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Forging STEM Pathways for Black Girls: An Exploratory Analysis of High School, College, and Career Trends

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ABSTRACT

The purpose of this article is to characterize the science, technology, engineering, and mathematics (STEM) pipeline for Black adolescent female students by reviewing trends in (1) Advanced Placement (AP) test performance, (2) college enrollment decisions, (3) degree attainment, and (4) early career choices. This article examined quantitative trends across these four transition points in the STEM pipeline to inform the academic preparation of Black girls for success in postsecondary STEM endeavors. The findings from this review indicate that AP test participation and success often mirror Black female student STEM college major decisions. Yet, early STEM employment trends indicate many nuances that warrant further investigation. The theoretical and practical contributions of these data are noteworthy, given that the data presented are often alluded to but have yet to be synthesized and presented in a manner that informs practice. Based on these data, we provide recommendations for identifying, preparing, mentoring, and retaining Black women and girls in STEM.

Keywords: equity, diversity, Black adolescent girls, STEM, degree attainment, career interest

Introduction

Black girls have the potential to take advantage of STEM pathways to enter the Science, Technology, Engineering, and Mathematics (STEM) workforce. However, the empirical stories of academically advanced Black girls parallel their underrepresentation in advanced mathematics and science classrooms as well as in STEM professions (Collins et al., 2020). The existence of Black women within two traditionally underrepresented groups (i.e., Black and female) creates unique challenges and opportunities for their entrance into the STEM workforce. However, their potential cannot be realized until we better understand the STEM pathways Black girls take through K-12 and post-secondary schools. Due to a longstanding emphasis on the racial and gender achievement gaps throughout history, the majority of the information available regarding the academic performance of Black girls is derived from trends observed among Black students as a whole, or all girls in general. Rather, many scholars make assumptions or overgeneralizations due to a lack of data disaggregation and limited quantitative intersectional research dissemination. Scholars who examine the research around Black

women and girls in STEM education have called for the use of intersectionality to better capture their unique experiences (Ireland et al., 2018). Quantitative intersectional research data are necessary because most reports present race and gender statistics dichotomously.

For example, according to the National Science Foundation (2016), 35.2% of chemists are women; 11.1% of physicists and astronomers are women; 33.8% of environmental engineers are women; 22.7% of chemical engineers are women; 17.5% of civil, architectural, and sanitary engineers are women; 17.1% of industrial engineers are women; 0.7% of electrical or computer hardware engineers are women, and 7.9% of mechanical engineers are women. But this raises the question of how many of these women are Black. This is an example of quantitative data that remains absent in STEM education. Pinpointing the representation of Black women in STEM careers is crucial for the K-12 education of Black girls because it provides Black girls and their parents with information on which STEM professions are more welcoming and more likely to have professional mentors to guide their academic and career success, a key factor in Black women and girls STEM persistence (Sendze, 2023). Here, we focus purely on Black women and girls by moving away from "gap-gazing," which focuses on the differences between Black and White students. Instead, we look at specific trends for Black women and girls (Young et al., 2017). Regarding the present study, what remains under-examined are trends in advanced placement (AP) learning outcomes, postsecondary enrollment, degree attainment, and STEM employment for Black women and girls. To inform educational practice, we examined trends across national datasets to characterize the progression of Black female learners through the STEM education pipeline, with an emphasis on these four critical time points in the STEM pipeline mentioned earlier.

Purpose

This article aims to explore critical points in the STEM pipeline for young Black women and girls, quantify specific "leaks," and provide recommendations for educational practice. For the present study, we will examine four critical points in the STEM pipeline: (1) high school preparation, (2) college enrollment, (3) degree attainment, and (4) employment. At each of these points, leaks often stem from the dual systemic discrimination Black girls face due to their race and gender. This synthesis of secondary data aims to elucidate trends in STEM preparation, college enrollment, degree attainment, and career pathways for Black women and girls. To this end, we examined four research questions, one for each critical point in the STEM pipeline. Our four research questions are presented below:

1. How is the STEM preparation of Black girls characterized by Advanced Placement (AP) exam participation and performance?
2. What are Black women's predominant professional intentions in STEM fields at the onset of their college education?
3. What are the longitudinal trends in STEM degree attainment among Black women over the past decade?
4. How are Black women represented across various STEM professions with respect to employment distribution?

In the following discussion, we argue that a data deficiency exists regarding specific numeric STEM data trends for Black women and girls. To fill this void, we examined trends across national data sets reflecting four critical points in the STEM pipeline: (a) high school, (b) college enrollment, (c) degree attainment, and (d) early career. We first review the relevant K-12 and post-secondary research literature on Black girls' STEM education, achievement, and career attainment. Next, we contextualize Black female progression through the STEM pipeline through the lens of the

opportunity-propensity framework. The opportunity-propensity framework provides a conceptual model that we used to depict how three categories of factors (i.e., antecedent, opportunity, and propensity) afford and constrain the STEM attainment of Black girls. Then, we describe specific structural elements related to the three factors that have an acute influence on STEM attainment of Black women and girls. This is achieved by reviewing the related literature and drawing connections between the factors influencing the STEM degree attainment of Black women and girls in the opportunity-propensity model.

Next, we present the research methods used to analyze the national datasets and provide a rationale for using single-group summaries. Third, we expound on the results of the data summaries and provide implications for education praxis to support Black women and girls. These summaries represent data from the last decade from public use databases and national research centers that collect and report educational, occupational, and professional demographic data. Finally, we provide recommendations to support the identification, preparation, mentorship, and retention of Black women and girls in STEM education. The following discussion paints a compelling narrative about the systemic inequities, untapped potential, and resilience of Black women and girls in the STEM pipeline. It highlights critical issues across multiple stages of their educational and professional trajectories, presenting both challenges and opportunities for interventions.

Literature Review

The persistence and employment trends for Black women in STEM fields are critical areas of investigation, reflecting broader issues of diversity, equity, and inclusion in STEM education and careers (King, 2021). Prior research indicates that Black women face unique challenges at various stages of the STEM pipeline, from K-12 education to professional careers. This review synthesizes relevant literature on STEM participation and outcomes for Black women, providing context for the current study's exploration of STEM AP exam performance, college enrollment intentions, degree attainment, and employment trends.

Black Female Student Participation in K-12 STEM Education

The journey to STEM careers often begins with early exposure and success in STEM subjects during K-12 education. Research has consistently demonstrated that participation in Advanced Placement (AP) courses is strongly associated with higher rates of declaring a STEM major in college (Bohrnstedt et al., 2023; Maltese & Tai, 2011; Warne et al., 2019). Jewett and Chen (2020) found these effects to be even stronger for girls, with Chen et al. (2024) finding that taking high school computer science courses enhanced girls' chances of majoring in computer science related fields. These courses and exams serve as critical indicators of early engagement and preparation, offering students a challenging curriculum that can inspire continued interest in STEM fields. Moreover, success in AP STEM courses can allow students to earn college credit, which may further motivate them to pursue STEM degrees and careers.

Despite the recognized benefits of AP courses, Black female students are significantly underrepresented in STEM-related AP courses. A report by the College Board (2012) highlights that Black girls are enrolled in STEM AP courses at much lower rates than their White and Asian counterparts. This underrepresentation suggests systemic barriers that limit access to these rigorous courses, an under-representation mentioned frequently in the literature (Hirschl & Smith, 2023; Young et al., 2020). Factors affecting Black female participation and success in AP STEM courses include a lack of resources, insufficient preparation in earlier grades, and limited encouragement from teachers and counselors (Collins et al., 2020). This disparity in access can lead to fewer opportunities for Black girls to develop the foundational knowledge and skills necessary for success in STEM.

Furthermore, Black girls who show interest and potential in STEM often face additional challenges, such as a lack of mentorship and support. Studies have shown that mentorship fosters students' interest and persistence in STEM (Riegle-Crumb & King, 2010; Young et al., 2019). Without role models and mentors who can guide and encourage them, Black female students may struggle to see themselves succeeding in STEM fields, as suggested by literature finding that role model interventions can increase STEM aspirations (Gonzalez-Perez et al., 2020). This lack of support and limited access to rigorous coursework for Black girls can impede their progress through the STEM pipeline, ultimately affecting their enrollment and retention in post-secondary STEM education as shown by Ireland et al.'s (2018) review of the literature on Black women and girls in STEM education. Addressing these barriers is essential for increasing the participation and success of Black female students in STEM, thereby diversifying the field and enriching the STEM workforce.

Black Female Student STEM College Enrollment Intentions

College enrollment intentions are a proxy for interest in STEM careers and indicate future STEM participation. According to data from the Higher Education Research Institute (HERI), Black women are significantly less likely than their peers to express intentions to major in STEM fields (Eagan et al., 2016). This disparity reflects broader systemic issues, including the underrepresentation of Black women in STEM disciplines, which can discourage interest and confidence in pursuing these careers. The visibility of role models and mentors in STEM is crucial. Without seeing people who look like them succeeding in STEM, Black women may feel that STEM careers are not accessible or welcoming (Dickens et al., 2021). The cultural and social dynamics influencing career choices further compound this issue.

Black women often navigate complex intersections of race and gender, which can shape their educational and professional aspirations. Studies collected by a qualitative meta-synthesis have shown that societal expectations, family influence, and community support play significant roles in career decision-making (Jaumot-Pascual et al., 2021). The lack of culturally relevant curricula and supportive environments in educational institutions can also deter Black women from pursuing STEM majors (Espinosa, 2011; McGee, 2021). These barriers highlight the need for targeted initiatives that address the unique challenges faced by Black women, fostering an inclusive and encouraging atmosphere for their academic pursuits.

Black Female Student STEM Degree Attainment

The attainment of STEM degrees is a critical milestone in the STEM pipeline, serving as a gateway to advanced career opportunities and leadership roles within the STEM fields. Despite progress in overall STEM degree completion, significant disparities persist for Black women who only comprise 2% of the STEM workforce (Fletcher et al., 2023; Sendze, 2023). The National Science Foundation's (NSF) report on Women, Minorities, and Persons with Disabilities in Science and Engineering (2013) highlights these disparities, noting that Black women are particularly underrepresented among STEM degree recipients. This underrepresentation is most pronounced in high-demand fields such as engineering and physical sciences, where the presence of Black women is notably sparse compared to their peers (Charleston et al., 2014). Such trends underscore the importance of targeted interventions to support Black women through their educational journeys in STEM.

Several factors contribute to the underrepresentation of Black women in STEM degree retention and attainment. Academic preparation is a significant barrier, as many Black female students have limited access to advanced coursework and resources critical for success in STEM fields (Block et al., 2019). Financial barriers also play a crucial role, with many Black women facing challenges in

affording higher education due to systemic economic disparities (Clotfelter et al., 2008; Shapiro, 2004). Additionally, the pervasive impact of stereotype threat—a phenomenon where individuals from marginalized groups experience anxiety and reduced performance due to negative stereotypes about their group's abilities—further hampers the academic success and persistence in STEM disciplines of Black women and girls (Burnett et al., 2023; Steele, 1997). These challenges are compounded by a lack of role models and mentors who can provide guidance and support through the rigors of STEM education. Both Dickens et al. (2021) and Ireland et al. (2018) emphasized the importance of mentors and support systems in retaining Black women in STEM fields. The systemic challenges Black women face in STEM education are not isolated to academic environments but extend into the workforce, where similar barriers impede their representation and career advancement in STEM professions.

STEM Employment Trends for Black Women

The transition from STEM education to employment presents significant challenges for Black women. According to data from the National Center for Science and Engineering Statistics (NCSES, 2023), Black women remain underrepresented in STEM occupations, especially in high-status fields such as engineering and computer science (Fletcher et al., 2023; Yamaguchi & Burge, 2019). This underrepresentation is not only a matter of lower participation rates but also reflects systemic barriers that hinder the career progression of Black women in STEM. These barriers include limited access to resources, mentorship, opportunities for advanced education, and exposure to high-level STEM projects and roles (Ireland et al., 2018). The cumulative effect of these obstacles is a persistent gap in the entry and retention of Black women in STEM professions.

Discrimination, both overt and subtle, is a significant barrier to the entry and advancement of Black women in STEM careers. Studies have documented instances of racial and gender bias that manifest in various forms, from hiring practices to workplace interactions and evaluations (Beasley & Fischer, 2012). Black women often lack mentorship and sponsorship, crucial for career development and progression. The absence of role models and mentors who share similar racial and gender identities can lead to feelings of isolation and discouragement. Moreover, according to McGee and Bentley (2017), networking opportunities, which are vital for career advancement, are frequently less accessible to Black women, further limiting their ability to progress in their careers.

The research presented in this literature review highlights the systemic barriers that Black women face at each stage of the STEM pipeline. These barriers include early educational experiences, college enrollment intentions, degree attainment, and employment outcomes. All of these reflect broader patterns of inequality that need to be addressed to create a more inclusive STEM ecosystem. The current study builds on this foundation by analyzing multiple data sources to provide a comprehensive overview of STEM persistence and employment trends for Black women. By highlighting these trends, the study aims to inform policy and practice interventions to support Black women navigating and succeeding in STEM fields.

The Opportunity-Propensity Framework

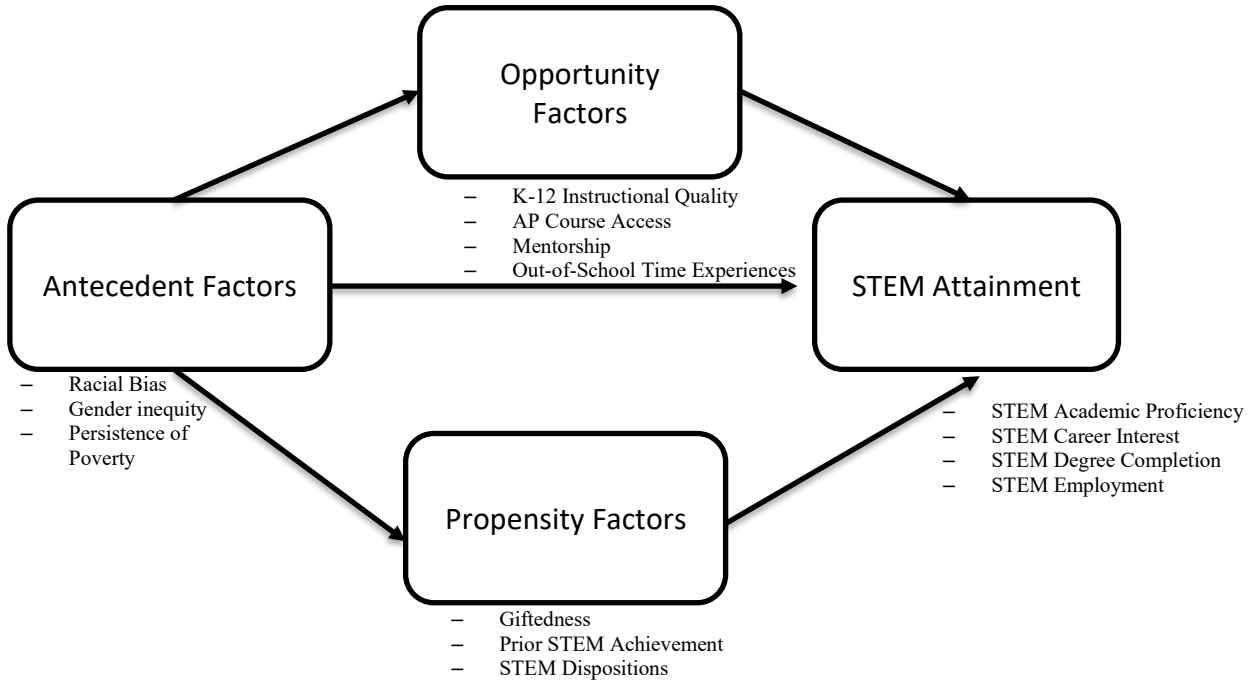
Numerous theories and frameworks explain the underachievement and lack of retention of Black women and girls throughout the STEM pipeline. According to Ford et al. (2011), relevant theories include: (a) Stereotype Threat, (b) Attitude-Achievement Paradox, (c) Secondary Resistance Among Involuntary Minority Groups, and (d) Acting White (see also Fordham & Ogbu, 1986; Mickelson, 1990; Ogbu, 1987; Steele, 1997). In the present study, we argue that opportunities to learn are the main hindrance to the achievement and retention of Black women and girls in STEM. These opportunities to learn are particularly inaccessible in STEM classrooms that serve both large populations of students of color and white students experiencing poverty (Basile & Lopez, 2015;

Heafner & Fitchett, 2015). The relationship between these opportunities and the success of Black women and girls in STEM is further explained by considering the Opportunity Propensity Framework in the context of critical transition points within the STEM pipeline, such as high school, college, and early career.

Opportunities to learn remain elusive for minoritized students of color and white students experiencing poverty. These opportunities are necessary to develop students' interests that promote participation and persistence in STEM-related content and careers. According to the opportunity-propensity framework, learning is influenced by three factors: (a) antecedent, (b) opportunity, and (c) propensity (Byrnes & Miller, 2007). Numerous studies indicate that antecedent factors (e.g., race, gender, and socioeconomic status) and opportunity factors (e.g., teacher quality and access to rigorous curricula) have an acute effect on the learning of traditionally minoritized learners. Still, propensity factors (e.g., giftedness, motivation, interest, and identity) also warrant further consideration (Young, 2020; Young et al., 2017, 2018). The opportunity-propensity framework provides a conceptual model of the interplay between these related factors and subsequent student learning. As shown in Figure 1, antecedent factors directly and indirectly influence STEM attainment. The impact of race and gender on the STEM attainment of Black women and girls is complicated by the effects of dual marginality, which is well-documented within the intersectional research literature, finding STEM interest and achievement to be critical themes (Ireland et al., 2018).

Figure 1

Operationalization of the Opportunity-Propensity Model for the Examination of Factors Related to the STEM Attainment of Black Women and Girls



Note: Adapted from Brynes and Miller (2007, p. 602).

Antecedent Factors and Dual Marginality

Black female learners are often unaccounted for in middle and high school advanced mathematics and science courses. During the 2015-2016 school year, Black girls accounted for 16% of high schoolers enrolled in STEM classes (U.S. Department of Education, 2018). Black girls who pursue and are successful in STEM fields are seen as an anomaly and are more susceptible to experiencing racism and gender-based exclusion. This trend is often attributed to the "double jeopardy" or additive discrimination Black female learners face as members of two stigmatized groups (King, 2016; Young et al., 2017). Black girls who persist through the STEM pipeline encounter various barriers (i.e., racism, sexism, academic, and systemic factors) that can inhibit their STEM attainment. Black girls and Black women are overlooked and, in many cases, entirely excluded from professional STEM careers.

Not only do Black women and Black girls face multiple intersecting marginalizations due to their racial and gender status, but they also combat academic and professional stereotypes based on decades of deficit-oriented scholarship built on the persistence of the Black-White achievement gap (Burnett et al., 2023). The gaps in performance between White and Black students are notable, but the magnitude of these gaps is extreme in mathematics and science, even within gifted education. For instance, White girls, regardless of gifted identification, statistically significantly outperform Black girls identified as gifted in both mathematics and science on the 4th grade National Assessment of Educational Progress (Young et al., 2017). This unfortunate finding can be attributed to the influence of antecedent factors on Black girl achievement within the Opportunity Propensity Framework.

Propensity Factors: Black girl STEM dispositions

The influence of antecedent factors does not operate in isolation; rather, antecedent factors are moderated by the effects of opportunity and propensity factors. For the present discussion, we focus on the influence of a specific propensity factor for Black girls: STEM dispositions. Black girls possess unique mathematics and science affinities and skills that can remain unrealized if not cultivated before middle school because data trends indicate girls lose confidence in their STEM abilities and experience a decrease in their STEM dispositions in the middle grades (Knezek, 2015). Surveys historically report more negative STEM dispositions among girls and women overall (Sadler et al., 2012; Wang & Degol, 2013). However, Black girls historically express more positive dispositions toward STEM content and professions than White girls (Charleston et al., 2014; Johnson, 2011).

Therefore, early STEM preparation for Black girls has the propensity to prime the STEM pipeline for Black girls. Harnessing the knowledge and skills of Black girls requires more intersectional research within STEM education. STEM career choices are influenced by inadequate STEM preparation early in the K-12 pipeline, arguably where the most substantial leaks can occur. This lack of preparation becomes more apparent in secondary and postsecondary course interest and performance (Decoito, 2014). Approximately 25% of Black students are interested in STEM but lack sufficient preparation in mathematics to pursue a STEM career (Business-Higher Education Forum, 2011). Student perceptions of their abilities and prior performance in mathematics and science mediate dispositions such as STEM interest and identity development (Hughes et al., 2013). Thus, as students become more aware of their inadequate preparation and proficiency, they are more likely to become disinterested in STEM. However, if Black girls are identified and placed in high-quality STEM education programs, their talents can be cultivated, which supports a positive STEM identity. Therefore, researchers must assess Black girls' mathematics and science achievement and dispositions early and often. Thus, access to equitable opportunities is an additional consideration modeled within the Opportunity Propensity Framework.

Opportunity Factors and Equitable Access to Advanced STEM Content

Several opportunity factors are important to consider when examining the STEM attainment of Black women and girls, such as teacher quality, enrichment activities, and technology resources. However, we will focus on access to and participation in STEM-related AP courses. Traditionally, AP courses are offered to the highest-achieving high school students to earn college credit before entering postsecondary educational settings (Klugman, 2013). Thus, participation and success on AP exams is an important indicator of STEM success for Black female high school students because they require content mastery, foster higher-order thinking, and are predictive of subsequent success in related content areas in college (Chajewski et al., 2011; Marin & Halpern, 2011). These courses are typically reserved for the top five to 10% of students and often require a teacher's recommendation to participate (Klopfenstein & Lively, 2016). Teacher recommendations and financial barriers can often impede the access of Black female students to AP STEM courses.

Because AP courses are arguably one of the most widespread and standardized resources for academically and intellectually gifted high school students, alongside International Baccalaureate and dual enrollment, we have placed our attention here, rather than earlier in the pipeline, where Black girl data is less representative (Park et al., 2014; Speroni, 2011). AP exams also permit using a single data source that provides disaggregated data by race and gender for all U.S. students rather than relying on a selected sample. Furthermore, because many of the same mechanisms and protocols are used to identify students for AP courses, there are implications for access, participation, and success that are applicable to STEM education. AP courses are extremely rigorous, and college credit is only granted to students who earn a specific score on the AP examination, typically a three or above. AP exam scores range from one to five. Still, according to the College Board, a score of five indicates that a student is exceptionally well qualified in that content area, and a score of one does not receive a recommendation.

Access, participation, and achievement in AP coursework remain a challenge for many minoritized students in the U.S. Even as AP enrollment and test taking have increased, racial and socioeconomic gaps in course-taking and scores remain (Rodriguez & McGuire, 2019; Xu et al., 2021). In 2013, Black students represented 14.5 percent of the graduating student population, 9.2 percent of the AP exam participants, and only 4.6 percent of the students earning a three or above on an AP exam, the score typically needed to receive college credit (College Board, 2014). Unfortunately, although participation has increased for Black students over the last few decades, performance trends have not. Black student pass rates declined from 35.9 percent in 1997, to 29.1 percent in 2012 (Eugene & Hobson, 2015). Additionally, results of the 2016 exam indicate that over 70 percent of Black students who took an AP exam did not pass, indicating that this decline has remained consistent (Tugend, 2017). For girls, these numbers can be even worse, with Krakehl and Kelly (2021) reporting traditionally underrepresented women had failure rates of over 80% on the AP Physics 1 exam. By examining antecedent, propensity, and opportunity trends, the Opportunity Propensity Framework provides a theoretical lens through which we can characterize the Black female data trends along the STEM pipeline.

Method

This study uses multiple data sources to characterize the STEM attainment trends for Black women and girls across four crucial points in the STEM pipeline. Altogether, we summarized and analyzed four main sources of data: STEM AP exam performance, STEM college enrollment intentions, STEM college degrees, and STEM employment. These data help unpack a complex narrative of systemic barriers and resilience, highlighting persistent inequities and opportunities for targeted interventions to support Black women and girls in STEM.

Data

We used the reporting data (i.e., means and standard deviations) for Black girl performance on the 2012 administrations of the STEM-related AP exams from the College Board to answer our first research question: How is the STEM preparation of Black girls characterized by Advanced Placement (AP) exam participation and performance? To answer this question, we extracted data for STEM-related AP exams. We chose the following AP exams as relevant STEM content: Biology, Chemistry, Environmental Science, Calculus AB, Calculus BC, Statistics, Computer Science, Physics B, and Physics C1. Data were analyzed from N = 32,675, for every Black female learner in grades 9 through 12 who took the AP exams. We received the data directly from the College Board, which creates and administers the exams. These data represent the early STEM content participation and preparation of arguably the highest-achieving Black girls in the nation. As these datasets contained descriptive statistics (i.e., N, M, and SD), we calculated 95% confidence intervals for data inference. We present confidence intervals in visual form via graphs and include the proportions of each test taken by Black girls in 2012 as a pie chart.

Next, we analyzed data from the NSF's Women, Minorities, and Persons with Disabilities in Science and Engineering 2013 report. This data provided information about STEM-related degrees earned by Black women. The included fields are mathematics and statistics, engineering, biological sciences, physical sciences, and computer science. Computer science and information technology are often grouped in the same category regarding degrees, as an undergraduate computer science degree is frequently used as a prerequisite for entry into IT jobs (Charles & Bradley, 2006). Data were analyzed for a sample N = 1,159,157 of Black female college graduates. This data comes from surveys administered by federal organizations: NCSES, National Center for Education Statistics, Department of Education, Census Bureau, Department of Commerce, and Bureau of Labor Statistics. These data were summarized using descriptive statistics (i.e., frequencies) displayed as a line graph over time.

Finally, we summarize employment trends from the data from the NCSES 2015. The fields of employment included mathematical scientists, physical scientists, psychologists, social scientists, engineering positions, biological and life scientists, and computer and information scientists. While psychologists and social scientists were included based on their designation by the NSF, we will not be discussing those results as they do not match the study's definition of STEM. Data were analyzed for a sample N = 116,388 Black female college graduates. These data were summarized using descriptive statistics displayed as a pie chart.

Analysis

In the sections that follow, we provide single-group summaries of Black female performance at critical points in the STEM pipeline to explore participation and achievement trends across the STEM pipeline. Researchers in the medical sciences utilize single-group summaries to explicate the unique medical considerations of different demographic groups (Blank & Antaki, 2017; Najafi et al., 2015). A single-group summary is the estimation of group trends for specific populations or categories of participants on a particular outcome (e.g., the prevalence of disease amongst women or mean score for children experiencing poverty on a test). Here, we utilize single-group summaries to characterize data related to STEM learning outcomes for Black women and girls. Confidence intervals were selected because they provide point estimates for population parameters, as well as a measure of the precision of these estimates that were used to compare across administrations (Cumming & Finch, 2001). The point estimates are sample statistics, two of the most commonly used: means and effect sizes (Zientek et al., 2010). The sample statistics were referred to as point estimates because they approximate population parameters. Using confidence intervals to compare

and characterize Black girl AP STEM performance is critical because it allows for a more nuanced understanding of differences and trends that simple point estimates might otherwise mask. Confidence intervals offer a visual and statistical way to assess the overlap and distinction between group performances, helping to identify both meaningful gaps and areas of progress. This approach strengthens the validity of inferences drawn about population-level achievement patterns, ensuring that interpretations are both statistically grounded and sensitive to the variability inherent in educational data.

The present study used a sample of African American female mean scores on each exam as point estimates. A 95% confidence interval was chosen by convention; a 90% or any other level would be equally valid, but the 95% confidence interval is a stricter measure (Zientek et al., 2010). A 95% confidence interval does not indicate that a point estimate correctly represents the population parameter with 95% certainty, but rather that if an infinite number of confidence intervals are constructed, then one can be 95% certain that the population parameter is present. The confidence intervals were calculated in Microsoft Excel, specifically the confidence macro present in the available list of macros. To perform these calculations, one needs the mean, standard deviation, and population size retrieved from the College Board.

Results

Black women and girls have the potential to become strong leaders in STEM, lending their unique expertise to improving the STEM field. Specifically, Black girls represent a unique population of K-12 learners who remain an essentially untapped sources of STEM potential. The results in the sections below provide important implications for education praxis to support Black girls and women at critical moments in the STEM education pipeline.

AP Participation and Performance

Based on the descriptive statistics summarized in Table 1, the mean scores across five science subjects (i.e., Biology, Chemistry, Environmental Science, Computer Science, and Physics B) were below the minimum passing score of three or better on the AP exam.

Table 1

Descriptive Statistics of AP Exam Scores Across Science and Mathematics Tests for Black Girls

Science							
	Biology	Chemistry	Environment	Computer Science	Physics B	Physics C_1	Physics C_2
N	8210	3876	4347	252	1571	89	270
M(SD)	1.68(1.17)	1.59(1.03)	1.67(1.02)	1.63(1.24)	1.68(1.00)	2.70(1.34)	2.31(1.28)
Mathematics							
	Calc AB	Calc BC	Statistics	Calc AB	Calc AB	Calc BC	Statistics
N	7791	1026	5243	7791	7791	1026	5243
M(SD)	1.81(1.27)	2.92(1.52)	1.78(1.05)	1.81(1.27)	1.81(1.27)	2.92(1.52)	1.78(1.05)

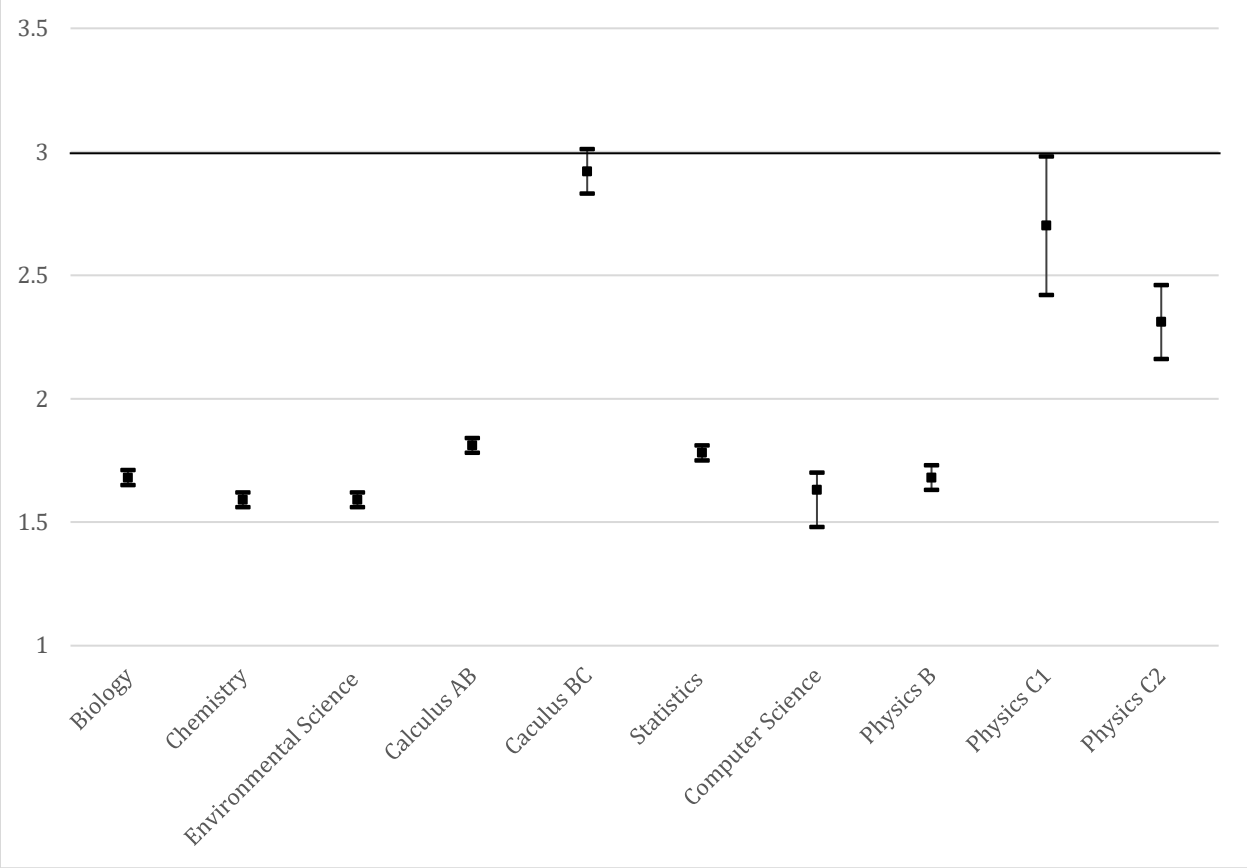
Note. 1= Electricity and Magnetism; 2= Mechanics; CI= 95% confidence interval for the mean

Mean mathematics performance across three math subjects (i.e., Calculus AB, Calculus BC, and Statistics) followed a similar trend. Mean scores on the Calculus AB and Statistics exams were less than the mean score of three necessary to receive college credit at most colleges and universities. The

mean scores on the Calculus BC exam were only 0.08 of a point away from the score needed to earn college credit. This indicates that the overall performance of Black girls on this exam was close to a score of 3.0, which would be a sufficient score to earn college credit for Calculus 1 and 2. Few Black girls earned college credit from any STEM AP courses based on the mean group performance. This is further evidenced by the data in Figure 2, which presents the 95% confidence interval plots for the mean performance of Black girls across STEM content areas.

Figure 2

95% Confidence Intervals for Mean Scale Scores of Black girls on AP STEM



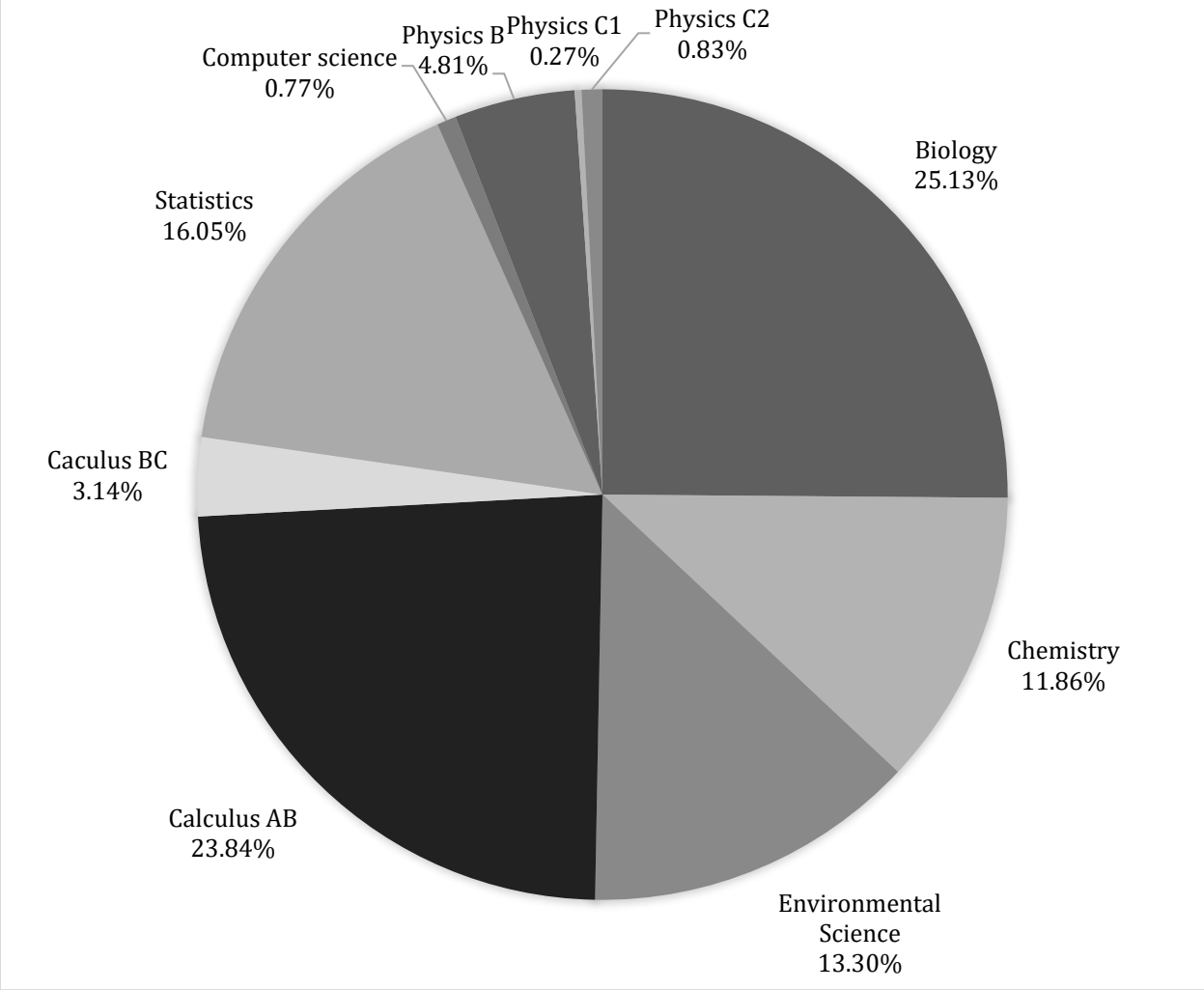
The dots represent the mean score, while the bands extending from the dots represent the 95% confidence interval range. Based on the lack of overlap between the confidence bands of the content areas and the score of three, as depicted by the bold black line in the figure, it can be concluded that most Black girls do not earn college credit through AP examinations.

Figure 3 represents the proportion of each test in our sample of Black girl AP test takers. Representation data presented in Figure 3 indicate that the largest proportion of Black girls in our sample attempted the Biology and Calculus AB exams, respectively. Fewer than 10% of Black girls attempted the Calculus BC, Computer Science, and Physics exams combined. This is interesting because score trends for these exams were typically slightly higher than the mean scores for the attempted exams more often. This may indicate rigor, access, and instructional quality differences across the STEM examinations. However, as mentioned earlier, schools serving large populations of Black students tend to have fewer AP exam options. Hence, it could be argued that the higher scores for Black girls on the more rigorous AP exams reflect the effects of increased access and opportunities

to learn at schools serving primarily White students. Yet, the absence of these variables within this dataset made it impossible to investigate this further.

Figure 3

Black Female Student AP STEM Exam Participation

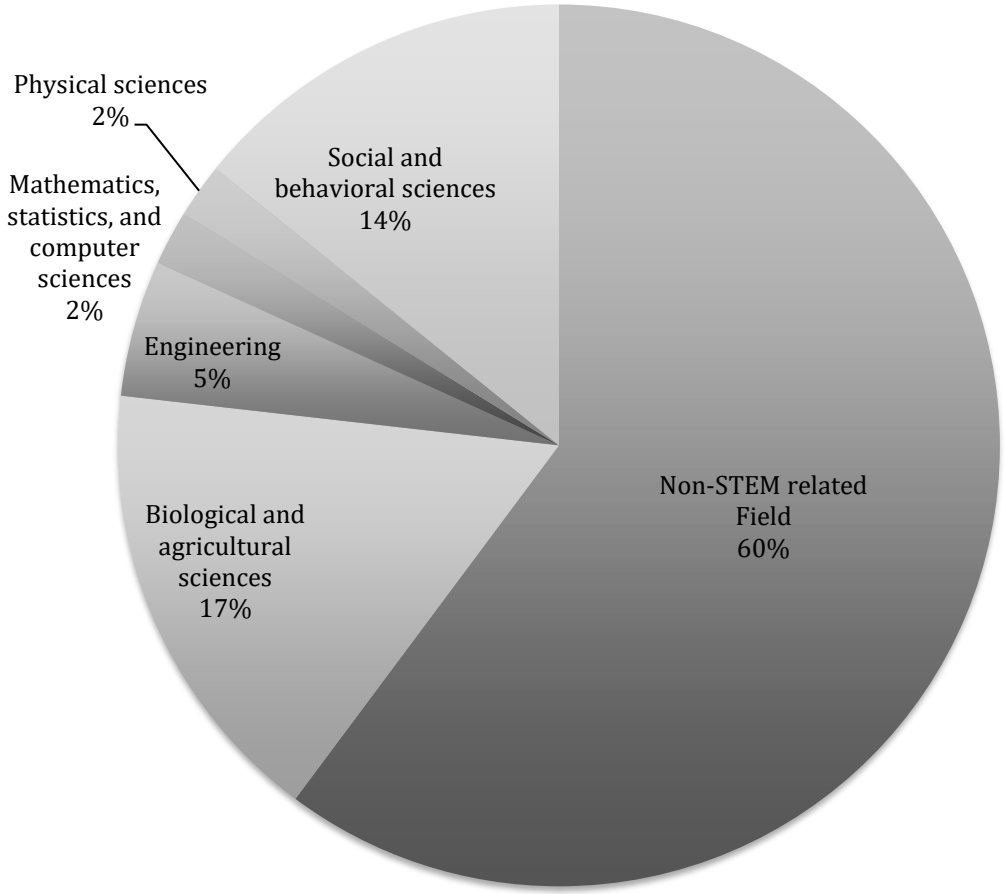


Enrollment Intentions

According to the data summarized in Figure 4, those who intend to pursue a STEM-related field are more likely to consider a biological and agricultural sciences major than more computational sciences. The data in Figure 4 also indicates that only approximately nine percent of Black female freshman students intend to pursue physical science, mathematics, engineering, or computer science. These represent what some would consider more computationally heavy STEM content areas. A similar trend is present within the AP participation and performance data presented in the previous section, where the largest proportion of Black girl test takers took the Biology AP exam at 25%. Notably, enrollment intentions favor biological sciences, which is comparable to the vast number of Black female students attempting the biology AP exam.

Figure 4

Black Female Student Freshman Enrollment Intentions



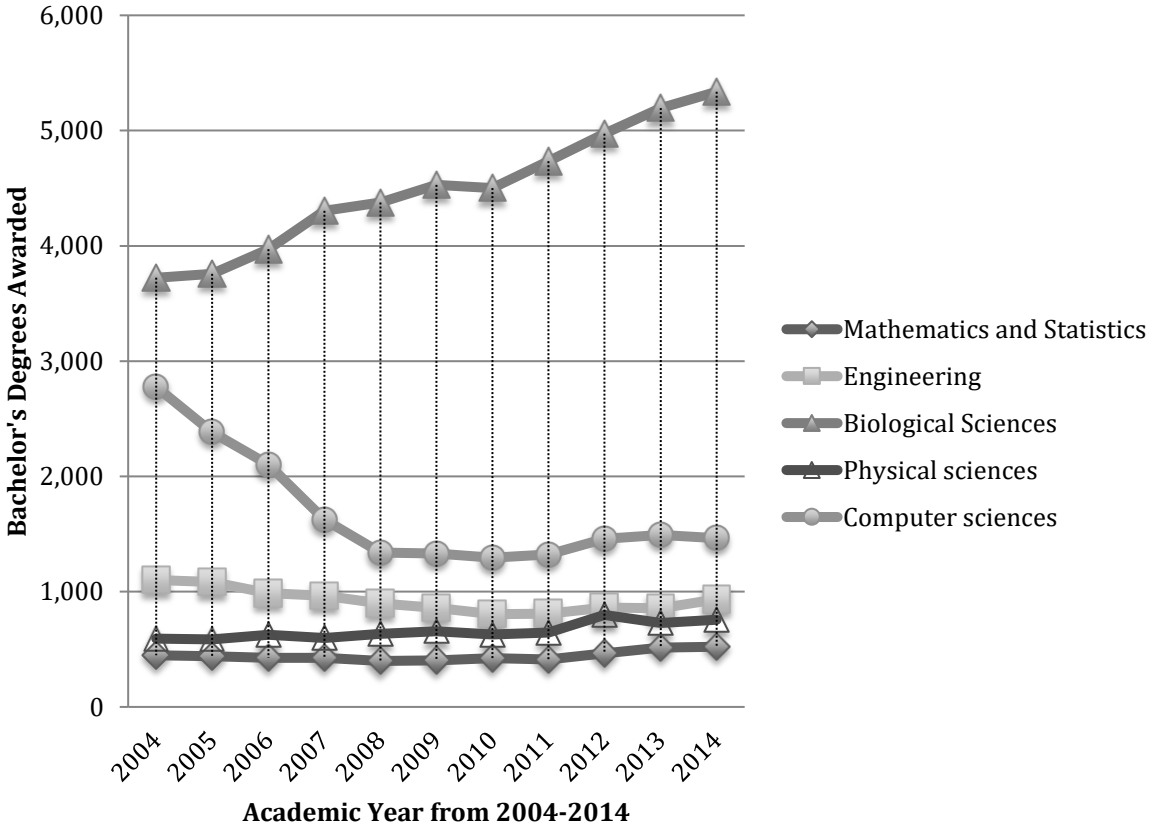
STEM career interest begins early, but we can learn a great deal from reviewing the enrollment intentions of Black female students based on major course of study declarations. As presented above, data from the Higher Education Research Institute's 2014 survey of American freshmen indicates that most Black female freshman college students do not intend to earn a degree in a STEM-related field. This finding parallels the historical trends in STEM career interest for Black female students and female learners in general.

Degree Attainment

According to data from the NSF, between 2004 and 2014, most Black female STEM learners earned a degree in biological sciences. This was the only STEM-related field with a positive degree attainment trend. This result coincides with the trends in Black female student enrollment intentions and the most attempted AP exams. The complete set of degree attainment trends can be seen in Figure 5.

Figure 5

Black Female STEM Degree Attainment Trends from 2004 to 2014



Computer science degree attainment experienced a sharp decline from 2004 to 2008 and has been relatively flat since 2009, while engineering, physical sciences, and mathematics/statistics historically represent the three lowest degree attainment career categories for Black girls. Likewise, these areas also represent three of the least attempted AP exams for Black girls, with some subtle nuances related to AP exam performance in each content area. As Nix and Perez-Felkner (2019) observed, Black women who believed they had a higher ability to handle difficult mathematical tasks were more likely to have outcomes in physics, engineering, mathematics, and computer science. This could connect with those willing to take the potentially difficult related AP exams.

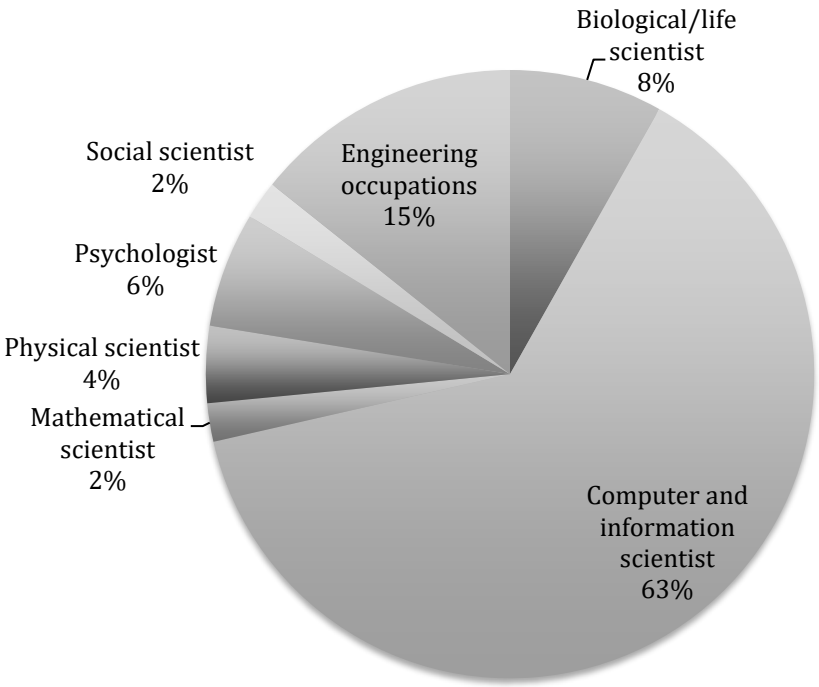
Employment Trends

According to the NCSES 2015 survey of college graduates, most Black female STEM professionals with a bachelor's degree are often employed as computer or information scientists. This suggests that although fewer Black female students are attempting AP computer science, enrolling in computer science as a major, or graduating in computer science-related fields, computer-related careers remain the largest STEM profession for Black female professionals with a bachelor's degree. Similarly, the second largest proportion of Black STEM professionals are employed in engineering fields despite very low intent to major in engineering for Black girls. A final point for consideration is the disconnect between substantial Black girl participation and performance challenges in the Biology

AP exam compared to the large number of degrees earned in the biological sciences and the relatively small number of Black women employed in related fields.

Figure 6

Black Female Professional STEM Employment Distribution



Limitations

Our data allows us to examine general trends for Black women and girls in STEM and make inferences about their path. However, as this is aggregate data, we cannot control for factors such as socioeconomic status and self-efficacy. Also, the categorization options in the dataset limit the information available about specific STEM fields entered. For example, while biological/life scientists could include various life science-related fields, we cannot see that in the data. Additionally, we focused solely on STEM careers, yet it is reasonable to assume that Black women in the sample went on to successful non-STEM careers in business or other fields. Furthermore, we cannot truly determine the causes behind this trend and can only hypothesize based on previous research. It would be remiss not to mention that these data do not include Black women with advanced degrees, nor are the exact numbers of Black girls identified as gifted provided in national datasets. Here, we only use AP data, while some scholars have considered dual enrollment courses where high school students earn college credit to be an evenly matched alternative to AP coursework.

Discussion

Reports repeatedly conclude that Black women and girls are uniquely resilient, creative, and productive STEM learners (Farinde & Lewis, 2012; Young et al., 2017). The findings of this study highlight critical trends and challenges in the STEM pipeline for Black women and girls, offering valuable insights into their educational and professional trajectories. The discussion integrates these

findings into a cohesive narrative, focusing on the relationship between preparation, degree attainment, and career outcomes while aligning with the Opportunity Propensity Framework to contextualize the results.

AP Participation and Performance

Black girls' STEM preparation through AP exam participation and performance is characterized by underrepresentation in more advanced exams and lower-than-passing mean scores in most STEM subjects. For instance, few Black girls earned college credit from STEM AP exams, as evidenced by the lack of overlap between the 95% confidence intervals for mean performance and the passing score of three. This highlights the challenges Black girls face in achieving college-credit-qualifying scores on STEM AP exams. These results indicate limited access to resources and opportunities necessary for success on these exams.

The analysis revealed significant disparities in AP participation and performance among Black girls, particularly in computationally intensive subjects such as computer science and advanced mathematics. However, prior research indicates that large populations of students of color lack opportunities to participate in high school advanced mathematics and science courses (Woolley et al., 2010). These gaps are consistent with broader inequities in STEM education access. Some posit that underrepresentation results from cultural discontinuity or mismatch between teachers and Black girls (Ford, 2013; Young & Larke, 2017). Cultural discontinuity is one mechanism that dually marginalizes Black girls in gifted education and STEM education. These findings underscore the interplay between systemic inequities in educational access and the untapped potential of Black girls in STEM, highlighting both the challenges and opportunities for intervention.

The higher mean scores on Physics C exams suggest that, when opportunities align with strong preparation and support, Black girls can succeed in even the most challenging STEM subjects. The implications of these findings are profound. Limited participation in AP courses restricts the STEM opportunities available to Black girls at the postsecondary level, perpetuating a cycle of underrepresentation. While the trends in Physics C scores are promising, they highlight the importance of targeted resources and interventions to extend such success to other STEM subjects. Moreover, based on the results of the present study, we support the recommendation of the National Research Council (2013) to include factors beyond academic achievement when assessing the STEM academic capacity of Black girls.

Teacher training is integral to creating more equitable STEM opportunities by gender, race, or both because when a student's giftedness deviates from the teacher's perceived norm, the student may not receive a referral, even when matched on test scores and grades with White students (Ford & Moore, 2013; Grissom & Redding, 2016). Thus, we recommend specialized STEM identification training for AP courses to help address the underrepresentation of Black girls in AP STEM courses. The number of states that require pre-service teacher training in gifted education is limited (Farkas & Duffett, 2008), especially with a multicultural focus (Ford, 2011a). Only 17 states require teachers to have gifted education credentials (see National Association for Gifted Children, 2014).

Teacher perceptions are informed by cultural synchronization, or the ability of teachers to recognize and appreciate the cultural nuances and characteristics of culturally and linguistically diverse students (Mattai et al., 2010). When cultural synchronization exists, the possibility of misinterpretations of cultural orientations is decreased. Thus, training teachers who serve culturally, linguistically, and economically diverse students on how to recognize high ability, as well as how to respond, is imperative (Ford, 2011b; MacFarlane, 2015). However, as observed in the AP data from the present study, this training must be content-specific and reflective of trends in access, participation, and performance.

Regarding early preparation and AP performance, the present study's results indicate that Black girls' participation in AP STEM exams is low, particularly in computationally intensive subjects like computer science and advanced mathematics. Moreover, when Black girls do participate, their scores often fall below the threshold for college credit, reflecting disparities in preparation. Yet, promising data trends in Physics C scores demonstrate that with proper preparation and support, Black girls can excel in challenging STEM areas, underscoring the importance of targeted resources and interventions.

College Enrollment Intentions

The predominant professional intentions in STEM fields among Black women at the onset of their college education are concentrated in biological and agricultural sciences rather than computationally intensive areas such as physical sciences, mathematics, engineering, or computer science. According to the data, only about 9% of Black female freshman students intend to pursue degrees in these computational STEM areas. This trend aligns with AP participation data, showing that the most significant proportion of Black female AP test takers took the biology exam (25%), indicating a stronger preference for biological sciences.

Additionally, historical trends suggest that most Black female students do not intend to earn degrees in STEM-related fields, a pattern reflective of broader trends in female learners' STEM career interests. Other studies have also found that women and girls are more drawn to biological sciences. Perez-Felkner et al. (2017) found that high school mathematics ability beliefs and performance made them more likely to major in physical science, engineering, mathematics, and computer science.

The results of the present study indicate that the same gender bias and institutionalized sexism within K-12 and higher education settings are also present in our nation's STEM culture (Moss-Racusin et al., 2015). However, it is essential to note that underrepresentation in high-demand fields like computer science and engineering reflects broader systemic barriers, including a lack of mentorship and culturally relevant curricula that might encourage broader STEM engagement. These enrollment intentions underscore the need for early interventions to diversify Black girls' STEM interests, addressing the cultural and structural factors that shape their academic and professional choices.

In sum, Black girls disproportionately intend to pursue biological sciences, with limited interest in computational and physical sciences. This trend reflects broader systemic and cultural influences, including a lack of mentorship and exposure to diverse STEM careers. We contend that gender biases and institutionalized sexism contribute to limited engagement in computational STEM fields, reinforcing traditional stereotypes about "appropriate" roles for women in STEM.

Degree Attainment

The longitudinal trends in STEM degree attainment among Black women over the past decade reveal significant disparities across STEM fields. From 2004 to 2014, biological sciences demonstrated the only positive trend in degree attainment for Black women, aligning with their enrollment intentions and the largest number of attempted AP exams. In contrast, computer science experienced a sharp decline in degree attainment from 2004 to 2008, stabilizing at a low level after 2009. Engineering, physical sciences, and mathematics/statistics consistently represented the lowest degree attainment categories, correlating with the minimal attempts at AP exams in these subjects.

These trends highlight a strong connection between perceived ability, willingness to engage with challenging content (e.g., AP exams), and outcomes in physics, engineering, mathematics, and computer science. As Nix and Perez-Felkner (2019) suggest, the belief in one's mathematical ability plays a critical role in degree attainment in these traditionally underrepresented fields. These findings

underscore the need for targeted interventions to bolster confidence and preparation in these areas to support greater representation of Black women across all STEM disciplines.

Earlier data have suggested that the representation of women and Black women decreases with each advanced degree designation (Ceci et al., 2009). Thus, student achievement in STEM should be recognized and rewarded to foster future interest and efficacy in STEM (Beier & Rittmayer, 2008) to support advanced degree attainment. Addressing these gaps requires a dual focus on increasing access to advanced STEM coursework and fostering a sense of belonging in underrepresented STEM fields. Mentorship, role models, and supportive institutional cultures are critical for bridging this divide (Ireland et al., 2018).

Thus, the degree attainment trends indicate a multitude of disparities, with biological sciences being the only area of growth for Black women. In contrast, engineering, mathematics, and computer science remain critically underrepresented. Based on these trends, we argue that confidence in mathematical ability and access to challenging coursework are pivotal for the degree attainment of Black women. This highlights the need for interventions that build self-efficacy and engagement in underrepresented fields.

Employment Trends

Based on the employment distribution data, the representation of Black women across various STEM professions reveals distinct trends. Black women with bachelor's degrees in STEM are most frequently employed in computer or information science professions, despite their underrepresentation in AP Computer Science participation and degree attainment. Engineering fields represent the second-largest employment category for Black women in STEM, although the intent to pursue engineering among Black girls is notably low. Interestingly, there is a disconnect in the biological sciences. Despite substantial participation in biology AP exams and numerous degrees earned in the biological sciences, relatively few Black women are employed in these fields. This distribution highlights a misalignment between educational pathways and workforce representation for Black women in STEM.

The employment data reveal a disconnect between degree trends and workforce representation. Despite low degree attainment in computer science, Black women with STEM degrees are predominantly employed in computer and information science fields. This may reflect a combination of career adaptability and opportunities in less mathematically intensive roles within the technology sector.

These findings suggest the importance of aligning educational preparation with workforce demands. Unfortunately, people of color have been excluded from education advocacy discussions and advisory groups (Davis, 2010), which can contribute to Black women's lack of participation in certain STEM fields. This is important because representation affects the social, emotional, and racial identity development of students of color (Davis & Moore, 2016; Ford, 2010). For instance, cultural stereotypes are abundant, and these perceptions often lead many women to believe that STEM careers are not conducive to their desire to work with others (Diekman et al., 2011).

Strengthening pathways into high-demand STEM fields, particularly through internships and professional mentorship programs, could better prepare Black women for success in these careers. With respect to employment trends, the data indicate a workforce misalignment for Black women in STEM, as employment trends reveal a disconnect between educational preparation and workforce representation. Despite low degree attainment in computer science, Black women are more likely to be employed in technology sectors, reflecting adaptability and a misalignment between education and industry demands. Furthermore, despite high AP participation and degree attainment, the biological sciences see lower workforce representation, suggesting systemic barriers in translating education into employment.

Theoretical Implications

The following discussion situates the present study's findings within the opportunity-propensity theoretical framework, emphasizing how systemic barriers, intersecting identities, and cultural perceptions shape Black women and girls' educational and career trajectories in STEM. Although the racial achievement or opportunity gap may contribute to the lack of recruitment of Black girls into STEM careers, other data suggest that Black girls possess a unique affinity for STEM-related tasks despite divergent achievement trends (Hanson, 2004; Riegle-Crumb et al., 2011; Young, 2016a). Many gifted and academically advanced Black girls receive less than adequate STEM instruction because of a lack of learning opportunities and access to gifted education (Ford, 2014; Young, 2016b). Therefore, many Black girls are likelier to exhibit a strong interest in STEM but lack sufficient advanced preparation in mathematics and science.

The Opportunity Propensity Framework provides a valuable lens for interpreting these findings. Antecedent factors, such as race and gender, intersect with opportunity factors, including access to AP coursework and high-quality instruction, to shape Black girls' STEM trajectories. Propensity factors, such as STEM dispositions and self-efficacy, further mediate these outcomes. By addressing gaps in opportunity and fostering positive STEM identities, stakeholders can create conditions for success.

The Opportunity Propensity Framework aims to comprehend the impact of opportunities, individual propensities, and their interactions on educational outcomes. The results of the present study reveal several important implications for supporting Black girls and women in STEM education and professions. At the same time, it is crucial to consider how the opportunity-propensity theoretical framework may shed light on how systemic barriers and intersecting identities shape educational and career trajectories for Black girls and women in STEM.

Opportunity Implications

The resilience, creativity, and productivity of Black women and girls as STEM learners have been repeatedly highlighted in the STEM literature (Farinde & Lewis, 2012; Young et al., 2017). Despite this, the potential of Black women as leaders in STEM remains underutilized, especially among gifted Black girls in K-12 education. Our analysis of AP participation and performance reveals significant barriers.

The AP participation and performance trends indicate that many Black girls nationwide lack preparation in advanced science and mathematics content. The mean scores across five science subjects (Biology, Chemistry, Environmental Science, Computer Science, and Physics B) are below the passing score of three, with most mean scores under two. However, Physics C exams (Electricity and Magnetism and Mechanics) show promising results, with mean scores below three. This suggests that with better support and resources (i.e., opportunities), Black girls could achieve higher scores across all STEM subjects. However, small subsets of Black female learners seem well prepared in the most advanced mathematics and science content areas assessed on the AP exam.

This high-performing group of Black female learners is vital because persistence in STEM is highly contingent upon student achievement in the related mathematics and science content. Still, passion and support along the STEM pipeline are essential factors that cannot be overlooked. Ong et al. (2011) also noted, in a synthesis of the research, that difficulty with transition periods and discrimination discourage women of color from entering STEM fields. Currently, access to rigorous AP courses is limited for many Black female learners, particularly in schools serving large Black student populations, highlighting a critical need for equitable resource distribution.

Propensity Implications

Despite the challenges, black girls have shown potential in specific areas of STEM. The results of the Physics C exams indicate that when provided with the right opportunities, black girls can excel even in the most challenging subjects. This suggests an inherent propensity for success that could be harnessed with adequate preparation and support. Furthermore, enrollment intentions reflect a strong interest in biological and agricultural sciences, aligning with trends in AP exam participation, where Biology was the most attempted exam. Likewise, from 2004 to 2014, black women earned substantially more degrees in the biological sciences compared to other fields. More specifically, fewer than 10% of black girls combined pursue degrees in physical sciences, mathematics, engineering, or computer science.

On the other hand, longitudinal career data indicate that computer science declined from 2004 to 2008 before leveling off just above the bottom three categories. It is important to note that nationally, a concerted effort exists to increase women's presence in computer science. This is marked by national and university initiatives such as Black Girls Code, Code First: Girls, and Girls Teaching Girls to Code, to name a few (see Miller, 2013). These and other efforts to strengthen the recruitment and retention of women and underrepresented minorities in STEM fields have failed to foster racial and gender parity in the engineering, computer science, and physics disciplines, especially at the highest levels (Hill et al., 2010; Wang & I, 2016). The data presented in the present study indicate small increases and decreases observed in engineering, physical science, and mathematics/statistics from 2004 to 2014. However, Black girls earn substantially fewer STEM degrees in these areas. Thus, encouraging broader STEM interests from an early age could diversify the career paths of Black women and tap into their full potential as STEM professionals.

Antecedent Implications

The antecedent factors contributing to the current state of Black girls in STEM include systemic inequities in education and a lack of early exposure to a diverse range of STEM fields. Historical trends show that Black female freshmen are less likely to declare STEM majors, a pattern consistent with broader female student populations. Degree attainment data from the NSF between 2004 and 2014 show that biological sciences are the only STEM field with a positive trend among Black women. One consideration for the present study's employment trends is that women tend to feel out of place in most STEM fields (Stout et al., 2011). Thus, women and girls with the highest STEM interest and competence often choose STEM professions with the largest female representation (Perez-Felkner et al., 2012).

The trends from these data indicate that there is a substantial lack of correspondence between high school achievement, college enrollment intentions, degree attainment, and employment of Black women in STEM. For example, the small proportion of AP Computer Science test takers and freshmen intending to major in computer science, and the decline in computer science degree attainment, do not match computer and information science, which is the largest STEM employment field for Black women. This could be because information science is less mathematically intense and requires different skills than mathematically intense computer science and coding-related degrees.

Moreover, Black women who persist in the more coding-heavy computer science fields face multiple challenges that may not be present in information science (Thomas et al., 2018; Yamaguchi & Burge, 2019). Also, biology-related degrees could serve as a starting point for entering medical fields like nursing and medicine, which may explain the lack of biological scientists. However, such speculations are beyond the scope of this study. These disconnects warrant further consideration in the research literature. Fields like computer science, engineering, and physical sciences have low degree attainment rates. This is reflected in AP exam participation, where fewer Black girls attempt exams in

these subjects. Addressing these antecedents requires initiatives that provide early and sustained exposure to a wide range of STEM disciplines, supported by mentors and role models who reflect their experiences.

Achievement Implications

Despite these barriers, Black women achieve notable success in STEM professions. Data from the NCSES (2015) show that most Black female STEM professionals with bachelor's degrees work as computer or information scientists, even though few pursue these degrees initially. This suggests that once in the workforce, Black women may gravitate toward less mathematically intense fields within STEM or face challenges in more coding-intensive roles. Similarly, many Black STEM professionals are employed in engineering despite low initial interest. There is also a notable disconnect between the high participation in Biology AP exams, degree attainment in biological sciences, and relatively low employment in related fields. This indicates a need for better alignment between education and career opportunities.

By addressing these issues, the untapped potential of Black girls and women in STEM can be fully realized, fostering greater diversity and leadership. The results of the early enrollment intention data were not surprising. Despite early STEM career interest, young Black women face unique obstacles in STEM, as noted earlier. Teacher bias and poor institutional support for pursuing STEM compound the double bind challenge for Black girls (Hill et al., 2010). This trend is similar to the results of Bowen et al. (2005), which concluded that students of color typically choose majors based on the ability to give back instead of potential monetary gain, with McGee and Bentley (2017) observing this among high-achieving undergraduate Black and Latinx STEM students. It is thus not unexpected that Black female students demonstrate a greater propensity to pursue disciplines such as biology or anatomy, given that these fields are intimately associated with professions such as medicine, where they are more likely to encounter role models who are Black women.

Conclusion

Black girls are an underrepresented resource for increasing and sustaining a diverse STEM profession. Increasing access and equity in STEM is a national concern referred to as the STEM crisis (Nasereddin et al., 2014). The U.S. Census Bureau (2012) posits that by 2050, one-half of the U.S. population will be non-White. Moreover, the absence of female professionals, particularly women of color, in STEM fields is a persistent problem (National Academy of Sciences, National Academy of Engineering, Institute of Medicine, & National Research Council, 2010). Despite the prevalence of this phenomenon, effective solutions remain elusive. There are widespread disparities in Black women's recruitment and retention in STEM (Young et al., 2017). Data indicate that Black women earn 10.7% of STEM bachelor's degrees and 13% of STEM master's degrees, yet comprise less than 1% of the STEM workforce (NSF, 2013).

Moreover, Black women's mathematics degree attainment is 800% less than that of white women (Pepitone, 2013). The ramifications of these data are twofold: (1) first, these data indicate that Black women are earning degrees in STEM but failing to matriculate into corresponding STEM professions at the same rate, and (2) these data indicate that Black women's STEM degree attainment and career success could be relegated to specific STEM content areas and professions. This significantly affects Black girls' STEM career interests and degree attainment. Despite these challenges, Black women pursuing STEM majors and careers often demonstrate remarkable resilience and determination (Sendze, 2023). Their commitment to overcoming obstacles and succeeding in STEM underscores the importance of providing robust support systems to sustain their interest and engagement. This includes mentorship programs, scholarships, and academic resources tailored to

their needs (Ireland et al., 2018). Educational institutions and policymakers must prioritize these interventions to ensure Black women enter and thrive in STEM disciplines.

Academic support programs offering tutoring, mentorship, and enrichment activities have improved academic outcomes and retention rates (Jones & Perna, 2013). Financial aid initiatives, such as scholarships and grants specifically targeting underrepresented minorities, have also played a critical role in alleviating the financial burdens that hinder degree completion. Furthermore, efforts to create inclusive and supportive educational environments where Black women feel valued and empowered are essential for fostering their success in STEM. Addressing the multifaceted barriers that Black women face and implementing comprehensive support systems can enhance their representation and achievement in STEM fields, thereby contributing to a more diverse and innovative STEM workforce. Addressing these issues can help close the gap in STEM enrollment intentions and pave the way for greater diversity and innovation in these critical fields.

Moreover, initiatives aimed at fostering inclusive environments and supporting the career advancement of Black women are essential. Such initiatives include creating mentorship programs, offering leadership development opportunities, and implementing policies that actively counteract discrimination and bias (Corneille et al., 2019). Additionally, organizations must commit to transparent hiring and promotion practices and provide training on unconscious bias. By addressing these systemic issues, the STEM community can work towards creating an equitable environment where Black women can thrive and contribute their talents fully.

These results tell a story of persistent systemic challenges and immense opportunity to leverage Black women and girls' unique strengths and potential in STEM through targeted equity-driven reforms. This article provides pertinent data on current trends in AP examination participation, enrollment, degree attainment, and employment to inform the development of profiles for academically advanced Black girls in STEM. More specifically, the present study underscores the resilience and potential of Black women and girls in STEM while illuminating the systemic barriers they face. By aligning educational preparation with workforce demands and addressing inequities in access and support, educators, policymakers, and industry leaders can work together to forge smoother pathways for Black women and girls in STEM. Future research should continue to explore these dynamics, focusing on intersectional and longitudinal analyses that further elucidate the unique experiences of Black women in STEM education and careers. We also hope that higher education researchers and STEM professionals consider these data and our participatory obligations in forging smoother pathways along the STEM pipeline for academically advanced Black girls. Thus, we call for reimagining STEM education and workforce preparation to address structural inequities, promote diversity, and ensure that Black women and girls can fully realize their potential as resilient, creative, and productive STEM contributors.

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