

The Underrepresentation of African American Female Students in STEM Fields: Implications for Classroom Teachers

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African American women are underrepresented in STEM (science, technology, engineering and math) fields (Catsambis, 1994). The socialization and “under-education” of African American female students engenders ideas of inferiority, while the presence of an inferior race, sex and class, in one body, may produce an ideology of mediocrity. Data findings from NCES (national center for education statistics), College Board, the 2008-2009 Baccalaureate and beyond longitudinal study reaffirm African American girls’ weakness in math and science (NCES, 2009, 2011; College Board, 2011). To prevent African American female students from accepting societal beliefs that blame disparities in math and science on racial or gender inferiorities, recommendations encourage teachers to re-educate this group of girls by employing culturally relevant teaching practices that will undermine gender and racial biases within the classroom.

Keywords: African American female students, STEM (science, technology, engineering and math), culturally relevant pedagogy

Introduction

African American women are underrepresented in STEM (science, technology, engineering and math) fields (Price, 2010; as cited in Riegle-Crumb, Moore, & Ramos-Wada, 2010). Catsambis (1994) stated that when compared with other subgroups, women of color were significantly absent in STEM professions. Unfortunately, few researchers have examined how the dual presence of race and gender affect the educational experiences of these marginalized women. Rather, the issue of race and gender is often addressed in isolation (Catsambis, 1994; Riegle-Crumb et al., 2010). Seldom are these two features and their simultaneous effects thoroughly explored through empirical research so that certain truths may be revealed about the African American female’s experience. In an attempt to give an impactful voice to the often untold, misinterpreted and commercialized narratives of African American women, this paper examines the reluctance, exclusion, mis-opportunities and “under-education” of African American female students within K-12 (kindergarten thru 12th grade) and higher education, and offers educators suggestions on how to possibly improve the likelihood of African American female students pursuing STEM majors and careers.

Internal and external constituents may ask the reason why researchers should focus on African American female students’ entry into STEM professions. The answer lies in the intersection of race and gender within a

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profession that could potentially secure African American women “a seat at the table” and gain them power, authority and influence through the obtainment of financial security. Race beyond the discussion of African American men and gender beyond the topic of white women reveal an often neglected, yet unique perspective, which, from a noticeable member of a historically inferior race and sex, exposes subtle and at times blatant institutionalized barriers (Hall, 2004). Moreover, by examining and improving the detrimental schooling experiences that deter African American female students from pursuing STEM careers, perhaps a change in vocational choices may occur, which will aid African American female students in reaching their full potential, situating them within the educational realm instead of on the outer limits, and possibly providing them with greater life chances.

Race and gender, socially defined as physical and intellectual hindrances, create biases within STEM fields. Because of enduring racist and prejudice ideology that linger within the American society, those exhibiting features (the white and male) of the dominated race and gender have an innate advantage, afforded privileges of the ruling class (McIntosh, 1988). African American women, the stark contrast of what is deemed “normal”, are frequently deemed lesser in both ability and intellect. Unfortunately, whether consciously or unconsciously, the engrained perceptions, beliefs, and popular depictions of African American women, past and present, have led many to either overlook or discount their contributions and capabilities in STEM areas. Race and gender that deviate from the norm should be valued for possessing a two-dimensional perspective and unique life experiences that further STEM exploration. Instead, those possessing the existence of both features are often underestimated. This claim is solidified through the underrepresentation of women and people of color in contrast to the persisting domination by white men in STEM professions (Catsambis, 1994; Mickleson, 1989; Morganson, Jones, & Major, 2010; Riegle-Crumb et al., 2010; Van Langen & Dekkers, 2005).

Literature Review

One piece of legislation that sought gender equity within STEM education is Title IX of the Education Amendment Act (1972). Title IX states (as cited in Edwards, 2010, p. 300):

No person in the United States shall, on the basis of sex, be excluded from participating in, be denied, the benefit of, or be subjected to discrimination under any educational program or activity receiving federal financial assistance.

Though the good intentions of Title IX are clear, its goals have not yet been met. Ineffective enforcement practices by the US Department of Education’s Office of Civil Rights have led many educational institutions to weaken their resolve in promoting a gender equity environment (Kennedy, 2010; Walters & McNeely, 2010). Although female representation in often male-dominated areas has improved since the 1970s, disproportionalities remain, engendering a predominately male STEM workforce (Walters & McNeely, 2010). Likewise, disparities within education impede many African American female students from taking upper-level math and science courses in high school, majoring in STEM fields in college and securing STEM careers upon entering the workforce. These blatant realities reveal that gender discrimination is not being adequately addressed within the education arena. Instead, gender equity within the classroom has been minimized, as African American female students are identified as doing well when compared with their male counterparts (Rollock, 2007). This perception of doing well perpetuates the under-education of African American female students. Educators see African American female students outperforming African American male students in STEM related areas.

Rather than cultivating a passion for math and science exploration, African American female students are taught the fundamentals, but are often not further challenged academically in regular math and science courses. Though AP (advanced placement) courses by definition offer a higher degree of rigor, not all high schools provide AP courses at a higher, academically challenging level (Van Lagen & Dekkers, 2005). Furthermore, African American students are typically underrepresented in these high-level advanced placement courses (Solorzano, 2004; Whiting, 2009). How can African American female students strengthen their interests in math and science, if they are not exposed to higher-level concepts in these areas?

Far from well, a number of young African American female students, though initially desiring a career in STEM, have their hopes extinguished at an early age when excluded from many high-level math and science classes because of achievement tests and school tracking. This exclusion stems from the fact that a great number of African American female students, possessing low socioeconomic statuses, often experience poor academic preparation in STEM areas (Moses, Howe, & Niesz, 1999). Rather than placing the blame on where it is due (inadequate academic preparation), African American female students internalize this blame, attributing poor performance to personal inadequacies. Consequently, the utilization of achievement test and ability group tracking weakens African American female students' confidence in their personal abilities, formulating negative perceptions of math and science, while reinforcing inaccurate stereotypes about girls' strengths and weaknesses.

Though Title IX legally prohibits the denial of female students from public school courses, gender segregation still occurs within the classroom (Moses et al., 1999). Once African American female students are identified as low achievers, they are tracked from primary education to secondary education, placed in lower-level courses that prevent academic growth (DeSena & Ansalone, 2009; "Teaching Inequity", 1989). Ladson-Billings (1997) furthered this statement by asserting that schools with a large population of African American are plagued with less rigorous mathematics programs which limit students' exposure to high-level college preparation courses. Oakes et al. (1990; as cited in Ladson-Billings, 1997; Van Langen & Dekkers, 2005) also declared that these same schools possess fewer highly-qualified teachers. With these factors considered, how can Title IX feasibly eliminate gender discrimination and close the gender gap in education, if lax enforcement practices and countless disparities continue to academically stunt, not just African American female students, but a majority of American students?

One argument for the underrepresentation of African American female students in STEM fields asserted that these girls are simply disinterested in math and science exploration (Riegle-Crumb et al., 2010). This generalized argument does not draw an accurate nor comprehensive picture of the desires of many African American girls. Even if this statement held a bit a truth, its truth resides in the traditional and stereotypical depiction of scientists. When one considers a portrait of a scientist, an intellectual, nerdy image of a man wearing a lab coat with bifocals arched over the brim of his nose as he constructs experiments in his laboratory is formed (Ladson-Billings, 1997; Van Langen & Dekkers, 2005; Powell, 1990; Riegle-Crumb et al., 2010). Pictures of Aristotle, Albert Einstein, Sir Isaac Newton, Benjamin Franklin, Bill Nye the Science Guy, Dr. Jekyll and Mr. Hyde, and Victor Frankenstein solidify the accepted image of scientists. These pictures demonstrate that whether in fiction or in life, scientists are often depicted as white and male. This dominated image, not resembling African American female students, engenders a false assumption that these young girls should not aspire to become scientists, because either STEM careers are only designated for white men, or the obtainment of a STEM career would go against accepted traditional gender role

assignments for African American women. Sadly, these ideas are subtly implied through the absent images of African American female scientists both within the American education system and society. A student, regardless of race or gender, would probably assume that African American female scientist do not exist or are limited in number after continually exposed, year after year, to one concrete image of scientists. Imagine how these reoccurring illustrations of scientists may affect the vocational choices and aspirations of young African American female students.

In addition to bias images, traditional gender roles have contributed to the socialization of young African American girls. Societal gender stereotypes characterize women as emotionally driven, irrational, yet articulate, cooperative, dependent followers. In contrast, men, who are supposedly more suited for math and science fields, are logical, rational, competitive, problem-solving, independent explorers and producers (Altermatt & Kim, 2004; Tindall & Hamil, 2004). These stereotypes, emphasizing gender roles, do not only reside within society, but also have found their way into American households. For instance, traditional gender roles imply that fathers are more likely than mothers to manage the family's finances. Within this household, little girls are expected to play house, reinforcing their presence in the domestic sphere and furthering their emotional development, while little boys are equally expected to play sports and to construct, manipulate and dismantle toy figures (Tindall & Hamil, 2004). These subtle socially assigned activities and stereotypes that are deeply embedded into the American culture teach boys and girls early on about their appropriate gender roles, possibly affecting future course enrollment and career aspirations (Moses et al., 1999). Another factor that may deter African American female students from pursuing STEM careers is the conflict between STEM careers and family life. Catering to assigned gender roles, women are expected to take care of children, husbands and homes. STEM professions, which, in most cases, are full-time careers, are characterized as demanding and inflexible, qualities that oppose the requirements of motherhood (Van Langen & Dekkers, 2005; Moses et al., 1999). How is one to manage the demands of two equally, all-consuming occupations? Logic dictates that one area will suffer or will not even be explored.

Another issue that may cause the underrepresentation of African American female students in STEM fields is standardized testing. Standardized achievement tests which are deeply entrenched within the American education system (Grant, 2004) are misleading, but are still often considered as error proof. These glorified tests are the main measurement used to determine intelligence and future performance. Though it is often argued that these tests are not heavily weighed and do not solely affect the progress of students, not mastering these tests often produce detrimental results. As mentioned earlier, standardized tests are often used to track poor-performing students, restricting them to low-ability classes (DeSena & Ansalone, 2009; "Teaching Inequity", 1989). In addition, achievement tests, taken from third grade and beyond, show African American female students at an early age which subjects are "hard" and difficult to master and are incompatible with their own abilities. Rather than promoting practice through continual academic growth, what is implanted at an early age is not striving to overcome a challenge. Instead, African American female students take on the persona of simply being bad at math and science. After this idea is planted throughout primary, middle and secondary schooling, higher education continues the lesson, inculcating additional ideas of inferiority.

The SAT (scholastic achievement test), the gatekeeper of all college entry applications, is a three hour, multiple-choice exam that consists of both verbal and mathematics questions. This highly-weighted, impactful national standardized measure of students' performances not only determines college entry, but can also possibly psychologically affect which major a student will pursue after gaining entry into college.

Students who take this exam undergo emotions and fears, even though this standardized test is not linked to high school curriculum (Isaacs, 2001) and cannot predict with absolute certainty the future intellect performance of diverse students possessing different racial backgrounds, genders and socioeconomic statuses. Nevertheless, scores on the SAT supposedly provide objective feedback and solidify students' belief that they are either capable or incapable of successfully pursuing a STEM profession (Riegle-Crumb et al., 2010).

An additional discrepancy within the SAT is the known fact that women and minorities have historically scored lower on the exam than their white male counterparts and that economic status may affect one's score (Everson & Millsap, 2004; Isaacs, 2001). With these truths in mind, many African American female students are placed at a threefold disadvantage—race, gender and class. These disadvantages are heightened in the face of stereotype threat (Steele, 1997). Steele's (1997) theory of stereotype threat is consequential in nature. It claims that because people are cognizant of negative stereotypes associated with their social group, they feel pressures in certain situations where the stereotype is salient not to confirm the stereotype's existence. Consequentially, this pressure indeed causes impaired performance, presenting a confirmation of the assigned stereotype. Based on this theory, though African American female students may be knowledgeable, test anxiety on the SAT sparked by stereotype threat may hinder their performance. When declaring a major, stereotype threat may once again leave them fearful of confirming racial and gender stereotypes that women and people of color are innately bad at math and science (Altermatt & Kim, 2004; Steele, James, & Barnett, 2002). This mindset along with other unknown variables may explain the reason why African American female students choose to avoid or not complete STEM majors, predominately pursuing careers in the social sciences and the humanities (Mickelson, 1989; Powell, 1990).

Continually receiving low test scores in a particular subject area from childhood to young adult does little for one's academic self-esteem and confidence. Inevitably, one may display learned helplessness. Powell (1990) argued that after continual failed attempts at mastering mathematics and science, African Americans internalized learned helplessness, believing that failure to succeed at a task was beyond their control. Such an engrained ideology produces defeatist thoughts, preventing African American female students from pursuing and securing positions in STEM area—positions of power, authority and influence. Consequently, their reluctance to STEM fields prevents the obtainment of economic security. Presently, in this unstable economic climate, African American female students cannot afford to exclude themselves from STEM careers. Rosser (1990; as cited in Moses et al., 1999) furthered this thought by describing how opt-out of math and science prohibits women from 75% of college majors, limiting their career options as well as earning capabilities.

These learned helplessness, defeatist behaviors and thoughts are developed in the classroom especially under the direction of ineffective teaching practices. Rather than fostering and nurturing African American female students' interest in math and science, cultural and gender biased teaching practices contribute to the "under-education" of African American female students, implanting ideas of inferiority. To assist African American female students in the area of math and science, first classroom instruction and treatment should be void of gender biases. In addition to an instruction void of gender biases, Ladson-Billings (1997) also encouraged culturally relevant teaching (infusing one's culture into the teaching process so that more effective teaching and learning ensues). In order to lessen the achievement and gender gaps, the education system must consider the cultural and economic diversity of its students when solidifying curricula and instruction. Instead of tailoring curricula to the needs of white middle-class students (Ladson-Billings, 1997), the differing cultural

specific learning styles of all races must be considered.

Educators must understand that subjects, such as mathematics and science, are not culture free. Lacking such knowledge perpetuates the under-education of not just African American female students, but all students. As educators recognize the importance of culture, they will come to understand that “school mathematics (and science cannot be) presented in ways that are divorced from the everyday experiences of most students” (Ladson-Billings, 1997, pp. 700-701). By separating math and science from the real world, African American female students see these subjects as foreign, irrelevant things and in direct opposition to their culture. Rather than promoting engagement in mathematics and science that would benefit African American female students, as they negotiate their surroundings, memorization is instead deemed an appropriate way to ensure proficient scores on standardized tests. Ladson-Billings (1994) illustrated that all students, not just African American female students, will benefit from emphasizing a community of learners, asking students higher-level thinking questions, utilizing cooperative learning groups, providing supplemental materials that highlight the contributions of all races, building a strong student-teacher relationship and encouraging and caring about the academic success of each student. If these strategies are employed, perhaps then more African American female students will pursue degrees specializing in math or science, equipped with a solid education, so that they may politically, economically and socially elevate themselves within the set social structure.

Data

Data were retrieved from three separate sources: National Assessment of Educational Progress, College Board and the 2008-2009 Baccalaureate and Beyond Longitudinal Study (NCES, 2009; College Board, 2011; NCES, 2011). Table 1 employs data from the High School Transcript Study, a data set of the National Assessment of Educational Progress, retrieved from the National Center for Educational Statistics. The data explorer for the High School Transcript Study revealed the national combined GPA (grade point average) averages of 12th grade students in math and science. Tables 2 and 3 use the data from College Board’s “2011 College-Bound Seniors: Total Group Profile Report”. Specifically, mean scores from the SAT are examined. Table 4 was retrieved from the B & B: 2008-2009 (2008-2009 Baccalaureate and Beyond Longitudinal Study), which describes the enrollment and employment experiences of a national sample of college graduates who completed a bachelor’s degree in the academic year of 2007-2008, one year after they graduated. It addresses the percentage distribution of 2007-2008 first-time bachelor’s degree recipients by sex and race/ethnicity.

Table 1

Averages and Percentages for GPA-Combined Mathematics and Science Courses, Grade 12 by Race/Ethnicity Six Categories (RACE), Year, Jurisdiction and Gender (SEX): 2009

Race/ethnicity	Year	Jurisdiction	Male		Female	
			Average	Percentage	Average	Percentage
White (not Hispanic)	2009	National	2.67	50	2.87	50
Black (not Hispanic)	2009	National	2.24	46	2.44	54

Notes. The NAEP (National Assessment of Educational Progress) Science Scale ranges from 0 to 300. Detail may not sum to totals because of rounding. Some apparent differences between estimates may not be statistically significant. Adapted from US Department of Education, Institute of Education Sciences, National Center for Education Statistics, NAEP, HSTS (High School Transcript Study), 2009 Combined Math and Science GPA.

Table 2

Male SAT Mean Score by Ethnicity—College Board: College-Bound Seniors: Total Group Profile Report—Demographic Information

SAT	Test-taker	Critical thinking	Mathematics	Writing
Black or African American	95,939	425	435	405
White	410,811	531	552	507

Note. Adapted from College Board, 2011 *College-Bound Seniors: Total Group Profile Report*.

Table 3

Female SAT Mean Score by Ethnicity—College Board: College-Bound Seniors: Total Group Profile Report—Demographic Information

SAT	Test-taker	Critical thinking	Mathematics	Writing
Black or African American	119,877	430	422	426
White	454,849	526	520	524

Note. Adapted from College Board, 2011 *College-Bound Seniors: Total Group Profile Report*.

Table 4

Percentage Distribution of 2007-2008 First-Time Bachelor's Degree Recipients by Sex, Race/Ethnicity, Demographic and Enrollment Characteristics: 2009

Demographic and enrollment characteristics (Bachelor's degree major)	total	Sex		Race/ethnicity	
		Male	Female	White	Black
Stem major	16.3	25.5	9.7	16.0	14.9
Computer and information science	2.9	5.5	1.0	2.4	5.3
Engineering and engineering technology	6.1	11.6	2.0	6.0	4.7
Biological and physical science, science technology, mathematics, and agricultural science	7.4	8.4	6.7	7.6	4.9
General studies and others	3.0	2.5	3.4	3.0	2.9
Social science	15.5	13.5	16.9	14.6	14.8
Humanities	12.0	11.3	12.6	13.1	4.3
Health care fields	6.7	2.0	10.1	6.8	8.7
Business	23.3	27.6	20.3	22.4	33.7
Education	8.0	3.7	11.1	9.2	4.7
Other applied	15.1	14.0	15.8	14.9	16.1

Note. Adapted from U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, NAEP, Demography and Enrollment by Sex and Race/Ethnicity (2008-2009).

Findings

All four tables reveal a common trend. From high school to college and into the workforce, a disconnection exists between African American female students and the subjects of math and science. When examining combined math and science GPA averages for white and African American male and female students (see Table 1), white female students, averaging 2.87, are surprisingly outperforming white male students who possess an average GPA score of 2.67. Though African American female students are outperforming African American male students by 20%, African American female students lag behind both white male and female students.

SAT mean scores of white and African American male and female students (see Table 2 and Table 3) show that on the mathematics portion of the SAT, African American female students have a score of 422 trail behind African American males (435), white male (552) and female students (520). In critical thinking, African American female students exceed African American male students only by five points and continue to lag behind white male and female students whose mean scores are 531 and 526, respectively.

Table 4 is a result of the trends shown in the previous Tables 1-3, which shows a percentage distribution of majors completed by first-time bachelor's degree holders. Data provided for STEM majors affirm that African American female students are gravitating away from STEM careers. In regards to gender, male students lead in STEM pursuit with 25.5%, while female students only make up 9.7%. When examining race/ethnicity, white students represent 16% of STEM majors, while African American students only make up 14.9%.

The data provided showed that African American female students when compared to other subgroups are uncompetitive and lack needed skills in the area of math and science. From high school GPA to SAT scores to college major and degree, all of these components build on one another to engender the underrepresentation of these girls in STEM related fields. The only way to ensure changes in this cycle is for educators to ameliorate inadequate teaching practices that prevent African American female students from becoming literate in math and science. This change cannot begin with secondary or higher education. Primary school must be used as a vehicle to foster math and science exploration.

Discussion

The findings from the national databases explored in this study have crystallized the issue of African American female students' performances in K-12 STEM courses, SAT assessments and enrollment in post-secondary STEM majors. As a result, it is now clear that in order to alter this educational pipeline (Jackson & Moore, 2008), a new and concerted effort must be implemented to promote access, equity and achievement for African American female students in STEM courses at the K-12 level, particularly within the early grade levels. Success for African American female students will only come when teachers in our nation learn how to engage and nurture this population to embrace STEM opportunities (Landsman & Lewis, 2011). The literature is replete with examples (Emdin, 2010; Delpit, 1995; Ladson-Billings, 1997, 1994) that all students, particularly African American female students perform better when curriculum and instructional practices value their cultural backgrounds and utilize these cultural backgrounds effectively, so students can see their lives inside of the curriculum (Lewis, 2009). When teachers take the time to learn about their students and the most effective instructional strategies to reach this population, we can find that interest in fields, such as STEM become more appealing to students (Howell & Lewis, 2011).

Recommendations

To improve the academic achievement of African American female students in the K-12 schools, classroom teachers must take a more active role than ever before to push this population to achieve at a higher level in the STEM areas. The review of literature and the findings of this study indicate that teachers play a vital role in promoting the academic achievement of African American female students. As a result, the following recommendations are provided to teachers as professionals on the front-lines with African American students:

(1) Every attempt should be made to hold African American female students to the same academic standards as their male counterparts and their female counterparts from other races. Different levels of expectations impede the African American female students in their development (Landsman & Lewis, 2011);

(2) Educators must nurture African American female students' interest in math and science, initially encouraging these girls to pursue a non-traditional career path. Continual encouragement and constant exposure to math and science-related work should be accessible to these young girls;

(3) Teachers should be mindful of classroom participation engaging boys and girls in class discussions, asking both of them higher-level thinking questions, providing feedback, encouraging problem-solving, and setting high expectations in math and science classes for both genders (Tindall & Hamil, 2004);

(4) Teachers should not allow African American females to passively engage in memorizing math/science concepts. Hands-on application through active cooperative learning groups should be the norm;

(5) Teachers should infuse culturally relevant teaching strategies into math/science instruction. This that includes, but is not limited to acknowledging the contributions of African American women within math and science will help alidate young African American female students' presence in STEM areas in their mind.

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