

## **Examining Psychological and Social Factors That Impact the Experiences and Representation of Black Women in Computer Science (A Case Study)**

**Dr. Edward Dillon, Morgan State University**

Dr. Dillon received his B.A. in Computer and Informational Science from the University of Mississippi in 2007. He would go on to obtain his Masters and Ph.D. in Computer Science from the University of Alabama in 2009 and 2012, respectively. Dr. Dillon is a newly tenured Associate Professor in the Department of Computer Science at Morgan State University. Prior to his arrival to Morgan State, Dr. Dillon served as a Computer Science Instructor at Jackson State University (2012-2013), and a Postdoctoral Researcher at Clemson University (2013-2014) and the University of Florida (2014-2016). His research focuses on human-centered computing, computer science education, social computing, and broadening participation in computing. Dr. Dillon has received >\$750k in research funding and awards from external agencies and non-profit organizations, including the National Science Foundation (NSF), the Maryland Pre-Service Computer Science Teacher Education Program (MCCE), and the Collaborative Research Experience for Undergraduates (CREU - CRA-WP). Dr. Dillon currently serves as a Co-PI for the STARS Computing Corps, which recently has been renewed for funding by NSF. He has also conducted a Faculty in Residency at Google during the summer of 2018 to learn more about this company's culture, practices, and to understand the expectations for candidates (e.g. aspiring CS majors) who pursue career opportunities at this company and related prominent companies in tech.

**Theodore Wimberly Jr.**

**Mariah McMichael**

**Miss Lauren Brown, Morgan State University**

Lauren Brown is a Morgan State University Research Assistant majoring in Computer Science.

**Abigail Dina**

**Krystal L. Williams, University of Georgia**

# **Examining Psychological and Social Factors that Impact the Experiences and Representation of Black Women in Computer Science (A Case Study)**

## **Abstract:**

As technology continues to evolve and spaces in the field of Computer Science (CS) are expanding, the promotion of equity, inclusion, and representation for all need to reflect this evolution and expansion. Even though efforts have been made to address such challenges for women and minorities in CS, more work needs to be done. This is especially the case for black women, who account for less than 3% of the tech workforce. As Computer Scientists, black women face regular affronts to their character and capabilities because of their race and gender. While the combination of racial and gender discrimination have spanned over decades for black women in CS, the tech industry, and related spaces, efforts regarding their equity, inclusion, and overall representation in these areas need to be addressed more. In recent years, there has been a rise of college-to-company pipeline initiatives with the purpose of increasing the disproportionately under-representation of black women in tech. However, there has only been a slight increase in the representation of black women in tech from these initiatives, which still indicate an insufficient level of their representation in tech.

The objective of this research is to examine critical factors that impact the representation of black women in CS. To look at such factors directly, this article discusses a case-study consisting of a series of focus groups conducted on 24 black women, who were either current CS majors or recent graduates/new professionals in CS. Both groups of women were from the same Historically Black University in the Mid-Atlantic United States. The questions asked during these focus groups covered topics such as: established identity in CS with themselves and others, personal experiences and challenges as a black woman in CS that are gender and/or race related, psycho-social characteristics experienced (e.g. imposter syndrome and confidence), and personal feedback/recommendations for promoting equity, inclusion, and representation of black women in CS. Key results revealed that the majority of these women exhibited an identity with CS. Yet, the majority of them also noted a lack of confidence and exhibiting imposter syndrome as part of their CS experiences. Overall, this research and case study contribute to the attention needed to address equity, inclusion, and representation challenges of black women in CS by highlighting issues faced when trying to develop and establish themselves in the field.

## **1. Introduction**

The field of computer science (CS) has grown rapidly in recent years. Despite this progress, disparities in the industry persist, particularly for individuals from underrepresented groups. For instance, black women, who pursue CS as a career choice, experience significant underrepresentation in the field. This underrepresentation is also reflected in the percentages of black women who are awarded Bachelor's, Master's, or their Doctorate in CS and related fields

[12]. By examining challenges faced by black women as they matriculate through a computational curriculum, pursue tech-based career opportunities, and seek to establish themselves as prominent practitioners in the field of computing, we can begin to understand how such challenges can be addressed. Due to the overall nature of CS and its potential to provide spaces that promote inclusion for all [3, 4], it is possible that black women (and other underrepresented groups alike) can make impactful contributions to the field and society at large.

This article aims to provide a deeper understanding of the experiences of black women firsthand in CS as majors and practitioners. Overall, this work aims to contribute to the gap in current literature that emphasizes underrepresentation at the intersection of both race and gender. This work is a crucial step towards creating a more diverse and inclusive CS community with the intent to serve as a valuable resource for educators, and industry leaders within the field.

## **2. Literature Review**

The intersection of race and gender has a significant impact on black women's experiences in the computer science field. While the combination of racial and gender discrimination that black women face in CS professions has spanned over decades, the issue has begun to receive much needed attention. Ignoring this intersection can lead to an incomplete understanding of the challenges imposed on black women who pursue CS as a career choice. Research has shown that recent efforts to increase the number of women in CS do not fully consider the impact of intersecting identities, such as race and ethnicity, on the experiences of black women, and thus, fail to recruit black women effectively [8]. This literature review aims to highlight influential factors that have impacted the representation of black women in computer science. Moreover, this review synthesizes existing literature that call attention to the underrepresentation from the aspect of race and gender, with a focus on how these intersecting identities shape the experiences of black women.

### **2.1 Black Women Representation - Field of Computing**

To gain insight into the issue of underrepresentation in the computing industry, it is essential to consider the extent to which black women are underrepresented in the field. The Taulbee Survey is an annual study conducted by the Computing Research Association that provides a comprehensive view of the demographic make-up of individuals pursuing degrees in computing-related fields, including computer science, computer engineering, and information [12]. This survey considers enrollment rates and the number of degrees awarded in these fields to give a precise depiction of the higher-education computing landscape.

According to the data from the most recent 2021 Taulbee Survey, black women make up approximately 7.7% of the Bachelor's, 2.3% of the Master's, and 3.9% of the Doctorate degrees awarded within the computing field recently [12]. Even though this current data shows a slight

increase in degrees awarded to black women in comparison to past Taulbee surveys, there is still more work to be done. In 2005, black women accounted for only 0.6% of graduations in computing [7], and by 2012, this number had barely risen to 1.0% [7]. This suggests that there has been small progress in the graduation rate of black women in computing.

Black women are vastly underrepresented in both the academic and professional computing communities. A 2020 report from the United Negro College Fund revealed that Black women account for only 3% of the tech workforce and hold even fewer leadership positions in Silicon Valley (less than 0.5%) [11]. This low representation, especially in positions of leadership, limits their voice within the industry, which further perpetuates the challenges they encounter. Moreover, even when women in these positions speak out about their grievances, they may not receive the necessary support for change. Unfortunately, black women who express concerns about race in tech may face misogynoir when their experiences are overlooked or dismissed in a white-male centered environment [6].

When placing further emphasis on the racial and gender challenges that black women face in CS, prior literature has noted both dynamics to be prevalent barriers. Stigmas and perceived assumptions that CS is primarily suitable for their Caucasian and Asian counterparts has been noted as one barrier [10]. A related barrier is the perception that CS is a male-centered field altogether [5, 8]. Other literature suggests that such perceptions and stigmas about CS plays an integral role in overall representation [1].

### **3. Methodology**

The methodology of this research was designed to provide a comprehensive understanding of the experiences of black women in the computer science field. This was accomplished through the combination of surveys and focus group interviews with a sample of 24 participants who self-identified as black women pursuing a computer science degree or working in the computer science field as a practitioner. The participants were recruited through online platforms such as *email*, *LinkedIn*, and *GroupMe* to ensure a diverse sample of black women from different backgrounds and experiences.

The scheduling of the interviews was based on the participants' availability, with each focus group consisting of 2 to 4 people. The platform *Doodle* was used to coordinate the meeting times, and the focus groups were conducted via the *Zoom Video/Web Conferencing System* to allow for a convenient and accessible way for the participants to share their experiences. The use of focus groups allowed for a more in-depth examination of the experiences of black women in the computer science field and provided a platform for participants to discuss their experiences with others who faced similar challenges.

### **3.1 Survey**

Using *SurveyMonkey*, a pre-survey was administered prior to the focus group sessions, and consisted of both closed and open-ended questions to gauge the participants' feedback about their experiences in CS. Key questions were asked to acquire information pertaining to their identity as computer scientists, the challenges and barriers they have faced, and their experiences with imposter syndrome and confidence. The questions were carefully crafted to provide a nuanced and comprehensive examination of the experiences of black women in the computer science field. The use of closed-ended questions allowed for quantifiable data to be collected, while open-ended questions allowed for a more in-depth examination of the participants' experiences.

### **3.2 Focus Group Sessions**

Aforementioned, each focus group session comprised 2 to 4 participants at a time. These sessions lasted roughly 45 minutes to 75 minutes based on the amount of feedback given by the participants. Each session was recorded and sent to *Rev.com* for transcription, after which the transcriptions were analyzed using both quantitative and qualitative methods. The use of sentiment analysis allowed for an examination of the participants' experiences through the lens of positive or negative emotions and provided a more comprehensive understanding of the challenges and barriers faced by black women in the computer science field. Scaling from 0 to 5 allowed for a quantifiable examination of the participants' experiences and allowed for the identification of common challenges and barriers faced by black women in the field.

## **4. Results**

The data reported in this section strictly reflect key findings that were acquired during the focus group sessions (and not the pre-survey). These findings are classified below as subtopics:

- 1. Established identity in CS with themselves and others.*
- 2. Personal experiences and challenges in CS that are gender and/or race related.*
- 3. Psycho-social characteristics experienced.*
- 4. Personal feedback/recommendations for promoting equity, inclusion, and representation of black women in CS.*

Each subtopic and corresponding findings are discussed below.

### **4.1 Established Identity in CS with Themselves & Others**

Findings for this classification were based on five key questions that were asked during the focus group sessions:

- Q1: Do the participant(s) exhibit an identity towards computer science?*  
*Q2: Do the participant(s) consider themselves as computer scientists?*  
*Q3: Are they proud to be a computer scientist?*  
*Q4: Is being a computer scientist an important reflection of who they are?*  
*Q5: Do they feel a strong tie to other computer scientists in this discipline?*

The participants' responses to these questions were quantified into either *Yes*, *No*, or *Maybe*. Table 1 provides descriptive analysis pertaining to the participants' responses to each of these five questions.

Table 1: Example Factors that Foster Identity in CS

<b>Asked Questions</b>	<b>Results (N=24)</b>
<i>Q1: Do the participant(s) exhibit an <u>identity</u> towards computer science?</i>	<i>Yes: 68%</i> <i>No: 32%</i>
<i>Q2: Do the participant(s) consider themselves as computer scientists?</i>	<i>Yes: 65%</i> <i>Maybe: 13%</i> <i>No: 22%</i>
<i>Q3: Are they proud to be a computer scientist?</i>	<i>Yes: 88%</i> <i>No: 12%</i>
<i>Q4: Is being a computer scientist an important reflection of who they are?</i>	<i>Yes: 67%</i> <i>Maybe: 20%</i> <i>No: 13%</i>
<i>Q5: Do they feel a strong tie to other computer scientists in this discipline?</i>	<i>Yes: 50%</i> <i>Maybe: 12%</i> <i>No: 38%</i>

As noted in Table 1, the majority of these participants, identified with computer science in some capacity (68%), considered themselves as computer scientists (65%), were proud to be computer scientists (88%), and noted that being a computer scientist is a reflection of who they are (67%). Yet, only 50% of the participants felt a strong tie to other computer scientists in the discipline.

#### **4.2 Personal Experiences & Challenges in CS that are Gender and/or Race Related**

During the focus groups sessions, participants were asked about personal experiences and challenges as being black women in CS. This was comprised of three questions that captured general challenges, gender-related challenges, and race-related challenges:

- Q1: What are some challenges you face in Computing?*

*Q2: Do you feel that these challenges are gender-related?*

*Q3: Do you feel that these challenges are race-related?*

Q1 was asked as an open-ended question. The participants' responses were categorized, using document analysis [2], into themes that provide a consensus of what the group noted as typical challenges. Qs 2 & 3, respectively, were quantified into *Yes*, *No*, or *Maybe* based on the responses given to either question. Table 2 provides descriptive analysis pertaining to the participants' responses to each of these three questions.

Table 2: Perceived Challenges in Computing

Asked Questions	Results (N=24)
Q1: <i>What are some challenges you face in Computing?</i>	<i>Competence/Perfection: 50%</i> <i>Confidence: 25%</i> <i>Focus: 4%</i> <i>Invisibility/Isolation: 17%</i> <i>No Challenges: 4%</i>
Q2: <i>Do you feel that these challenges are gender-related?</i>	<i>Yes: 50%</i> <i>No: 50%</i>
Q3: <i>Do you feel that these challenges are race-related?</i>	<i>Yes: 42%</i> <i>Maybe: 4%</i> <i>No: 50%</i> <i>N/A: 4%</i>

The data revealed 50% of the participants believed the lack of necessary competence and even perfection in their computation skills were challenges they faced in the field. There were 25% participants who also felt that inner confidence deficiencies are another challenge experienced. When emphasizing personal challenges pertaining to gender and race, respectively, it was found that 50% believe that some of their challenges were gender-related while only 42% noted that some of their challenges were race-related.

### 4.3 Psycho-Social Characteristics Experienced

Questions surrounding *imposter syndrome* and *inner confidence* were asked to gauge certain aspects of psycho-social characteristics that these participants potentially exhibited during their experiences in CS:

*Q1: Did the participant(s) note experiences with **imposter syndrome** as a CS major/practitioner?*

*Q2: Did the participant(s) note struggles with **confidence**?*

The participants' responses to these questions were quantified into *Yes*, *No*, or *Maybe*. Table 3 provides descriptive analysis pertaining to the participants' responses to each of these two questions. It was found that the majority of these participants experienced imposter syndrome (92%) and struggled with inner confidence (95%) as a CS major/practitioner.

Table 3: Psycho-Social Characteristics

Asked Questions	Results (N=24)
Q1: <i>Did the participant(s) note experiences with <b>imposter syndrome</b> as a CS major/practitioner?</i>	Yes: 92% Maybe: 4% No: 4%
Q2: <i>Did the participant(s) note struggles with <b>confidence</b>?</i>	Yes: 95% No: 5%

#### 4.4 Personal Feedback/Recommendations for Promoting Equity, Inclusion, & Representation of Black Women in CS

To conclude each focus group session, two questions were asked to each participant to gather feedback and/or recommendations about ways to promote equity, inclusion, and representation of black women in CS:

*Q1: What is some advice you would give to other black women entering the computing field?*

*Q2: If there is something you could change about your current workplace, department, circles, etc. to make it a better experience for black women in computing what would it be?*

Both questions were open-ended, thus the participants' responses were categorized, using document analysis, into themes that provide a consensus reflecting their feedback/recommendations. For Q1, some of the participants' responses were directly categorized using *Confidence*, *Knowledge*, *Mentorship & Support*, or *Being Proactive* as the themes, while other responses were categorized as overlapping between multiple themes (or *Overlapping Themes*). Half of these participants' responses were categorized using the theme *Confidence* since their feedback reflected acts of encouragement to future black women who aspire to become computer scientists. This encouragement also addressed the need for confidence to play a crucial role in their career pursuits. Other responses (17%) were categorized as *Mentorship & Support*, which reflected the belief that mentorship and support systems are beneficial for black women who pursue CS as a career choice. The overlapping themes were *Knowledge/Confidence*, *Mentorship & Support/Knowledge*, and *Mentorship &*



*Support/Confidence*, 21% of the participants feedback were categorized with having one of these overlapping themes.

For Q2, some of the participants’ responses were directly categorized using *Mentorship & Support*, *Knowledge & Opportunities*, and *Increased Representation* as the themes, other responses were labeled as overlapping themes, and a small subset of responses were noted as *N/A*. A slight majority of the participants’ responses (25%) were categorized as *Increased Representation*, which reflect their belief that increased representation of black women in faculty, administrative, managerial, and related positions of leadership in CS would foster better experience for other black women in computing. Similar to Q1, *Mentorship & Support* was also found to be contributory feedback given by the participants (21%). The overlapping theme was *Knowledge & Opportunities/Increase Representation*, 21% of the participants’ feedback were categorized with this overlapping theme.

Table 4 provides descriptive analysis pertaining to the participants’ responses to each of these two questions:

Table 4: Personal Feedback & Recommendations

Asked Questions	Results (N=24)
Q1: <i>What is some advice you would give to other black women entering the computing field?</i>	<i>Confidence: 50%</i> <i>Knowledge: 8%</i> <i>Mentorship &amp; Support: 17%</i> <i>Being Proactive: 4%</i> <i>Overlapping Themes: 21%</i>
Q2: <i>If there is something you could change about your current workplace, department, circles, etc. to make it a better experience for black women in computing what would it be?</i>	<i>Mentorship &amp; Support: 21%</i> <i>Knowledge &amp; Opportunities: 17%</i> <i>Increased Representation: 25%</i> <i>Overlapping Theme: 21%</i> <i>N/A: 17%</i>

## 5. Discussion

From these focus group discussions, it was collectively found that these 24 participants tended to identify with CS in a variety of ways. Yet, most of them are not able to relate to other computer scientists in the field. This particular finding suggests that environments or cultural dynamics within the field of CS may not be equitable or inclusive to black women. Moreover, the fact that an overwhelming majority of these participants experience imposter syndrome and struggle with their inner confidence further challenges their sense of belonging in the field, which could play an integral role in their overall representation in CS.

Challenges that black women face are uniquely different from other groups due to the fact that they reside in the middle of the intersection of race, gender, and in some cases class. This unique dynamic may be indicative for why 50% of the participants feel pressure to show adequate competency and perfection in these settings. Being one of very few on team projects and related interactions, or feeling immediate isolation and invisibility from their male counterparts could warrant the imposed pressure to exhibit perfection and adequate competency in such settings. Establishing mentorships and support systems may assist in combating some of the challenges faced by black women in CS. Many participants alluded to this in some capacity when inquired about the advice they would give to future constituents entering the field. This feedback was also noted when prompted to discuss ways to improve the experiences for black women in CS.

## **6. Threats to Validity/Limitations and Assumptions**

One potential threat to the validity of this study was the small sample size of 24 participants. A larger sample size would be necessary to generalize the findings to a larger population. The more perspectives inquired by black women in this type of study would allow for an increased understanding of their experiences and challenges in CS. Moreover, all 24 participants are associated with the same institution. This is a related threat to validity. Examining black women from a variety of institutions could control for environmental and cultural dynamics at a given institution that may also influence their responses to the questions asked during these focus groups.

Another threat to validity relates to the underlying influences and pressures when being interviewed concurrently with other participants. The focus group format alone may have influenced the participants' responses during this study based on social desirability bias. For instance, it is possible that some participants may have provided feedback to questions they perceived as desirable by other members in their particular focus group, rather than expressing their true opinions.

The identities of the parties present in these focus group sessions pose another threat to validity. Majority of the focus groups were moderated by a black male professor in the computer science department at this Historically Black University. There is a possibility that the participants were not as candid with their responses due to the underlying factor of a male presence in the interview space.

Another threat to validity reflects the level of experiences these participants possessed in the field of CS during the time of this study. The participants were either undergraduates or recent graduates from the same Historically Black University. Thus, the acquired feedback from this study only provides preliminary insight to the experiences of black women in the computer science field over the past 1-6 years. Therefore, the necessity of recruiting well-established black

women CS professionals for this study could foster more in-depth experiences and deeper perspectives due their longer tenure in the CS field.

## **7. Conclusion & Future Work**

When it comes to diversity, equity, and inclusion in the field of CS (and related STEM fields), the representation of black women is important. Factors such as imposter syndrome and inner confidence issues could play a critical role in their low representation. This study showed a potential for black women to effectively identify with CS. One reason could be due to the nature of CS and the variety of spaces it provides to accommodate one's interest. Moreover, establishing settings in CS that foster the equity and inclusion of black women may be vital to improve representation. Aforementioned, support systems and mentorship opportunities could assist in this effort, which could promote increased representation of black women in administrative, managerial, and related positions of leadership in CS that could further motivate younger black women to aspire to pursue careers in this field.

To expand upon this study, it is the plan to explore specific problems and hurdles that racial, institutional, educational, and recruitment bias in tech impose on black women in computer science. This future work will also examine geographical, environmental, and cultural factors that may influence the perceptions of black women in the tech industry.

From an assessment standpoint, it is the plan to employ additional approaches for collecting data such as forming an in-person focus groups and/or one-on-one interviews. The use of either in-person focus groups or one-on-one interviews, respectively, could help the participants freely voice their opinions more (and alleviate instances of social desirability bias). Another addition to this study will be to include a male control group. Having a control group comprised of male CS majors and professionals will enable comparative analysis to further explore discrepancies within the data pertaining to perceptions of imposter syndrome, confidence, and identity that potentially impact the representation of black women in computer science.

### **Acknowledgements:**

This current work is funded by the National Science Foundation (award no. *NSF-EDU 2011793*) and the National Institute of Health (award no. *NIGMS-RISE 5R25GM0058904*).

### **References:**

- [1] S. Beyer. "Why are women underrepresented in computer science? gender differences in stereotypes, self-efficacy, values, and interests and predictors of future cs course-taking and grades." *Computer Science Education*, 24(2-3), 2014, pp. 153–192.

- [2] G. A. Bowen. "Document analysis as a qualitative research method." *Qualitative research Journal*, 9(2):27, 2009, pp. 27-40.
- [3] CSforAll.org. "CS for All." <https://www.csforall.org/>. (Retrieved February 28, 2023).
- [4] E. Dillon and K. L. Williams. Course content as a tool of inclusivity for Black/African-American women in computing. *Journal of Computing Sciences in Colleges*, 36(3), 2020. pp. 151-160.
- [5] J. S. Eccles, J. E. Jacobs, and R. D. Harold. "Gender role stereotypes, expectancy effects, and parents' socialization of gender differences." *Journal of Social Issues*, 46(2), 1990, pp. 183-201.
- [6] J. Kwarteng, S.C. Perfumi, T. Farrell, and M. Fernandez. "Misogynoir: public online response towards self-reported misogynoir." In *Proceedings of the 2021 IEEE/ACM international conference on advances in social networks analysis and mining*, 2021, pp. 228-235.
- [7] S. Lunn, L. Zahedi, M. Ross, and M. Ohland. "Exploration of intersectionality and computer science demographics: Understanding the historical context of shifts in participation." *ACM Transactions on Computing Education (TOCE)*, 21(2), 2021, pp. 1-30.
- [8] Y. A. Rankin, J.O. Thomas, E. S. "Black women speak: Examining power, privilege, and identity in CS education." *ACM Transactions on Computing Education (TOCE)*, 21(4), 2021 pp. 1-31.
- [9] M. Sadker and D. Sadker. *Failing at fairness: How America's schools cheat girls*. Simon and Schuster, 2010.
- [10] J. Steinke, M. K. Lapinski, N. Crocker, A. Zietsman-Thomas, Y. Williams, S. H. Evergreen, and S. Kuchibhotla. "Assessing media influences on middle school-aged children's perceptions of women in science using the Draw-A-Scientist Test (DAST)." *Science Communication*, 29(1), 2007, pp. 35-64.
- [11] UNCF.org. "Black Females Moving Forward in Computing Program Launched." <https://uncf.org/annual-report-2020/black-females-moving-forward-in-computing>. (Retrieved February 27, 2023).
- [12] S. Zweben, and B. Bizot. "Taulbee survey: CS Enrollment Grows at All Degree Levels, With Increased Gender Diversity." *Computing Research Association*, 2021.