult	Hazardous
Potential scientist	0	2	0	0
“I don’t know” students	0	3	2	1
“I want to know” students	0	5	4	1
Inside outsiders	0	3	1	1
<b>Total:</b>	0	13	7	3

This cursory analysis pointed to an important gap in the framework advanced by Costa and Aikenhead. While a cultural congruency framework may help to explain why some Black and African-American students struggle in their CS programs, it does not capture or provide any insight into the different coping strategies, supports/facilitators, and resources that help students bridge cultural gaps such that their transition experiences become more manageable than theory might otherwise expect. In the following sections, we explore two key supports for students as they navigated the transition into their CS programs: social networks and mentorship. The findings are organized into four main sections: 1. Key motivations for students to pursue a CS degree, 2. Student experiences through the lens of racial, gender, and national identities, 3. The role of social networks in facilitating border crossings, and 4. The role of mentorship in “brokering” cultural incongruencies.

### Motivations for and Barriers to Pursuing a CS Degree

All student respondents shared the primary motivations that ultimately pushed them to pursue a degree in CS. A common theme among respondents centered on career advancement, with respondents emphasizing its role in opening diverse pathways within the field. Among the respondents we interviewed as referenced in Table 3, thirteen identified with manageable border crossings, six identified with difficult border crossings, and three identified with hazardous border crossings.

Of the 13 respondents who described their border crossings as manageable, the majority, (10 of 13), were US-born citizens. Among this group, Black females were the predominant demographic identifying with such manageable border crossings. Their pursuit of a degree was

significantly influenced by various factors linked to career advancement. Black female students also expressed unique motivations for pursuing a degree in the field.

One female PhD student respondent highlighted the significant role mentors played in her journey, serving as sources of inspiration and insight. She expressed her initial uncertainty about her path, noting that graduate school seemed like the most straightforward choice. However, her perspective shifted after being mentored by three Black individuals with PhDs, two in CS and one in math. Witnessing their impactful work within the Black community inspired her to pursue a PhD and conduct research that benefits their community. This example underscores the profound impact of mentorship and representation in academia, showing the way positive role models can inspire individuals to pursue higher education and contribute meaningfully to their communities. Among the respondents who identified with manageable border crossings, a common thread emerged—a shared longing for a profound sense of connection as they embarked on their journey toward a degree in CS. This sense of connection manifested in diverse forms, ranging from eagerness to enhance personal development and contribute to civic progress to fostering an environment for others to flourish in the space. Furthermore, one respondent shared a strong motivation to pursue CS—more specifically, AI technology to improve the lives of others. She shared:

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I wanted to do something that mattered, if not mattered, at least help the world or help people. And so, that was really important to me and something that was really gnawing at me. And so, when I found out about AI fairness, it really did spark ... It felt like an intersection of a lot of my interests and who I was, someone who really ... I wanted to help the world, make it better. I knew technology was the future, a lot of truths, and this made sense, like I can use technology to help the world, to make things better, to improve the lives of others.

– *(Master's Student, female)*.

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Seven respondents (4 male, 3 female) identified with having difficult border crossings. The driving forces behind their aspirations were a collective desire for increased job security, flexibility, and a profound sense of fulfillment in their careers. Notably, job security emerged as a prominent motivator, encompassing a spectrum of concerns—from shielding themselves from potential layoffs to seeking the flexibility of choosing their work locations. Similarly, respondents expressed finding fulfillment in their professional roles, particularly when liberated from the routine day-to-day aspects. Respondents who reported difficult border crossings, reported that potential flexibility in their profession was a critical aspect to explore different pathways within CS. One respondent shared, “It’s the idea of being able to learn new things and being able to try different things, because everything is a learning experience, and then also being able to work in as a team.” (Undergraduate student, male).

When comparing the experiences of hazardous border crossings to difficult and manageable, we noticed some variability in the composition of respondents. Three respondents identified as having hazardous border crossings, all of whom identified as foreign nationals. These respondents' experiences varied in the aspects of they were not raised in the United States and their motivations were tied to access. For example, a male PhD respondent exemplifies the pursuit of education across borders. He stated that his primary motivation for pursuing a degree was the absence of CS programs in his home country. To realize his academic ambitions, he needed funding to study abroad, a crucial requirement that shaped his educational journey. Despite having previously received a full scholarship for his master's degree, financial limitations forced him to pause his studies. He faced this setback largely alone because no one in his immediate circle had encountered such circumstances or could offer advice on them. While one respondent sought personal access to education and opportunities in another country, another respondent reflects on her motivations in providing access to information to others:

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"I'm just motivated to have the knowledge and teach other people in foreign countries where they can help others. I can't be the one to help everyone but teach one person and then they teach one person and then it just spreads."

– (Master's student, female).

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## Student Experiences in CS programs

Respondents shared their experiences navigating identity-related challenges in their CS programs, highlighting commonalities. We examine the ways individuals with intersecting identities and differing border crossings manage these challenges. These include issues related to identity (race, gender, nationality, other), as well as sense of belonging, the feeling of fitting in and being accepted (Allen et al., 2021), and imposter syndrome (Feenstra et al., 2020), feelings of inadequacy and denial of accomplishments." Notably, those experiencing imposter syndrome, isolation, and a lower sense of belonging primarily belong to the manageable (2 of 23) and difficult (4 of 23) border crossing categories.

Within both manageable and difficult border crossings, respondents reflect on the challenges they experienced in regard to race. Feelings of imposter syndrome and loneliness were salient across respondents when noting being the only Black or African American in predominately white spaces. For example, some students (6 of 23) expressed feelings of loneliness, comparing their experiences in predominantly Black neighborhoods with the predominantly white environments of their schools and majors. One respondent shared her struggle in the transition from a "tight-knit community" of people with whom she felt connected into a very secluded community in order to pursue her doctoral degree:

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So, it kind of felt lonely, and I think it was just shocking, because I grew up in predominantly Black neighborhoods, and then I went to [Midwest state], where it was 2% Black. And now it was just eye-opening because not only was I in a school that was predominantly white, I also knew that I was going into a major that wasn't going to represent myself.

– *PhD student, female*

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In addition, among the six respondents who reported distinct feelings of imposter syndrome in their CS spaces, most identified as female (5 of 6), while one identified as male. Two respondents had manageable border crossings (both female), and four respondents had difficult border crossings (3 female, 1 male). These respondents cited several key factors contributing to these feelings. One common theme was the inability to present their authentic selves and the challenge of gaining acceptance in their CS environments. One respondent, a female master's student, said, "I think to feel truly comfortable, you have to feel like you can bring your authentic self, and have that authentic self-embraced. I don't think that [I] would be embraced and/or supported by the current CS department." This respondent conveyed that she did not feel safe to show up to her CS program as her authentic self, and that further exacerbated her feeling that she did not belong. Across all border crossing types, female students (7 of 23), in particular, conveyed a more acute sense of isolation and inadequacy when each found herself to be the sole woman and Black/African American student within her CS program. One female PhD student shared, "Because it's different way back at home, I didn't get to worry about being a Black. I only get to worry about being a female in engineering. But now, you're in a space whereby you're not just Black, you're a female. You're now in a male dominated field." Another female student discussed the challenge of navigating a male-dominated field and facing difficulties when switching her career field, along with a general lack of support systems in CS. She highlighted the need to bridge knowledge gaps, recognize the struggle of being a female Black individual in a highly competitive male-dominated field, and mitigate the constant pressure to stand out and prove her own competence. She explained that these experiences led to feelings of inferiority and self-doubt. When comparing the experiences of American students with those of foreign nationals, we discovered some variability in the factors that influenced their CS experiences. American CS students with dissonant cultures often struggled to connect with family members who did not comprehend the demands and hurdles of the CS field, which caused feelings of isolation and frustration. American first-generation college students also grappled with the pressure to pioneer higher education in their families, which intensified imposter syndrome.

Foreign national CS students with discordant cultures encountered their own unique set of obstacles. For these students, challenges in adapting to American culture and in language

barriers posed additional difficulties in establishing a sense of community. One respondent spoke of her language challenges:

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“When I arrived, the first challenge that I had was the language because when you listen to English or you study, you read it... And the language, I would say that because everything was just English, even my courses, my exams, everything. So, at first that was the main difficulty.”

– (PhD student, female)

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Two foreign national students (2 of 10) who identified with difficult border crossings, expressed their feelings of being compelled to meet their parents’ career expectations, creating a divide between their own aspirations and familial pressures. In addition, two (2 of 10) had grown up in contexts that restricted their access to advanced technology and resources, which hindered their early learning. Further, their limited exposure to CS during high school contributed to imposter syndrome, as navigating a CS environment was more demanding than it was for their American peers, who had stronger academic preparation.

Black and African American students also had varying experiences depending on what type of institution they attended. Most respondents (3 of 5 students) in CS programs at private not for profit PWIs reported feelings of isolation, as compared with students from other institution types. They described a sense of having a “target on their backs” and expressed anxiety and unease when dealing with academic challenges, especially as the only Black individuals in their classrooms. These respondents identified as female and had both manageable and difficult border crossings. For some, there was pressure not to “let down” their entire race, which added to their feelings of being imposters. One respondent shared,

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“I know my experiences inside the computer science classroom are one, when I fret, when the teacher mentions that we have a project to work on, “Oh boy, here we go.” Because a lot of times I am the only Black person. It’s kind of been that way throughout my whole program.”

– (Master’s student, female)

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An undergraduate female shared, “I would say just in general, CS as a Black student isn’t exactly easy. So, it’s an experience, but I think the main thing is I just rely on the support of other Black students.” Similarly, among some students (4 of 6) who attended public 4-year universities that were not HBCUs or MSIs, four of six experienced marginalization and isolation, especially when they were among the few Black students in their classes. This lack of representation often led to feelings of not belonging and a lack of support. In contrast, students (2 of 6) at HBCUs and MSIs reported a greater sense of belonging and support within their academic communities. This greater sense of belonging may have shaped their willingness to take a more assertive stance

against incidents of discrimination. Some of these students mentioned that they confronted individuals who made derogatory comments about their skin color and ethnicity. In sum, respondents employ diverse coping mechanisms and strategies to navigate challenges in their CS programs. These coping strategies encompass a broad spectrum, ranging from relying on religious practices, family members, and mentors to seeking support in affinity group spaces. As previously noted, two respondents had manageable border crossings (both female) and four respondents had difficult border crossings (3 female, 1 male). Notably, one respondent, who was the sole Black person in her graduate department and identified with difficult border crossings, utilized the Black Graduate Student's Association to connect with other Black graduate students facing similar challenges in the academic landscape. This exemplifies the way individuals recognize the importance of aligning their coping strategies with sources of support and community.

Moreover, a respondent who identified with manageable border crossings revealed active participation in discussions about representation and sought support from fellow women in her academic program as a coping mechanism. Specifically, she shared that she engaged in conversations with another female student, delving into her experiences as a woman in a predominantly male-dominated field. These dialogues explored the gender imbalance within their academic community and delved into the intersection of their gender identity with their research. The discussions extended to addressing the impact on their interactions with colleagues and the pursuit of equitable treatment within the academic environment, highlighting the contribution of dialogue and mutual support to effective coping strategies.

### **Facilitating Border Crossings: The Role of Social Networks**

Different types of students who experienced a range of border crossings (i.e., manageable, hazardous, etc.) approached and leveraged their social networks in different ways. All student respondents were part of multiple social networks that provided vital academic, professional, and socioemotional support over the course of their degree programs. Respondents primarily identified networks comprising family, friends, peers, religious communities, and formal organizations/conferences. In terms of where they sought and found academic support, respondents most often referred to their peers, such as lab mates, cohort members, classmates, and upper-level students. Compared with other networks, the relationships that respondents had with their peers occurred more regularly and were most directly related to the substance and technical aspects of their degree programs because the respondents and their peers were working and/or taking classes together. One male master's student described turning to his peers to fill gaps in their understanding of the course material:



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If I have a problem, I personally don't have any problem going directly to the professor, [but] I also don't want to keep going to the professor, just because I don't want to seem like I'm disturbing [them], I guess. And there are other times where it's just more comfortable meeting my classmates who have understood the problem. Maybe they will sometimes be able to explain it in a way that I can relate to better.

– *Master's student, male*

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Student respondents also relied on their peers as key sources of information on other aspects of completing their degree programs, such as obtaining financial aid, finding networking opportunities, and navigating departmental processes and logistics.

Another common network type that provided respondents with academic, as well as career, support were external organizations, societies, and conferences at which students were able to find connections with other CS students and professionals with the same racial and gender identities. Respondents highlighted examples such as IAAMCS, the National Society of Black Engineers (NSBE), the AFROTECH conference, blackcomputHER, Black Women in Technology, and the STEM Advantage. About half of the student respondents spoke about how important these external networks were for them in providing additional opportunities to connect and build solidarity with others who had had similar experiences in CS programs and to learn about different research and career opportunities. For example, one undergraduate student shared the unique supports that the connections she had made through external networks provided for her:

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I think my community has gotten smaller but bigger in the same instance. . . Strangers are more supportive sometimes than the people that's supposed to be next door to you. I've met a lot of people [through] events or LinkedIn who support me. They'll [connect] you [to] opportunity. They'll open doors for you just off of a conversation you had. I've learned strangers can be a part of my community, as well.

– *Undergraduate, female*

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Particularly for Black women, who often found themselves in the race and gender minority in their CS programs, these external networks provided vital connections to other Black women in the CS field, helping to fill a void in their more immediate circles. One PhD student, who was recounting her experiences as an undergraduate student in a CS program in the Midwest, explained that her involvement with NSBE helped build important connections that she did not have immediate access to:

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[NSBE] just opened my eyes to the different career paths. It was finally an opportunity for me to see other Black engineers. I was saying that in [Midwestern state] there weren't many of us, and if there were, we weren't all in the same majors. Because NSBE had conferences . . . I learned how to attend a career fair and talk, because I always felt too nervous to attend a career fair that was offered at the school for some reason. But I felt more comfortable at NSBE.

– *PhD student, female*

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In terms of nonacademic supports—such as social, emotional, and financial support—respondents most commonly described turning to family, friends (not affiliated with their CS programs), and religious communities regardless of whether they knew anything about the CS field or respondents' programs. These more intimate networks provided a “home away from home” for students who were studying in programs that were in far-away locations. For example, some international CS students (4 of 10) would often look to connect with compatriots and other foreign nationals for social support and guidance on the way to navigate an unfamiliar U.S. culture.

Several respondents (13 of 23) also explained that their friend groups were where they could find community with and support from other Black and African American students, particularly since many of the respondents were in CS programs in which they were one of only a few who identified as such. One male undergraduate student explained that, even if his friends were not a part of the CS field, they were still an important source of emotional support because they understood his background and shared in some of the same struggles he experienced: “We all grew up in the same area, and it wasn't always the best area. So, I understand why they work so hard, and I work as hard as I do because we don't want to be in that situation. It definitely helps because it's a sense of encouragement. . . I understand where we all came from.”

Compared with students who experienced more manageable border crossings, the students who experienced difficult or hazardous border crossings had to take more proactive and intentional steps to build their social networks. Among this latter student group, there was a widespread recognition of their need for both academic and nonacademic support from their various networks to have a better chance at succeeding in their degree programs. However, for many of these students (5 of 10 respondents), plugging into supportive networks proved difficult. One PhD student described how she had trouble “integrating” with her peers in her CS program:

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It definitely still feels like there's a long way to go to feel fully integrated. . . . It's this thing where maybe I just haven't had much success when it comes to befriending or having these circles of people in the computing area. . . . I know I needed help, [but I] often just struggle through. And it just didn't make any sense because I wasn't making much progress.

– *PhD student, female*

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This student felt that she had trouble embedding herself into supportive networks because it required her to be “a little bit more vulnerable” in asking for help. That feeling of vulnerability was a common theme among students who experienced difficult or hazardous border crossings, perhaps because those students experienced a stronger feeling of imposter syndrome or insecurity about their sense of belonging in their CS programs as compared with potential scientists or students who experienced smoother border crossings.

Despite this feeling of vulnerability, some students, particularly “I want to know” students who were highly motivated to gain CS skills, were able to build their social networks by overcoming their personal insecurities. One female PhD student who fit the “I want to know” category described overcoming “a lot of inferiority complex and a whole lot of self-doubts” to network with her peers. “You have to leverage on your classmates’ strengths. . . I had to swallow my pride and everything and meet people that know [the things I don’t know].” A master’s student who could also be described as a highly motivated “I want to know” student exhibited an open and highly intentional approach to building key network connections:

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At every point, I try to make sure there is someone in the corner kind of mentoring me or something, giving me the extra support I need. Because if you're trying to struggle and figure it out on your own, most times, you're just going to get burnt out. That's the way I look at it. So, I try to open myself to asking questions as much as I can . . . because you really don't know where the supports can come from.

– *Master's student, female*

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In contrast, students who experienced more manageable border crossings and who may have felt more secure in their place in the program did not generally convey a need to overcome feelings of inferiority to build their network. Rather, their efforts tended to emanate from a place of security and a desire to “advocate” for themselves. As one female master’s student stated, “I came in with a sense of who I was, what I wanted out of the program. I very much had a plan in mind, and my ideas. And so, any time I had a question from, ‘Hey, is there funding for this kind of thing?’ or ‘I want to go to this kind of thing,’ it was pretty easy.” Although these students still put in an effort to build their social networks, the process was more seamless and came more naturally to them as they pursued their CS degrees.

## Mentors as Cultural Brokers: The Role of Mentorship in Facilitating Border Crossings

### *Descriptions of mentorship*

Respondents who faced difficult or hazardous border crossings were less likely to report having mentors than those who experienced manageable border crossings. Most respondents who had manageable border crossings reported having at least one mentor, compared with slightly more than half of students who experienced difficult border crossings. Those who did have a mentor (13 of 23 respondents) differentiated this relationship from other kinds of support in that mentors generally offered individualized resources, technical expertise, and/or holistic support in a consistent manner. Although any professor, school administrator, or fellow student might be available to answer questions reactively, mentees generally felt that their formal mentors were proactive and uniquely committed to their long-term growth and well-being.

Mentors usually had particular expertise or experience in the CS industry or academic space. Examples of mentors commonly cited by interviewees included high school teachers in the math or computing fields, current or past university faculty, academics, industry professionals, and peers more advanced in their careers.

Mentees often met their mentors through their academic programs (10 of 13 respondents), and some also said they cultivated their mentor relationships by reaching out to peers over email or through LinkedIn (5 of 13 respondents). However, many mentees (8 of 13 respondents) also explained that they obtained a mentor through extracurricular programs such as computing/coding camps, robotics clubs, and programs for minority students in the field (e.g., IAAMCS, the Computing Research Association's Committee on Widening Participation in Computing Research). Such programs often facilitated one-on-one interactions that led to mentor–mentee connections.

Some respondents reported facing challenges in securing a mentor, despite trying to do so (10 of 23). The key challenge noted by these respondents was mentors' general lack of availability. One respondent explained, "It's hard to identify those who want to have the expertise or the skills that you're looking for . . . and also who have the availability." Another respondent, a female master's student, echoed this, saying, "[Availability] is the main thing. I've reached out to a lot of people, and it goes unanswered."

Students who told us that they lacked mentorship more commonly faced difficult (5 of 7 respondents) and hazardous (2 of 3 respondents) border crossings (see Table 4). These respondents reported that they saw the importance of mentorship but often told us that they hadn't begun to seek a mentor. Some explained that it was not a priority and that they felt

supported through their existing social networks (e.g., friends, teachers; 4 of 10 respondents). Others, meanwhile, did not feel capable of obtaining a mentor despite trying to do so (6 of 10 respondents). As one female master’s student explained, “I just don't know where to start to find mentors or find people that would be very encouraging and just want to pour the resources on you. . . . I’m lost in finding [someone] to mentor or help.” Foreign national students were especially likely to feel this way; almost half these respondents (4 of 10) said they did not have a mentor. Rather, foreign national students relied on their social networks, such as friends who had also migrated to the United States or family back in their home countries, to help them navigate their academic and professional lives.

**Table 4. Reports of Mentorship, by Border Crossing Type**

	Smooth	Manageable	Difficult	Hazardous	Total
<b>Has a mentor.</b>	0	10	2	1	13
<b>Does not have a mentor.</b>	0	3	5	2	10
<b>Total:</b>	0	13	7	3	23

***Support provided through mentorship***

Students reported receiving holistic support from their mentors, who helped them develop across professional, academic, and personal domains. Most commonly, mentors provided professional support to the respondents. By connecting students with work and research opportunities and advising them on their academic and career paths, mentors helped students establish and advance toward their professional goals. Mentors helped many students find their career paths by sharing personal experiences and referring students to extracurricular research and work opportunities. For instance, one female master’s student said of her mentor, “She just kind of showed me all the opportunities and possibilities there were as a computer scientist.” In fact, a few respondents said that they began to see academia and CS research as a possible career path because of their mentorship experiences (3 of 13 respondents). Such was the case for one female PhD student with whom we spoke. Her mentor, an undergraduate professor, involved her in research projects and encouraged her to apply for PhD programs—a path that she had eventually pursued.

Mentees who already had long-term professional goals in mind received support from mentors to stay focused on their goals amid their studies. For example, a PhD student said her mentor advised her to pursue an internship opportunity rather than a research role to open up more relevant opportunities in the future. Another respondent reported that her mentor recommended that she take particular courses based on her desired career path. Mentees

described feeling accountable to their mentors, who would check in with them and ensure that their decisions aligned with their long-term goals.

Mentors also supported their mentees' professional goals by connecting them with opportunities for learning and professional experiences. Respondents mentioned that their mentors helped them find and participate in research projects, internships, and CS courses and camps. One respondent even said that her mentor helped her secure a place in a PhD program after she had received an initial rejection. These respondents generally stated that their mentors helped open doors for them.

Almost all respondents also reported that, beyond professional support, mentors provided academic support by helping them navigate their coursework, degree requirements, and funding challenges. Students benefitted from various types of academic support. For instance, some students reported that they had received technical advice and one-on-one tutoring through their mentorship experiences (3 of 13 respondents). One female master's student who also worked full-time in the tech industry described a colleague's mentoring her in that way: "He just helped me with my homework today, with the coding. I was telling him I was having such a hard time, and [he would] sit down . . . go over the code with me . . . give me resources. . . . And any question I have, I can just ask." Mentors, particularly those within a student's program or institution, also advised mentees (3 of 13) on successfully navigating their program's degree requirements (e.g., course sequencing, publishing advice) and even helped a few students secure funding by referring them to scholarships (2 of 13). Students with difficult and hazardous border crossings more commonly said that their mentors provided this kind of discrete advice (e.g., homework help, scholarship referrals) related to succeeding in their current programs. On the other hand, students with manageable border crossings benefitted more from extracurricular and professional learning experiences, which expanded on their coursework.

Finally, mentees described receiving social and emotional support from their mentors. The mentor relationship, for many students, was defined by openness and transparency on the part of both the mentee and the mentor regarding their struggles and successes (9 of 13 respondents). As one female master's-level student characterized her mentors, "I really felt like I could be real with them. We can have really real conversations about hard topics." Such a safe space made it possible for mentors also to provide social and emotional support to students. For instance, one female master's student described the way her mentor cared for her emotional well-being when she first entered their program: "She was also the first person to notice in my first semester that I was feeling overwhelmed, and she really checked in on me, supported me." Another respondent said that her mentor often encouraged her to take a break in order to care for her mental health. A number of mentees said that their mentors "cared for," "encouraged," or "understood" them, highlighting the way they gained social and

emotional support through mentorship. Although students who experienced difficult and hazardous border crossings emphasized the importance of this social and emotional support more than did students with manageable border crossings, even the latter group described facing identity-related setbacks (e.g., microaggressions) and personal setbacks (e.g., pregnancy), which made mentorship a vital support during their CS degree programs.

### ***The role of mentorship in facilitating cultural border crossings***

In general, students reported that their mentors' greatest impact was in validating them, modeling success in the CS field, and supporting their transitions into new spaces. In each of these areas, the mentorship was made more effective by the similarity of background, identity, or career focus of the mentee and mentor. Notably, because they were more likely to lack mentorship, respondents who were categorized as facing difficult and hazardous border crossings rarely reported benefitting from these impacts (see Table 4).

Mentors helped validate mentees in our sample (7 of 13 respondents), thereby supporting them in overcoming feelings of doubt and isolation. Students found that their mentors welcomed open, vulnerable, and honest exchanges about struggles and successes. A master's student described being able to "vent" to her mentor, while a female PhD student said, "[My mentor] is very open already about her own journey, and I think that just makes it easier to talk about mine." A number of mentees described feeling heard and seen by their mentors, sometimes while still feeling unheard and unseen in their academic spaces (5 of 13 respondents). To this end, a master's student stated,

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*"My mentor means a lot to me in the sense of, I finally have somebody that's hearing me and understanding that it is hard to break into this industry. . . . It's really, really difficult. I feel like for the last few years I've been trying, screaming to break through and no one is hearing me."*

*– (Master's student, female)*

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In this way, mentors can comprise a key part of a respondent's sense of community and belonging in the CS field. When students feel alone in their struggles and successes, mentorship offers a crucial site for validation and recognition.

During interviews, students highlighted a second impact of mentorship: the encouragement they felt on seeing their mentors' success in the CS field. This was particularly noted by male respondents, who described looking to their mentors and feeling, as one male PhD student explained, "If they can do those things, I know I can also do them." This aspect of mentorship went unspoken between mentors and mentees, but it was produced over time as mentors described their career paths and gained mentees' respect. For example, one student explained that he saw his mentor as an inspiration:

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“It felt like a family member relationship. Being a person of color, something that you can relate to. You can look at him and see yourself in him. In terms of being comfortable and seeing that there’s so much growth that you can grow to in order to improve yourself and be able to go to a point where he is.”

– *(PhD student, male)*

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Mentorship exemplified success in a relatable way, which helped some students envision their own future success.

A third impact of mentorship arose as respondents described the way progressing in the CS field required them to adjust and adapt to new academic and professional spaces. At times of transition, mentors helped students adjust to their new social and cultural environments by sharing advice from their own career transitions (5 of 13 respondents). Several of our respondents transitioned from undergraduate studies in Nigeria to postgraduate programs in the United States (7 of 23 respondents). One foreign national male PhD student described the support he received from his advisor and mentor, who was also a foreign national, this way: “Each time I’m facing a situation . . . [my mentor] always relates it to an experience she had. It’s important for me to know that she’s been through it, and she’s trying to tell me how to navigate it.” Several students (8 of 23) also reported facing a different kind of transition: entering into a new internship or research opportunity. Some of these students (5 of 13) told us that their mentors provided support through this transition. For example, one student described facing challenges in gaining entry into a specialty field, and she explained that her mentor guided her closely on which roles to pursue, how to build her career, and how to cope with struggles in new roles. Conversely, students who lacked mentorship expressed feeling that they had been wasting time or making missteps in their new spaces without the guidance of a mentor. Mentorship thus gave students the advice and confidence they needed as they navigated academic and professional transitions.

Mentors also helped students transition by coaching them on ways to communicate in unfamiliar academic or professional spaces (3 of 13 respondents). Students described receiving advice on the way to present research, to effectively communicate with their new faculty advisors, and to carry themselves during internships in “corporate America.” A female master’s student reported that her mentor guided her on ways to phrase questions in order to get more support—from teachers, as well as the internet—for homework assignments. The student reported learning that “different domains have different ways to approach getting questions answered. In CS, you need to state the problem you are experiencing, and you need to be able to describe it in detail.” Mentorship thus enabled some students to adapt their communication to new norms and successfully navigate new spaces.



Whether mentorship validates students, exemplifies success, or supports transitions, the alignment between mentor and mentee backgrounds seemed to facilitate greater impact on students. Our respondents appreciated it when their mentors shared aspects of their identity, including gender, race, national origin, socioeconomic background, and subspecialty within the CS field. Many had the feeling that, while other faculty and peers might try to be helpful, as a male PhD student commented, “they just don’t get it.” (See “Motivations for and Barriers to Pursuing a CS Graduate Degree,” above.) Mentors who shared one of these key aspects of identity with their mentees often gave advice and described experiences more relatable to the mentees. As a male PhD student explained, “Because all of [my mentors] are racial minorities, a lot of the advice that they give me also is centered around dealing with being a minority in these positions.” Students also said that they felt better understood by relatable mentors, who could empathize with the behavior and decision-making processes of their mentees. While some mentees were very satisfied with mentors whose backgrounds did not align with their own (3 of 13 respondents), many found that relatability heightened the feeling of mentorship as a safe and supportive space (10 of 13 respondents).

***Mentors’ conceptions of and approaches to mentorship***

In interviews, mentors revealed their motivations for engaging in mentorship and some key methods for supporting mentees. They highlighted the fact that they saw mentorship as a service to the Black and African American CS community, which motivated them to use informal and trust-based approaches to try to combat feelings of imposterism and advance the professional goals of mentees.

Our study included seven mentors from a variety of backgrounds (see Table 5). Most were female and working in the computing/tech industry, both at smaller startups and “big tech” companies. All seven possessed a graduate degree in technology, CS, or a related field. One was Caucasian. While we did not collect respondents’ age data, the sample appeared to include mid- and late-career professionals.

**Table 5. Profiles of Interviewed Mentors**

	Gender	U.S. Regions	Career	Nationality
<b>Mentor 1</b>	Female	South	Industry	Foreign national
<b>Mentor 2</b>	Female	Northeast	Industry	U.S.
<b>Mentor 3</b>	Female	South	Industry	U.S.
<b>Mentor 4</b>	Male	South	Academia	U.S.
<b>Mentor 5</b>	Female	Northeast	Industry	Foreign national

	Gender	U.S. Regions	Career	Nationality
<b>Mentor 6</b>	Male	South	Industry	U.S.
<b>Mentor 7</b>	Female	South	Academia	U.S.

Mentors tended to conceive of their mentorship role and responsibilities in broader, societal terms. In addition to providing professional and academic supports, mentors understood and measured their impact through a communal lens, that is, they saw their efforts as contributing to the success of Black and African American CS students overall. This conception of their role was rooted in mentors’ own marginalized identities and experiences (both academically and professionally) which made cultural border crossings difficult, especially if they did not have access to mentorship. Mentors spoke openly about how their past struggles informed their current approach to their students. For example, one mentor shared, “I was isolated in graduate school and so I had vowed that if I become a professor, I’m going to hire students like me and make sure they’re not isolated.” Another mentor shared,

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“I try to let [my mentees] know that if they work hard, they can make it. Because I let them know that I came from a state that had a very poor educational system. I knew I had some deficits, but I worked to fill those in...So [I] just try to encourage them that no matter where you start in technology, you can be a superstar and also impact the future of technology.”

– (Mentor 1)

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In forging these kinds of connections based on shared experiences and identities, several mentors said they developed trust with their mentees, which led to positive experiences academically—and also personally. On the academic side, mentors described helping students navigate the administrative aspects of their CS degrees. On the personal side, mentors tried to support the socioemotional needs that students voiced. Several, for instance, described counselling students through feelings of inadequacy and imposterism. As one mentor recounted,

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“I also share with them my moments of imposter syndrome so that they know that it’s not something that goes away, no matter how far you are along in your career.”

– (Mentor 3)

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In particular, mentors described two ways in which they supported mentees as they faced feelings of inadequacy and imposterism. First, mentors provided advice to mentees based on their own personal experiences with socioemotional challenges during their careers (this was the approach used by Mentor 3 in the above quote). By sharing their experiences of feeling academically inadequate and the ways that interfered with their ability to participate in class,

mentors provided encouragement and confidence to their students through affirming messages. Second, mentors supported students experiencing imposter syndrome by providing them with opportunities to build community in the CS field. Mentors recognized that underrepresented students battled imposter syndrome through discussing their experiences in community, and the mentors connected students with conferences and organizations in which they might build such community.

In addition to providing socioemotional support, mentors viewed themselves as a vehicle to professional advancement for their students. For instance, one respondent reported that she felt most successful as a mentor when she saw her mentees find fulfilling careers. Another mentor described the way their own professional challenges motivated them to support students on their journeys:

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“There were so many things I needed to figure out on my own . . . like the decision between going into academia or industry, what are the pros and cons . . . how to navigate the job search, when you’re in an internship, how to get the most out of it. . . . I think those kind of experiences shaped how I mentor.”

– (Mentor 5)

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In this way, mentors broadly affirmed that their ability to support students’ professional development was founded in personal experiences in overcoming professional obstacles.

## Discussion

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One of the key findings of this report is that, despite being underrepresented in CS programs throughout the country, there is no single narrative that adequately captures the rich diversity of the experiences, identities, and access to key resources such as social networks and mentorship of Black and African American students. Seen through an intersectional lens that accounts not only for these students’ identities and backgrounds but for their reported experiences with crossing cultural boundaries between their backgrounds and their CS programs, our study contributes a more nuanced understanding of these students’ experiences and the way that different student types (e.g., smooth border crossers) engage with social networks and mentorship. Below, we summarize some of the key takeaways of the report, along with some implications for the current understanding of the role of social networks and mentorship in the CS space.

## **Students are motivated by the prospects of career and financial stability to enter CS programs.**

It is unsurprising, then, that many of these students stated that their primary motivation for entering the CS field was to achieve career and financial stability. CS degrees were seen and understood as conferring more “technical skills” that were in high demand and thus offered a pathway to career and financial success, even if some students were not entirely clear on what that pathway looked like overall.

Although career and financial success were primary motivators, many respondents conveyed their understanding that their pursuit of a CS degree fit within a larger social and cultural context in which Black and African American students were generally underrepresented in the CS field. Thus, another key motivation for some students—especially those who had had hard but valuable experiences navigating CS that they wanted to share with others—was to give back to their community by opening for others the doors that had been closed to them. Both the motivations for and barriers to pursuing a CS degree were, thus, closely linked with the background of these students and the way they identified.

Students who came from cultures that were more congruent with the cultures of CS and higher education not only had a head start in terms of their preparation for college-level CS courses but exhibited a stronger mental mapping of the pathways they could take through degree programs and careers. They had witnessed family members and friends succeed in the field, which played a profound role in building confidence that they could also succeed in CS. By contrast, students who essentially came into CS programs of their own accord had to overcome more barriers to forge their own paths without the aid of relatable models who could infuse them with confidence. Increasing the representation of and access to Black and African American faculty, especially for students whose home cultures are less congruent with the culture of CS, is pivotal for their sense of belonging and success in the field.

## **An intersectional lens is necessary to understand more comprehensively students’ experiences and what fuels feelings of doubt, loneliness, and imposter syndrome.**

Our findings underscore the importance of understanding the experiences of CS students through an intersectional lens, attending specifically to the interplay between race and gender, and the way this interplay contributes to imposter syndrome and a sense of belonging among individuals in CS spaces. Women in our study repeatedly told us that they had found themselves in CS programs in which each was the only Black or African American, as well as one of the few women in a male-dominated space. This double isolation fueled feelings of

loneliness, self-doubt, and inferiority, and made it harder for these students to seek out and find the right kind of support.

An intersectional lens further revealed the variegated experiences of Black and African American CS students. For example, foreign national students faced unique challenges related to adjusting to American culture and language. Black and African American students who attended PWIs generally had a harder time, compared with students who attended HBCUs or other MSIs, connecting with support networks of people whom they felt that they could relate to. Moreover, first-generation college students experienced the additional burdens of being “pioneers” of sorts, which meant forging unfamiliar paths with the pressure of trying not to “let down” their families.

Thus, our findings underscore the fact that the identity-related challenges fuel feelings of isolation and imposter syndrome stemming from different and intersecting sources and are as diverse as the students themselves. Despite these challenges, the overarching theme of resilience and determination in the face of adversity was evident across student types and identities. These narratives reflect the universal struggle of aspiring computer scientists to navigate a complex and dynamic field, showcasing their resilience and adaptability as they forge their paths within the realm of CS.

### **Social networks are vital sources of academic and nonacademic support, but different types of students leverage these networks in different ways.**

Students’ social networks comprising family, friends, peers, religious communities, and formal organizations and conferences were the main form of both academic and nonacademic support. The extent to which students struggled with loneliness or imposter syndrome depended in part on their embeddedness within these overlapping social networks. For example, many respondents who struggled with being among the few or only Black or African American students in their CS programs reported that they found supportive communities outside their programs with others who shared their racial, gender, and/or national identities. Being plugged into such networks helped ameliorate feelings of isolation and provided students with vital emotional support.

In comparing two groups of students—students who felt more secure and experienced manageable border crossings (i.e., potential scientists) versus students who struggled with imposter syndrome and experienced difficult and hazardous border crossings (i.e., “I don’t know” and “I want to know” students)—it is evident that different student types leveraged social networks in different ways. Whereas the former group tended to settle into their networks in a way that felt organic, productive, and purposeful in terms of advancing their goals in their respective CS programs, the latter group had to overcome personal insecurities to

intentionally build networks that provided them with a stronger sense of belonging and support, which in turn, helped them navigate their more difficult border crossings.

### **Increasing faculty and mentors' capacities around cultural and linguistic competence can help them relate to their mentees' identities and cultural experiences, helping to counteract their feelings of doubt and imposter syndrome.**

Across student types, respondents articulated three main ways in which mentors acted as cultural brokers who helped them navigate the cultural border crossing into their CS programs: (1) through their own success, mentors encouraged CS students by modeling what success could look like and helping them envision success for themselves; (2) mentors helped students adjust to the unfamiliar social and cultural contexts of CS programs by sharing their own experiences; (3) mentors provided validation for students, which helped counteract feelings of inferiority, self-doubt, and imposter syndrome. For all three types of help, our findings strongly indicate that it mattered that mentors had the same racial, national, and gender identities as their mentees. These shared identities made mentors' experiences more relevant and salient, their validation more meaningful, and their success more inspirational to CS students.

In our study, respondents who reported experiencing difficult or hazardous border crossings into their CS programs—presumably, those who would benefit from mentorship the most—were less likely than students who experienced manageable border crossings to have mentors. Likewise, only about half the foreign national students in our sample reported having a meaningful relationship with someone they considered a mentor even as some struggled to adjust to life in the United States. While our study did not systematically explore the reasons so many of these students could not connect with mentors, some respondents explained that the lack of Black, African American, and female CS professors and mentors in their respective CS programs might have played a role. In the absence of these types of mentors, some respondents turned to their advisors, who while helpful in the technical aspects of their coursework, did not always “get it” when it came to fully understanding their experiences, backgrounds, and identities.

This finding highlights the need for the CS field not only to invest in increasing the number of Black and African Americans in the professoriate but to train existing faculty and prospective mentors to strengthen capacities around cultural and linguistic competence, and diversity, equity, and inclusion. Short of dramatically boosting representation of Black and African American faculty in the CS professoriate, increased capacities around cultural and linguistic competence; diversity, equity, and inclusion; and other allied frameworks may better equip CS

mentors to make more meaningful connections with minoritized students. Students need cultural brokers who can both identify with students and have knowledge of the CS field.

The findings also suggest that different mentoring approaches may be effective in addressing the diverse needs of Black and African American students. For example, potential scientists and those who experienced manageable border crossings reported that they sought out mentorship, such as with professional networking and external learning opportunities, that helped them beyond their immediate academic programs. In contrast, students who experienced more difficult or hazardous border crossings felt that the value of their mentor was rooted more in supporting them through the academic rigors of their CS program.

Respondents reported that a single mentor could not always offer sufficient support in all the ways they needed (i.e., professional, academic, and social and emotional support). Rather, students explained that they required multiple mentors to meet their various needs and to offer support related to an academic area or career path in which other mentors might lack experience.

**In the broader context of underrepresentation of Black and African Americans in the CS space, mentors tend to conceive of their role in broader, more altruistic terms of benefitting society as a whole.**

The Black and African American CS mentors whom we interviewed for this study recognized their vital role in terms of modeling success, sharing their personal experiences, and validating students. The mentors in our study conceived of their mentorship role in societal terms; they often spoke about their desire to “give back” and “pay forward” the support that had contributed to their own success, especially in a context in which Black and African American students were underrepresented in the CS field. Mentors recognized the importance of students’ having mentors with shared identities and of the ways the lack of representation in the CS fields could negatively affect their success, reiterating the need to increase the pool of Black and African American CS faculty and/or better train faculty in cultural competencies.

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## Appendix A. Interview Protocols

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### CS graduate students (master's degree)

1. Background
  - a. Please introduce yourself by telling me your name, university, year, and the name of your graduate program.
2. Journey to CS program
  - a. When were you initially introduced to CS as an area of study and potential career path?
    - i. Follow-up: How were you initially introduced to CS?
  - b. How would you describe the level of exposure you had to CS growing up? For example, is it something you proactively sought out, or were information and resources about CS readily available to you where you grew up?
  - c. Did you attend any CS programs (e.g., afterschool or summer programs) in K–12 or during your undergraduate education? If so, please describe them.
  - d. What motivated you to pursue a graduate degree in CS?
  - e. Thinking back to when you first became interested in CS, how would you describe the level of access you had to information and resources that were helpful to you as you considered pursuing a graduate degree in CS?
  - f. What were the biggest barriers or challenges that you had to overcome in order to ultimately enter a CS graduate program?
    - i. Follow-up: What were the biggest supports or facilitators?
3. Social networks
  - a. In general, how would you describe your social network?
    - i. Probes: size, supportiveness, geographic location, and so forth
  - b. Are there any specific individuals who have supported you in your academic and professional life? Please explain who they are and how they supported you.
  - c. We are interested in supports you may have received including financial, emotional, or skills development. Does your family provide any of these or other supports in your pursuit of a CS graduate degree? If yes, please describe the ways in which they support you.

- i. Follow-up: Do your friends support your pursuit of a CS graduate degree? If yes, please describe the ways in which they support you.
  - ii. Follow-up: Are you part of any formal organizations or programs that support your academic and professional pursuits? If yes, to what extent and in what ways do they support you?
- 4. Sense of belonging
  - a. How would you describe your community outside of your studies?
    - i. Follow-up: Outside of academic ones, what are the different groups or spaces that are important for your sense of community?
      - 1. Probes: religious community, family, friendships, and so forth
  - b. Do you feel a sense of community in your studies or academic life? Please explain.
    - i. Follow-up: What are the academic groups or spaces that are important for your sense of community?
  - c. To what extent is your academic community similar to your community outside of your studies? Please explain.
    - i. Follow-up: To what extent are you able to have discussions about computer sciences outside of academic and professional settings? Please provide some examples.
    - ii. Follow-up: To what extent are the skills you've acquired while studying CS (e.g., coding, logical, interpersonal) applicable outside of academic and professional settings?
    - iii. Follow-up: To what extent are the skills you've acquired outside of school (e.g., coding, logical, interpersonal) applicable in your academic and professional settings?
  - d. Describe your level of comfort or sense of belonging in your CS graduate program.
    - i. Follow-up: Is there any difference between your comfort and sense of belonging in academic versus nonacademic spaces? Why or why not?
  - e. What are some challenges that you feel you experienced in the CS field because of your gender, racial, or other identity?
    - i. Follow-up: How did you overcome those challenges if any?
    - ii. Follow-up: Can you think of anyone in particular who helped you overcome those challenges? If so, please describe what they did or how they did it.

## 5. Mentorship

- a. Whom would you currently describe as your mentor as you navigate your CS graduate degree program?
  - i. Probes: faculty, other graduate school students, program staff, and so forth
  - ii. Follow-up: How would you describe the mentorship they provide?
    1. Probes: academic, career, sociocultural, professional, and so forth
- b. Beyond academic or professional support, do you have any mentors who you feel can understand or relate to you (i.e., how you identify, the community in which you grew up, and/or the experiences that you had)?
  - i. Follow-up: If so, can you describe this relationship and what it means to you?
  - ii. Follow-up: If not, do you feel that a lack of this kind of mentor has been a hindrance to you as you try to complete your degree?
  - iii. Follow-up: To what extent have you felt like these mentors have helped you navigate the culture of your CS graduate degree program?
- c. Have you played a mentor role to another student who is pursuing a CS graduate degree? If so, can you describe this experience?
  - i. Follow-up: Have you found yourself sharing your own experiences to help other students? If so, please describe this experience.

## 6. Aspirations

- a. What are your plans after you complete your current degree program?
  - i. Follow-up: What is motivating you to pursue these plans?
  - ii. Follow-up: What barriers do you foresee in achieving these goals?
  - iii. Follow-up: What additional supports do you think would be helpful to achieve these goals?

## CS graduate students (PhD)

### 1. Background

- a. Please introduce yourself by telling me your name, university, year, and the name of your graduate program.

### 2. Journey to PhD program

- a. When were you initially introduced to CS as an area of study and potential career path?
  - i. Follow-up: How were you initially introduced to CS?
- b. How would you describe the level of exposure you had to CS growing up? For example, is it something you proactively sought out, or were information and resources about CS readily available to you where you grew up?
- c. Did you attend any CS programs (e.g., afterschool or summer programs) in K–12 or during your undergraduate education? If so, please describe them.
- d. Thinking back to when you first became interested in CS, how would you describe the level of access you had to information and resources that were helpful to you as you considered pursuing a graduate degree in CS?
- e. What motivated you to pursue a PhD in CS?
- f. What were the biggest barriers or challenges that you had to overcome in order to ultimately enter a CS PhD program?
  - i. Follow-up: What were the biggest supports or facilitators?

### 3. Social networks

- a. In general, how would you describe your social network?
  - i. Probes: size, supportiveness, geographic location, and so forth
- b. Are there any specific individuals who have supported you in your academic and professional life? Please explain who they are and how they have supported you.
- c. We are interested in supports you may have received including financial, emotional, or skills development. Does your family provide any of these or other supports in your pursuit of a PhD in CS? If yes, please describe the ways in which they support you.
  - i. Follow-up: Do your friends support your pursuit of a CS graduate degree? If yes, please describe the ways in which they support you.

- ii. Follow-up: Are you part of any formal organizations or programs that support your academic and professional pursuits? If yes, to what extent and in what ways do they support you?
- 4. Sense of belonging
  - a. How would you describe your community outside of your studies?
    - i. Follow-up: Outside of academic ones, what are the different groups or spaces that are important for your sense of community?
      - 1. Probes: religious community, family, friendships, and so forth
  - b. Do you feel a sense of community in your studies or academic life? Please explain.
    - i. Follow-up: What are the academic groups or spaces that are important for your sense of community?
  - c. To what extent is your academic community similar to your community outside of your studies? Please explain.
    - i. Follow-up: To what extent are you able to have discussions about computer sciences outside of academic and professional settings? Please provide some examples.
    - ii. Follow-up: To what extent are the skills you've acquired while studying CS (e.g., coding, logical, interpersonal) applicable outside of academic and professional settings?
    - iii. Follow-up: To what extent are the skills you've acquired outside of school (e.g., coding, logical, interpersonal) applicable in your academic and professional settings?
  - d. Describe your level of comfort or sense of belonging in your PhD program.
    - i. Follow-up: Is there any difference between your comfort and sense of belonging in academic versus nonacademic spaces? Why or why not?
  - e. What are some challenges that you feel you experienced in the CS field because of your gender, racial, or other identity?
    - i. Follow-up: How did you overcome those challenges, if any?
    - ii. Follow-up: Can you think of anyone in particular who helped you overcome those challenges? If so, please describe what they did or how they did it.
- 5. Mentorship
  - a. Whom would you currently describe as your mentor as you navigate your PhD program?
    - i. Probes: faculty, other graduate school students, program staff, and so forth

- ii. Follow-up: How would you describe the mentorship they provide?
    - 1. Probes: academic, career, socio-cultural, professional, and so forth
  - b. Beyond academic or professional support, do you have any mentors who you feel can understand or relate to you (i.e., how you identify, the community in which you grew up, and/or the experiences that you had)?
    - i. Follow-up: If so, can you describe this relationship and what it means to you?
    - ii. Follow-up: If not, do you feel that a lack of this kind of mentor has been a hindrance to you as you try to complete your degree?
    - iii. Follow-up: To what extent have you felt like these mentors have helped you navigate the culture of your PhD program?
  - c. Have you played a mentor role to another student who is pursuing a PhD in CS? If so, can you describe this experience?
    - i. Follow-up: Have you found yourself sharing your own experiences to help other students? If so, please describe this experience.
6. Aspirations
- a. What are your plans after you complete your PhD?
    - i. Follow-up: What is motivating you to pursue these plans?
    - ii. Follow-up: What barriers do you foresee in achieving these goals?
    - iii. Follow-up: What additional supports do you think would be helpful to achieve these goals?

## CS undergraduate students

### 1. Background

- a. Please introduce yourself by telling me your name, university, year, and your major.

### 2. Motivation to pursue CS program

- a. When were you initially introduced to CS as an area of study and potential career path?
  - i. Follow-up: How were you initially introduced to CS?
- b. How would you describe the level of exposure you had to CS growing up? For example, is it something you proactively sought out, or were information and resources about CS readily available to you where you grew up?
- c. Did you attend any CS programs (e.g., afterschool or summer programs) in K-12? If so, please describe them.
- d. What motivated you to major in CS?
- e. Thinking back to when you first became interested in CS, how would you describe the level of access you had to information and resources that were helpful to you as you considered majoring in CS?
- f. What were the biggest barriers or challenges that you've had to overcome in order to ultimately enter your CS undergraduate program?
  - i. Follow-up: What were the biggest supports or facilitators?

### 3. Social networks

- a. In general, how would you describe your social network?
  - i. Probes: size, supportiveness, geographic location, etc.
- b. Are there any specific individuals who have supported you in your academic life? Please explain who they are and how they supported you.
- c. We are interested in supports you may have received including financial, emotional, or skills development. Does your family provide any of these or other supports in your pursuit of a CS degree? If yes, please describe the ways in which they support you?
  - i. Follow-up: Do your friends support your pursuit of a CS graduate degree? If yes, please describe the ways in which they support you?
  - ii. Follow-up: Are you part of any formal organizations or programs that support your academic pursuits? If yes, to what extent and in what ways do they support you?

#### 4. Mentorship

- a. Whom would you currently describe as your mentor as you navigate the CS major?
  - i. Probes: faculty, other graduate school students, program staff, and so forth
  - ii. Follow-up: How would you describe the mentorship they provide?
    1. Probes: academic, career, socio-cultural, professional, and so forth
- b. Beyond academic or professional support, do you have any mentors who you feel can understand or relate to you (i.e., how you identify, the community in which you grew up, and/or the experiences that you had?)
  - i. Follow-up: If so, can you describe this relationship and what it means to you?
  - ii. Follow-up: If not, do you feel that a lack of this kind of mentor has been a hindrance to you as you try to complete your degree?
  - iii. Follow-up: To what extent have you felt that mentors have helped you navigate the culture of your CS program?
- c. Have you played a mentor role to another student who is pursuing a CS degree? If so, can you describe this experience?
  - i. Follow-up: Have you found yourself sharing your own experiences to help other students? If so, please describe this experience.

#### 5. What are your plans after you graduate?

- a. Follow-up: What is motivating you to pursue these plans?
- b. Follow-up: What barriers do you foresee in achieving these goals?
- c. Follow-up: What additional supports do you think would be helpful to achieve these goals?



## Postdoctorate students and recent graduates of CS PhD programs

1. Background
  - a. Please introduce yourself by telling me your name, title, and organization.
  - b. What graduate program did you attend?
2. Journey to CS program
  - a. When were you initially introduced to CS as an area of study and potential career path?
    - i. Follow-up: How were you initially introduced to CS?
  - b. How would you describe the level of exposure you had to CS growing up? For example, is it something you proactively sought out, or were information and resources about CS readily available to you where you grew up?
  - c. Did you attend any CS programs (e.g., afterschool or summer programs) in K–12 or during your undergraduate education? If so, please describe them.
  - d. What motivated you to pursue a graduate degree in CS?
  - e. Thinking back to when you first became interested in CS, how would you describe the level of access you had to information and resources that were helpful to you as you considered pursuing a graduate degree in CS?
  - f. What were the biggest barriers or challenges that you had to overcome in order to reach this stage in your career/studies in CS?
    - i. Follow-up: What were the biggest supports or facilitators?
3. Social networks
  - a. In general, how would you describe your social network?
    - i. Probes: size, supportiveness, geographic location, and so forth
  - b. Are there any specific individuals who have supported you in your academic and professional life? Please explain who they are and how they supported you.
  - c. We are interested in supports you may have received including financial, emotional, or skills development. Does your family provide any of these or other supports in your pursuit of a CS graduate degree? If yes, please describe the ways in which they support you.
    - i. Follow-up: Do your friends support your pursuit of a CS graduate degree? If yes, please describe the ways in which they support you?

- ii. Follow-up: Are you part of any formal organizations or programs that support your academic and professional pursuits? If yes, to what extent and in what ways do they support you?
4. Sense of belonging
- a. During your PhD studies, how would you describe your community outside of your studies?
    - i. Follow-up: Outside of academic ones, what were the different groups or spaces that were important for your sense of community?
      1. Probes: religious community, family, friendships, and so forth
  - b. Did you feel a sense of community in your studies or academic life? Please explain.
    - i. Follow-up: What were the academic groups or spaces that were important for your sense of community?
  - c. To what extent was your academic community similar to your community outside of your studies? Please explain.
    - i. Follow-up: To what extent were you able to have discussions about computer sciences outside of academic and professional settings? Please provide some examples.
    - ii. Follow-up: To what extent were the skills you've acquired while studying CS (e.g., coding, logical, interpersonal) applicable outside of academic and professional settings?
    - iii. Follow-up: To what extent were the skills you've acquired outside of school (e.g., coding, logical, interpersonal) applicable in your academic and professional settings?
  - d. Describe your level of comfort or sense of belonging over the course of your PhD studies.
    - i. Follow-up: Was there any difference between your comfort and sense of belonging in academic versus nonacademic spaces? Why or why not?
  - e. What are some challenges that you feel you experienced in the CS field because of your gender, racial, or other identity?
    - i. Follow-up: How did you overcome those challenges, if any?
    - ii. Follow-up: Can you think of anyone in particular who helped you overcome those challenges? If so, please describe what they did or how they did it.

## 5. Mentorship

- a. Who were your mentors as you navigated your PhD program?
  - i. Probes: faculty, other graduate school students, program staff, and so forth
  - ii. Follow-up: How would you describe the mentorship they provide?
    1. Probes: academic, career, socio-cultural, professional, and so forth
- b. Beyond academic or professional support, did you have any mentors who you felt understood or related to you (i.e., how you identify, the community in which you grew up, and/or the experiences that you had?)
  - i. Follow-up: If so, can you describe this relationship and what it meant to you?
  - ii. Follow-up: If not, do you feel that a lack of this kind of mentor was a hindrance to you as you tried to complete your degree?
  - iii. Follow-up: To what extent did you feel these mentors helped you navigate the culture of your CS graduate degree program?
- c. Have you played a mentor role to another student who was pursuing a PhD or graduate degree in CS? If so, can you describe this experience?
  - i. Follow-up: Have you found yourself sharing your own experiences to help other students? If so, please describe this experience.

## 6. Transition

- a. Describe what the transition was like after you completed your PhD to where you are now.
  - i. Follow-up: Did you experience any barriers in making this transition?
  - ii. Follow-up: What supports were important as you made this transition?

## Faculty and other mentors

Notes:

- *This protocol is modeled after an oral history approach. Prior to the interview, the interviewer should encourage participants to share stories and examples as they come to mind, guiding them to a more narrative interview. If possible, interviewers should build rapport with the interviewees and be familiar with their backgrounds prior to the interviews.*
- *Follow-up questions (a, b, c . . .) are only meant to be asked if the respondent needs probing and if relevant to the respondent's experiences. Ideally, respondents will speak narratively about their experiences without much probing.*
- *Per best practice in oral history, the tool starts with broader questions and proceeds to more provocative and thoughtful questions.*
- *Interviews may require between 45 and 90 minutes.*

### Early life

1. Can you tell me a little about how you grew up?
  - a. Probe (as appropriate) topics of family, community, spiritual beliefs, extracurriculars, and so forth
2. How did you become interested in CS?
  - a. Who, if anyone, inspired your interest in computer science?
  - b. What types of activities were you involved in during these years that motivated your interest in the field?
  - c. How did your family encourage your interest in computer science?

### Education and career

1. Tell me about your journey through school and higher education, specifically (where attended, how it was, etc.).
  - a. What kind of student were you?
  - b. What part of your education was most beneficial to your career?
  - c. How did your education shape your professional journey?
2. How did you come to your current role?
  - a. What led you to your first job?
  - b. If relevant: What led you to change positions/jobs at different points in your career?

- c. What moments in your life stand out as life-changing or critical moments in your career?
3. Were there any individuals or communities that were important to your educational or professional success?

*Interviewer: Be sure to probe for examples in the next two sections.*

### ***Personal experiences with obstacles***

1. What are the main obstacles or challenges you've encountered throughout your education and career?
  - a. Was there any time when you doubted yourself and/or your work?
  - b. Have you experienced discrimination during your career in CS?
2. How did you respond to obstacles and/or discrimination throughout your career?
  - a. Were there any individuals or communities that were important to your ability to cope with and/or overcome these obstacles?

### ***Reflections on mentorship/cultural brokerage***

1. Can you briefly describe an average day in your current role?
2. In your role, how do you generally interact with CS students and early-career professionals?
  - a. Tell me about some of the most challenging and/or rewarding moments you've experienced while working with CS students and young professionals.
3. What are the factors that allow young people to succeed in the CS field? What are the factors that keep them from succeeding?
  - a. More particularly, what factors have you seen preventing Black and African American students from succeeding in CS programs?
  - b. Would you describe key barriers to and facilitators of success as academic or nonacademic in nature?
4. Please tell me about a time when you helped mentor or advance the studies/career of a young person in CS.
  - a. How did you decide to approach this person?
  - b. How did your relationship with them develop? What was the outcome?
  - c. What lessons did you learn from this experience or from other experiences of supporting students/young professionals in CS?

5. To what extent do you think your experiences can help someone pursuing a postgraduate degree in computer science?
  - a. Beyond the resources/experiences you can offer, what else do CS students and young professionals—particularly those who identify as Black and African American—need to excel in this field?
6. If you were to change positions or retire, how would you like your students and colleagues to remember you?
7. How has the computer science field changed over the course of your career?
  - a. How do you hope the CS field will change in the future?
  - b. How can the CS field develop to better support Black and African American students/young professionals?

### ***Conclusion***

1. Is there anything that you would like to add?
2. Are there any other questions I should have asked you but didn't?

## Appendix B. IAAMCS Qualitative Codebook

Code	Description
<b>0_Global codes</b>	
0.1 CS Background	Descriptions of their personal upbringing as it relates to the congruence or dissonance with CS or science culture <b>(Note: Always double code this node.)</b>
0.1.1 Congruence	Respondents' background and/or upbringing consistent with the culture science and/or CS <b>(Note: Always double code this node.)</b>
0.1.2 Dissonance	Respondents' background and/or upbringing inconsistent with the culture science and/or CS <b>(Note: Always double code this node.)</b>
0.2 Educational journey	Respondents' educational background, including previous and current institutions <b>(Note: Always double code this node.)</b>
0.2.1 PWI	Respondents' educational background predominantly PWIs
0.2.2 MSI/HBCU	Respondents' educational background is predominantly MSIs/HBCUs
0.2.3 Other (e.g., international)	Respondents' educational background predominantly non-U.S.-based schools/institutions
0.3 Cultural border crossing	Descriptions of respondents' adjusting, navigating, and/or adapting to their CS programs <b>(Note: Always double code this node.)</b>
<b>1_Background</b>	
1.1 Student	Student's name, institution, year, and/or program, along with any other background information (undergraduate, master's, and PhD students)
1.2 Postgrad	Postgrad's name, company, educational institution and/or title, along with any other background information
1.3 Mentor	Mentor's name, institution, and/or title, along with any other background information
<b>2_Journey to CS program</b>	
2.1 Early exposure to CS	Initial and/or early exposure to CS as an area of study and potential career path
2.1.1. Access to CS resources	The level of exposure or access to CS information and resources respondents had growing up (refers to the years preceding their current degree program)
2.2 Motivation to pursue CS degree	Respondents' motivations to pursue their current degrees
2.3 Past barriers	Barriers that respondents experienced in their academic journeys <i>before</i> their current degree program
2.4 Past supports	Supports that respondents relied on in their academic journeys <i>before</i> their current degree program

Code	Description
<b>3_Social Networks</b>	
3.1 Academic and professional supports	Parent node; descriptions of academic and professional supports respondents received through their social networks (Code in the appropriate child node, below.)
3.1.1 Family	Description of networks with primarily family and the academic supports they provide
3.1.2 Friends	Description of network with primarily friends and the academic supports they provide; differentiated from their classmates/peers (If respondent talks about how their peers are mainly their friends, code below in 3.1.3.)
3.1.3 Peers	Description of network with primarily peers and the academic supports they provide (i.e., lab, cohort, program, etc.)
3.1.4 Other	Description of other networks that have not been listed above and the academic supports they provide
3.2 Nonacademic supports	Parent node. Descriptions of non-academic supports respondents received through their social networks. Code in the appropriate child node below.
3.2.1 Family	Description of networks with primarily family and the non-academic supports they provide
3.2.2 Friends	Description of network with primarily friends and the nonacademic supports they provide; differentiated from their classmates/peers (If respondent talks about how their peers are mainly their friends, code below in 3.1.3.)
3.2.3 Peers	Description of network with primarily peers and the nonacademic supports they provide (i.e., lab, cohort, program, etc.)
3.2.4 Religious	Description of networks that are primarily religious in nature and the nonacademic supports they provide
3.2.5 Other	Description of other networks that have not been listed above and the nonacademic supports they provide
<b>4_Sense of belonging</b>	
4.1 Community alignment	Descriptions related to the extent that respondents' academic community aligns with their nonacademic community
4.2 Sense of belonging	Respondents' comfort or sense of belonging in their CS program
4.2.1 Imposter syndrome	Any description related to students' feeling they don't belong in the CS program
4.5 Challenges related to identity	Descriptions of any challenges respondents have had to confront or overcome in their CS program related to their racial, gender, or other dimension of identity



Code	Description
4.5.1 Supports for these challenges	Sources of support that respondents received related specifically to identity-based challenges (i.e., individuals who have been helpful, etc.)
4.5.2 Nonidentity-related challenges	Other challenges that respondents faced not related to identity
<b>5_Mentorship</b>	
5.1 Description of mentor	General description of whom respondents consider to be their mentors
5.2 Type of mentorship received	Parent node; categorization of the type of mentorship respondents received (Code in the child node as appropriate.)
5.2.1 Academic	Primarily academic mentorship
5.2.2 Professional	Primarily professional mentorship
5.2.3 Socioemotional	Primarily socioemotional mentorship
5.2.4 Other	Some other form of mentorship
5.3 Relational mentorship	Description of mentorship in which respondents felt understood at a personal level (i.e., how they identify, the communities and backgrounds in which they grew up, the experiences they had, etc.)
5.3.1 Desire for relational mentor	Respondent without a mentor they can relate to on a personal level; but description in hypothetical or aspirational terms what a mentor like this would mean to them
5.4 No mentorship	Respondent without have any mentors
5.5 Mentorship provided	Experiences that respondents have had in providing mentorship to others, including the extent to which they share their personal experiences to help other students
<b>6_Aspirations</b>	
6.1 Plans for the future	Respondents' plans for after they complete their current degree or career stage
6.1.1 Motivations	Motivations for pursuing their stated plans
6.3 Barriers	Barriers that respondents foresee in pursuing their goals
6.4 Supports	The additional supports that respondents think they will need to achieve their goals
<b>7_Transition (Note: Only use this code for postgrad, postdoc, and mentors interviews.)</b>	
7.1 Transition description	Descriptions of the respondent's transition after they completed their PhD
7.2 Barriers	Barriers experienced during this transition period

Code	Description
7.3 Supports	Supports that respondents considered important in making the post-PhD transition
<b>8_Early life (Note: Only use this code for mentors interviews.)</b>	
8.1 Upbringing	Descriptions of mentors' early life and upbringing
8.2 Initial interest in CS	Mentors' initial interest in CS
<b>9_Education and career (Note: Only use this code for mentors interviews.)</b>	
9.1 Educational journey	Mentors' educational journey
9.2 Current role	Descriptions of the way mentors ended up in their current role, including key moments in their journey
9.3 Contributors to success	Individuals or communities that were instrumental in mentors' educational or professional success
<b>10_Personal experience with obstacles (Note: Only use this code for mentors interviews.)</b>	
10.1 Key challenges	Main obstacles or challenges that mentors experienced in their education and/or career
10.2 Coping strategies	Descriptions of the ways mentors responded to obstacles and/or discrimination throughout their careers, including descriptions of individuals or communities that helped them cope
<b>11_Mentorship and cultural brokerage (Note: Only use this code for mentors interviews.)</b>	
11.1 General interactions with CS students	Descriptions of general interactions that mentors have had with their CS students and early-career professionals, including examples of the most challenging and rewarding moments they may have experienced
11.2 Specific examples of mentorship	Specific examples of a time when mentors have helped advance the studies/careers of a young person in CS, including key lessons learned
11.3 Success factors for CS students	Mentors' perspectives on the key factors that enable young people to succeed in the CS field
11.4 Key barriers for CS students	Mentors' perspectives on the key barriers that inhibit Black and African American students from succeeding CS programs
11.5 Use of personal experience or identity in mentorship	The extent to which mentors tap into their own experiences and/or identity to mentor students

Code	Description
11.6 How mentors would like to be remembered	The way mentors might like to be remembered by their students or colleagues if they were to change positions or retire
11.7 Changes in the CS field	Mentors' perspectives on the way the CS field has changed over the course of their careers
11.8 Supports needed for Black and AA CS students	Mentors' perspectives on the way the CS field can develop or better support Black and African American students and young professionals
<b>12. Not sure where to code? Anything you're not sure of that you'd like to discuss?</b>	

## About the American Institutes for Research®

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