Cultural Diversity in STEM

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Abstract

The United States' inability to achieve science, technology, engineering, and mathematics (STEM) workforce diversity goals has long been attributed to the failure of the academic "pipeline" to maintain a steady flow of underrepresented minority (URM) students (Estrada et al., 2016). These gains require a strategic effort to expand the labor force— increasing the number of well-educated and highly skilled STEM-capable professionals to maintain the pace of producing meaningful technological breakthroughs (Espinosa et al., 2019). Research suggests that the way that campuses deal with diversity can influence Students of Color's success and persistence (Harper & Yeung, 2013; Hurtado et al., 1998b). Notably, historically black colleges and universities (HBCUs) have been evidenced to play a crucial role in helping to diversify STEM disciplines (Perna et al., 2009). Using the U.S. Department of Education, National Center for Education Statistics, 2012/17 Beginning Postsecondary Students Longitudinal Study (BPS:12/17), I used the data lab software to conduct a frequency analysis. Further, this study examines gender among students majoring in STEM at HBCUs and aims to answer the following question: How strong is the association between Historically Black Colleges and Universities and Black students pursuing STEM degrees? In this analysis, I examined the percentage of students with a focus on STEM fields as a major field of study for the following variables: race/ethnicity, gender, and Historically Black Colleges/Universities. The wealth of research on African American college students' experiences primarily focuses on Black female students, since there are twice as many in comparison to male students. Current research is more reflective of female Black college students' experiences than Black male students. Consequently, this analysis showcases there is a strong association among Black women but a weak association among Black men.

Introduction

The United States' inability to achieve science, technology, engineering, and mathematics (STEM) workforce diversity goals has long been attributed to the failure of the academic "pipeline" to maintain a steady flow of underrepresented minority (URM) students (Estrada et al., 2016). These gains require a strategic effort to expand the labor force—increasing the number of well-educated and highly skilled STEM-capable professionals to maintain the pace of producing meaningful technological breakthroughs (Espinosa et al., 2019).

Research suggests that the way that campuses deal with diversity can influence Students of Color's success and persistence (Harper & Yeung, 2013; Hurtado et al., 1998b). Within PWIs, there is evidence that STEM disciplines are often unwelcoming to Students of Color and women (Carlone & Johnson, 2007; Ong et al., 2011). To address national priorities related to progress and innovation, and to facilitate advances in the grand domestic and international challenges in the U.S. workforce, STEM diversity matters (Centre for Strategy and Evaluation Services, 2003; National Academy of Sciences et al., 2011, p. 2017).

Matriculation into a Welcoming Environment

Further research has cited that it is not a lack of interest in science that causes attrition in STEM, but rather, that educational disadvantages are cumulative in nature. The Science builds on its content through grade levels and failures (of student learning, insufficiency of teaching, low school funding, etc.) can prevent students from mastering the prerequisite knowledge that they need to understand the content and continue to be motivated (Sasso, 2008). Minority students entering U.S. colleges demonstrate an equal interest in STEM as their Caucasian peers, yet they are only two-thirds as likely as Caucasians to earn bachelor's degrees in those fields (Koenig, 2009).

Moreover, research on climates within STEM disciplines at HBCUs demonstrates that Students of Color experienced welcome climates in these institutions (Lent et al., 2005; Whitten et al., 2004). More importantly, historically black colleges and universities (HBCUs) have been evidenced to play a crucial role in helping to diversify STEM disciplines (Perna et al., 2009). Historically black colleges and universities (HBCUs) are institutions of higher education in the United States that were established before the Civil Rights Act of 1964 with the intention of primarily serving the African-American community. Most of these institutions were founded in the years after the American Civil War and are concentrated in the Southern United States. (Anderson, 1988)

Although America's STEM workforce has grown more diverse over time, its numbers are still far below the level of diversity represented in the general population (Pew Research Center, 2018). A clear takeaway from the projected demographic profile of the nation is that the educational outcomes and STEM readiness of students of color will have direct implications on America's economic growth, national security, and global prosperity (Espinosa et al., 2019). Accordingly, there is an urgent national need to develop strategies to substantially increase the postsecondary and STEM degree attainment rates of Hispanic, African American, American Indian, Alaska Native, and underrepresented Asian American students (Espinosa et al., 2019).

The studies selected for this literature review consists of both qualitative and quantitative research which provides a greater definition of increasing diversity among students who are pursuing STEM majors. The quantitative studies rule out selection bias by conducting randomized controlled trials and the qualitative studies define a target population and sampling frame to match the sampling frame to the target population as much as possible.

Research Question

Some work suggests that HBCUs are especially successful in producing African American female STEM bachelor's degree recipients, implying that there may be a less positive gendered effect for men at HBCUs (e.g., Perna et al., 2009). With this conceptualization, this study is a comparative analysis of Black students majoring in STEM at HBCUs versus students that are not. Further, this study examines gender among students majoring in STEM at HBCUs and aims to answer the following question: How strong is the association between Historically Black Colleges and Universities and Black students pursuing STEM degrees?

Gender in STEM

Women are undoubtedly underrepresented among all students earning post-secondary STEM degrees. In 2013, The National Science Foundation (Macmillan, 2013) reported that although women receive at least 57% of post-secondary degrees, they only earn 30% of undergraduate degrees in STEM fields, such as engineering and computer science (Macphee, 2013). When comparing the attainment of STEM degrees among women and men, data show that gender is an institutionalized hindrance (Farinde, 2012). Gender creates boundaries—both internalized and externally felt—for those pursuing STEM degrees. Research also shows that though many women feel the impact of gender-STEM stereotypes, women across varying ethnic groups might feel stereotypes in different ways and to differing extents (O'Brien, 2015). Rhetoric and research related to expanding the science, technology, engineering, and mathematics (STEM) pipeline implicitly reference an antiquated White, male-female dichotomy (Lundy, 2013). In this paradigm, STEM fields are associated with White men, academic rigor, and the manual labor associated with related work (Slaton, 2010). While this orientation undoubtedly marginalizes White women and women of color, it can also trivialize the experiences and outcomes of men of color in the context of the STEM pipeline (Lundy, 2013).

Based on a preliminary conjecture, my hypothesis is that there is a strong relationship between Black students pursuing STEM degrees at HBCUs. Referring to the literature, it is evident that a quality education is necessary to prepare students to enter the STEM workforce. Yet, institutional barriers prevent minorities, specifically black students from accessing the resources needed to launch a career in STEM.

With this, I posit that HBCUs can offer innovative strategies to the higher education landscape at large when it comes to increasing diversity among students who are pursuing STEM degrees.

Settings

Although research on HBCUs is often contrasted with the behavior, achievement, and outcomes of Black students at PWIs (Allen, 1992; Flowers, 2002; Gurin & Epps, 1975; Kim & Conrad, 2006; Nasim et al., 2005) gender is often not focal—a fact that is not necessarily fatal. In the comparative research that does address gender at HBCUs (e.g., Bonner, 2001; Fleming, 1984; Harper et al., 2004) the literature almost exclusively fixates on female experiences and marginalization with little attention to the experiences of men (as an exception, see Davis, 1994).

This research contributes to the scholarship that examines how the educational outcomes and STEM readiness of students of color will have direct implications for America's economic growth, national security, and global prosperity (Espinosa et al., 2019). It also has practical consequences for K–12 practitioners, higher education practitioners, STEM organizational recruiters, and policymakers seeking to positively address the STEM gap.

Data Sources and Sample

The source of this study is the U.S. Department of Education, National Center for Education Statistics, 2012/17 Beginning Postsecondary Students Longitudinal Study (BPS:12/17). The sample used for this study is the Beginning Postsecondary Students Longitudinal Study (BPS) which currently surveys cohorts of first-time, beginning students at three points in time: at the end of their first year, and then three and six years after first starting in postsecondary education. It collects data on a variety of topics, including student demographic characteristics, school and work experiences, persistence, transfer, and degree attainment.

Additionally, this study is examining students' major field of study with a focus on STEM fields 2011-12 by Historical black college indicator at the first institution. For the purposes of this analysis, the following variables are being examined:

Independent Variable: Gender, Race/Ethnicity

Dependent Variable: Pursuing a major field of study in a STEM field, Historically Black College or University (HBCU)

Analytical Methods

Using the U.S. Department of Education, National Center for Education Statistics, 2012/17 Beginning Postsecondary Students Longitudinal Study (BPS:12/17), I used the data lab software to conduct a frequency analysis. In this analysis, I examined the percentage of students with a focus on STEM fields as a major field of study for the following variables: race/ethnicity, gender, and Historically Black Colleges/Universities. Each graph presents a percentage breakdown of the variables and findings are reported.

Findings

Table 1. STEM field choices by HBCU status for Black males

	Major field of study with a focus on STEM fields 2011-12				
	Math/Computer/Sciences/ Engineering/Technologies (%)	Social/behavioral sciences (%)	Non-STEM field (%)	Undecided or not in a degree program (%)	Total
Overall	18.59	2.98	71.66	6.78	100.00
Historical black college indicator at first institution 2011-12					
No	18.74	2.71	72.51	6.04	100.00
Yes	17.02	5.76*	62.76	14.46*	100.00

Note: * indicates small sample size; interpret with caution

As Table 1 shows, the percent of Black males who chose to major in STEM was slightly lower in HBCUs, at 17%, as compared to 19% at non-HBCUs. This means that the percentage of Black males who pursue STEM degrees in HBCU's is much lower compared to Black males who pursue a STEM degree at other higher education institutions.

Table 2. STEM field choices by HBCU status for Males

	Major field of study with a focus on STEM fields 2011-12				
	Math/ Computer/Scienc (%)	Social/behavioral sciences (%)	Non-STEM field (%)	Undecided or not in a degree program (%)	Total
Overall	26.26	4.36	62.50	6.87	100.00
Historical black college indicator at first institution 2011-12					
No	26.35	4.36	62.52	6.78	100.00
Yes	19.80	4.98*	61.21	14.01*	100.00

Note: * Indicates small sample size; interpret with caution

As Table 2 shows, the percent of Males who chose to major in STEM was slightly lower in HBCUs, at 20%, as compared to 26% at non-HBCUs. This means that the percentage of Males who pursue STEM degrees in HBCU's is much lower compared to Males who pursue a STEM degree at other higher education institutions.

Table 3. STEM field choices by HBCU status for Females

	Major field of study with a focus on STEM fields 2011-12				
	Math/Computer/Sciences/Engineering/Technologies (%)	Social/behavioral sciences (%)	Non-STEM field (%)	Undecided or not in a degree program (%)	Total
Overall	10.49	7.89	76.28	5.33	100.00
Historical black college indicator at first institution 2011-12					
No	10.33	7.79	76.50	5.38	100.00
Yes	20.03	13.29*	64.0	2.73*	100.00

Note: * Indicates small sample size; interpret with caution

As Table 3 shows, the percent of Females who chose to major in STEM was much higher in HBCUs, at 20%, as compared to 10% at non-HBCUs. This means that the percentage of females who pursue STEM degrees in HBCU's is much higher compared to females who pursue a STEM degree at other higher education institutions.

Table 4. STEM choices by HBCU status for Black Females

	Major field of study with a focus on STEM fields 2011-12				
	Math/Computer/Sciences/Engineering/Technologies (%)	Social/behavioral sciences (%)	Non-STEM field (%)	Undecided or not in a degree program (%)	Total
Overall	9.59	7.89	79.12	3.41*	100.00
Historical black college indicator at first institution 2011-12					
No	8.24	7.21	81.05	3.5*	100.00
Yes	22.04	14.21*	61.17	2.58*	100.00

Note: * Indicates small sample size; interpret with caution

As Table 4 shows, the percent of Black females who chose to major in STEM was much higher in HBCUs, at 22%, as compared to 8% at non-HBCUs. This means that the percentage of Black females who pursue STEM degrees in HBCU's is much higher compared to Black females who pursue a STEM degree at other higher education institutions.

Discussion and Conclusion

In summary, research into the experiences of underrepresented minorities has identified a host of additional barriers, including college affordability, self-confidence, feelings of exclusion, and teachers' low expectations of such students (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, 2011).

This analysis contributes to the scholarship that examines how the educational outcomes and STEM readiness of students of color will have direct implications for America's economic growth,

national security, and global prosperity (Espinosa et al., 2019). It also has practical consequences for K–12 practitioners, higher education practitioners, STEM organizational recruiters, and policymakers seeking to positively address the STEM gap.

The wealth of research on African American college students' experiences primarily focuses on Black female students, since there are twice as many in comparison to male students. Current research is more reflective of female Black college students' experiences than Black male students.

Additionally, while research has been conducted on Black male college students, there is very little research on Black males who are majoring in a STEM discipline. Despite the gains by HBCUs in promoting the undergraduate STEM pipeline among African Americans in general, research on this racial group and these institutions consistently fails to consider male students (Lundy, 2013). This omission appears shortsighted given the large and persistent disparities in Black male and female achievement throughout the educational pipeline (Cuyjet, 2006; Lundy & Firebaugh, 2005; Mandara, 2006; Mickelson & Greene, 2006), and at HBCUs (Kimbrough & Harper, 2006; Lundy-Wagner & Gasman, 2011; Palmer, Davis, & Maramba, 2011; Palmer & Gasman, 2008).

The data indicate that many African American women who attend HBCUs persist to and through undergraduate STEM degree programs. Many of these women are high-achieving students and, although not a monolithic group, much of their success is directly attributed to the best practices of their undergraduate institutions.

For example, example, a study (Perna, 2009) conducted at the all-women's HBCU, Spelman College, found that the Black women who participated in the STEM programs felt that their shared interest in STEM yielded more of a supportive and uplifting environment. There was not an overwhelming sense of competition among the women because they felt their priority was to earn a degree and help their peers earn a degree to better inform the narrative of Black women's ability to achieve and persist in the STEM field (Perna, 2009). In addition, to support from peers, the study also found that institutional structures, policies, and practices contribute to the attainment of women and minorities in STEM fields (Perna, 2009).

Consequently, this analysis showcases there is a strong association among Black women but a week association among Black men. Within the race-specific context of HBCUs, gender inequality is primarily equated with female advantage or disadvantage, ignoring African American men (Lundy, 2013). Similarly, within the STEM context, White and Asian men are equated with prominence, while historically underrepresented men, similar to Black men, are overlooked and virtually ignored (Lundy, 2013). This approach is used to guide the research design, and data analysis by providing attention to Black men and critiquing the lack of explicit attention to this group as an important element of the Black HBCU STEM pipeline.

Therefore, the limitations include the need for more research on Black males pursuing STEM degrees. Also, the sample size is small which can potentially render this study meaningless.

Early research related to gender at HBCUs, and gender in STEM at HBCUs suggests that African American men dominate the STEM landscape (Allen, 1992; Fleming, 1984). While a few scholars specifically explore African American men in STEM (e.g., Maton, Hrabowski, & Greif, 1998; Moore, 2006; Stinton, 2006), none comprehensively characterizes their experiences or outcomes at PWIs or HBCUs. Failure to identify and acknowledge gendered STEM realities may contribute to the paltry growth in Black STEM degree completion nationwide, but especially at HBCUs.

References

Allen, W. R. (1992). The color of success: African American college student outcomes at a predominately White and historically Black public colleges and universities. *Harvard Educational Review, 62,* 26–44.

Anderson, J. D. (1988). *The education of Blacks in the South*, 1860–1935. University of North Carolina Press.

Beasley, M. (2011, November 1). *Opting Out*. University of Chicago Press. https://press.uchicago.edu/ucp/books/book/chicago/O/bo12079574.html.

Bonner, F. B. (2001). Addressing gender issues in the historically Black college and university community: A challenge and call to action. *The Journal of Negro Education, 70*, 176-191.

Centre for Strategy and Evaluation Services. (2003). *The costs and benefits of diversity: A study on methods and indicators to measure the cost-effectiveness of diversity policies in enterprises* [Executive summary]. European Commission.

Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline. (2011). *Expanding underrepresented minority participation*. National Academies Press.

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*(8), 1011–1245.

Cohn, D. V., & Caumont, A. (2020, July 27). *10 demographic trends that are shaping the US and the world*. Pew Research Center. https://www.pewresearch.org/fact-tank/2016/03/31/10-demographic-trends-that-are-shaping-the-u-s-and-the-world/

Cuyjet, M. J. (2006). *African American men in college*. Jossey-Bass.

Davis, J. E. (1994). College in black and white: Campus environment and academic achievement of African American males. *The Journal of Negro Education, 63*, 620–633.

Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., Hurtado, S., John, G. H., Matsui, J., McGee, R., Okpodu, C. M., Robinson, T. J., Summers, M. F., Werner-Washburne, M., & Zavala, M. (2016). Improving underrepresented minority student persistence in STEM. *CBE—Life Sciences Education, 15*(3), es5. https://doi.org/10.1187/cbe.16-01-0038

Espinosa, L. L., Mcguire, K., Jackson, L., National Academies of Sciences, Engineering, and Medicine Committee on Closing the Equity Gap, & Board on Higher Education and Workforce Policy and Global Affairs. (2019). *Minority serving institutions: America's underutilized resource for strengthening the STEM workforce*. The National Academies Press.

Farinde, A. A. & Lewis, C. W. (2012). *The underrepresentation of African American female students in STEM fields: Implications for classroom teachers* [Online Submiss.]. Retrieved April 9, 2018, from https://files.eric.ed.gov/fulltext/ED533550.pdf

Fleming, J. (1984). Blacks in college: A comparative study of students' success in Black and in White institutions. Jossey-Bass.

Flowers, L. A. (2002). The impact of college racial composition on African American students' academic and social gains: Additional evidence. *Journal of College Student Development, 43*, 403–410.

Gurin, P., & Epps, E. G. (1975). *Black consciousness, identity, and achievement: A study of students in Historically Black Colleges*. Wiley.

Harper, C. E., & Yeung, F. (2013). Perceptions of institutional commitment to diversity as a predictor of college students' openness to diverse perspectives. *The Review of Higher Education, 37*(1), 25–44. https://doi.org/10.1353/rhe.2013.0065

Harper, S. R., Carini, R. M., Bridges, B. K., & Hayek, J. C. (2004). Gender differences in student engagement among African American undergraduates at Historically Black Colleges and Universities. *Journal of College Student Development, 45*, 271–284.

Hurtado, S., Milem, J. F., Clayton-Pederson, A. R., & Allen, W. R. (1998). Enhancing campus climates for racial/ethnic diversity: Educational policy and practice [Qualitative summary of the literature]. *The Review of Higher Education, 21*(3), 279–302. https://doi.org/10.1353/rhe.1998.0003

Kim, M. M., & Conrad, C. F. (2006). The impact of Historically Black colleges and Universities on the academic success of African American students. *Research in Higher Education, 47*, 399–425

Kimbrough, W. M., & Harper, S. R. (2006). African American men at Historically Black Colleges and Universities: Different environments, similar challenges. In M. J. Cuyjet (Ed.), *African American men in college* (pp. 189–209). Jossey-Bass.

Koenig, R. (2009). Minority retention rates in science are sore spots for most universities. *Science, 324*(5933), 1386–87.

Lent, R. W., Brown, S. D., Sheu, H. B., Schmidt, J., Brenner, B. R., Gloster, C. S., Wilkins, G., Schmidt, L. C., & Lyons, H. (2005). Social cognitive predictors of academic interests and goals in engineering: Utility for women and students at Historically Black Universities. *Journal of Counseling Psychology 52*(1), 84–92. https://doi.org/10.1037/0022-0167.52.1.84

Lundy, G. F. & Firebaugh, G. (2005). Peer relations and school resistance: Does oppositional culture apply to race or gender. *The Journal of Negro Education 74*, 233–245.

Lundy-Wagner, V., & Gasman, M. (2011). When gender issues are not just about women: Reconsidering male students at historically Black colleges and universities. *Teachers College Record 113*, 934–968.

Lundy-Wagner, V.C. (2013). Is it really a man's world? Black men in science, technology, engineering, and mathematics at Historically Black Colleges and Universities. *The Journal of Negro Education, 82*(2), 157–168. https://doi.org/10.7709/jnegroeducation.82.2.0157

MacMillan, D. (2011). National Center for Science and Engineering Statistics (NCSES). *Reference Reviews, 25*(6), 40–41. https://doi.org/10.1108/09504121111156201

MacPhee, D., Farro, S., Canetto, S. S. (2013). Academic self-efficacy and performance of underrepresented STEM majors: Gender, ethnic, and social class patterns. *Anal. Soc. Issues Public Policy, 13*, 347–369.

Mandara, J. (2006). The impact of family functioning on African American males' academic achievement: A review and clarification of the empirical literature. *Teachers College Record, 108*, 206-223.

Maton, K. I., Hrabowski, F. A., III, & Greif, G. L. (1998). Preparing the way: A qualitative study of high-achieving African American males and the role of the family. *American Journal of Community Psychology, 26*, 639–668.

Mickelson, R. A., & Greene, A. D. (2006). Connecting pieces of the puzzle: Gender differences in Black middle school students' achievement. *The Journal of Negro Education, 75,* 34–48.

Moore, J. L. (2006). A qualitative investigation of African American males' career trajectory in engineering: Implications for teachers, school counselors, and parents. *Teachers College Record, 108*, 246–266.

Nasim, A., Roberts, A., Harrell, J. P., & Young, H. (2005). Non-cognitive predictors of academic achievement for African Americans across cultural contexts. *The Journal of Negro Education, 74*, 344–358.

National Academy of Sciences, National Academy of Engineering, & Institute of Medicine. (2011). *Expanding underrepresented minority participation: America's science and technology talent at the crossroads*. The National Academies Press. https://doi.org/10.17226/12984

O'Brien, L. T., Blodorn, A., Adams, G., Garcia, D. M., Hammer, E. (2015). Ethnic variation in gender-STEM stereotypes and STEM participation: An intersectional approach. *Cult. Divers. Ethn. Minor. Psychol., 21*, 169–180.

Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational Review, 81*(2), 172–209. https://doi.org/10.17763/haer.81.2.t022245n7x4752v2

Palmer, R. T., & Gasman, M. (2008). 'It takes a village to raise a child': Social capital and academic success for African American men at a historically Black college. *Journal of College Student Development, 49*, 52–70.

Palmer, R. T., Davis, R. J., & Maramba, D. C. (2011). The impact of family support on the success of Black men at an historically Black university: Affirming the revision of Tinto's theory. *Journal of College Student Development, 52*, 577–597.

Perna, L, Lundy-Wagner, V., Drezner, N. D., Gasman, M., Yoon, S., Bose, E., & Gary, S. (2009). The contributions of HBCUs to the preparation of African American women for STEM careers: A case study. *Research in Higher Education, 50*(1), 1–23. https://doi.org/10.1007/s11162-008-9110-y

Sasso, A. (2008). African Americans studying STEM: Parsing the numbers. *Science*. Retrieved from https://www.sciencemag.org/careers/2008/05/african-americans-studying-stem-parsing-numbers

Stinton, D. W. (2006). African American male adolescents, schooling (and mathematics): Deficiency, rejection, and achievement. *Review of Educational Research, 76*, 477–506.

Whitten, B. L., Foster, S. R., Duncombe, M. L., Allen, P. E., Heron, P., McCullough, L., Shaw, K. A., Taylor, B. A., & Zorn, H. M. (2004). Like a family: What works to create friendly and respectful student-faculty interactions. *Journal of Women and Minorities in Science and Engineering, 10*(3), 229–242. https://doi.org/10.1615/JWomenMinorScienEng.v10.i3