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The United States is at a critical juncture in its ability to remain internationally competitive in science, technology, engineering, and mathematics (STEM). At present, too few people from diverse populations, including women, participate in the STEM academic and workforce communities. This series of issue briefs is produced by American Institutes for Research (AIR) to promote research, policy, and practice related to broadening the participation of traditionally underrepresented groups in STEM doctoral education and the workforce.

AIR supports the national effort to prepare more students for educational and career success in STEM by improving teaching and providing all students with 21st century skills needed to thrive in the global economy; meeting the diverse needs of all students—especially those from underrepresented groups; and using technology, evidence, and innovative practice to support continuous improvement and accountability.

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The Role of Historically Black Colleges and Universities as Pathway Providers: Institutional Pathways to the STEM PhD Among Black Students

Introduction

The participation of diverse groups of individuals in the science, technology, engineering, and mathematics (STEM) academic and workforce communities is severely lacking, particularly in the context of the nation's shifting demographic landscape (American Institutes for Research, 2012). The need to broaden participation in STEM is particularly salient for those who identify as African American or Black. In 2008, Blacks represented 12 percent of the U.S. population and 11 percent of all undergraduate enrollments, but they earned just 9 percent of STEM bachelor's degrees in 2009 (American Institutes for Research, 2012). In 2010, Blacks received 7 percent of all bachelor's degrees awarded in the biological sciences, 6 percent in the physical sciences, 5 percent in mathematics and statistics, and only 4 percent of the bachelor's degrees awarded in engineering (NSF, 2011). This disproportionately low level of STEM participation and degree completion among Blacks calls into question the extent to which Blacks have equitable access and opportunity in STEM academic pathways from undergraduate to doctoral level education. It also raises questions about the higher educational pathways and characteristics of Blacks who have persisted in STEM and gone on to earn the highest of degrees—the doctorate.

Historically Black colleges and universities (HBCUs) may hold a unique advantage in the nation's efforts to bolster the participation of Black individuals in the STEM academic and workforce communities and might play an especially critical role in increasing the number of Black STEM PhD holders. HBCUs represent just 3 percent of the nation's population of higher education institutions, and despite relatively small endowments and low institutional resources, HBCUs have remained among the nation's top educators of Blacks who go on to earn STEM doctoral degrees¹ (Solorzano, 1995; Strayhorn, 2008; Strayhorn, Williams, Tillman-Kelly, & Suddeth, 2012). HBCUs contributed 19 percent of the nearly 9 percent of all bachelor's degrees in science and engineering awarded to Blacks in 2010 (Gasman & Nguyen, 2014). By 2010, approximately 33 percent of all Black students who earned bachelor's degrees in mathematics and statistics attended HBCUs, and HBCUs

¹ In 2010, 22 percent of all HBCUs in the U.S. offered doctoral degree programs or doctoral and professional degree programs (Palmer, Hilton, & Fountaine, 2012).

produced nearly 37 percent of all Black undergraduates who received bachelor's degrees in the physical sciences (Gasman & Nguyen, 2014). In 2009, Blacks earned approximately 2 percent of all U.S. STEM doctoral degrees, and less than 2 percent of the doctorates in the physical sciences (Washington, 2011). Moreover, data drawn from the Survey of Earned Doctorates² and the Integrated Postsecondary Education Data System³ suggest that by 2010, HBCUs generated nearly 10 percent of all Black STEM doctoral degree recipients.

An examination of Black STEM PhD recipients' institutional pathways to the doctorate can provide insight into who among Black students are earning STEM doctoral degrees, whether Black students are earning these degrees at HBCUs or other types of institutions, and the extent to which they being supported financially in their degree pursuits. Studies demonstrate that HBCUs tend to produce a larger percentage of STEM bachelor's degrees among Blacks than do predominantly white institutions (PWIs; American Institutes for Research, 2012; Strayhorn et al., 2012). It should be noted that little research investigates the role HBCUs or other types of institutions play in Black students' degree attainment when moving from an undergraduate STEM degree to a STEM doctorate. This brief aims to further explore the institutional pathways of Black STEM PhD recipients by focusing special attention on the different characteristics and financial supports of these individuals by type of institutional pathway taken to the doctorate. Specifically, this brief examines the following questions:

1. How many STEM doctoral degrees were awarded to Black students overall and by discipline of study?
2. What proportion of Black STEM PhD recipients earned their doctoral degrees from HBCUs, and which HBCUs were the top producers of Black STEM PhD recipients?
3. What are the institutional pathways of Black STEM PhD recipients?
4. How do the characteristics of Black STEM PhD recipients, including discipline of study, citizenship status, gender, first-generation college status, and level of graduate student funding and graduate student debt, differ by institutional pathway taken to the STEM doctorate?

Data were examined between 2005 and 2010 in order to maximize the sample size and to take advantage of the most recent years of data available at the time the analyses were conducted. During this timeframe, the data suggested that Blacks and other underrepresented minorities⁴ exhibited a large increase in STEM doctoral degree completion, yet these individuals constituted only a small percentage of the U.S. citizens who earned STEM doctorates. Key findings include the following:

Among Black STEM PhD recipients who earned their degrees between 2005 and 2010:

- *More than one third earned their undergraduate degrees at an HBCU.*
- *Twelve percent earned their doctorates at an HBCU.*
- *A few HBCUs stood out as top producers of Black STEM PhD recipients, though there was variation among the top-producing HBCUs by discipline of study.*
- *Most Black STEM PhD recipients earned their bachelor's or doctoral degrees at PWIs, but attending an HBCU as an undergraduate or graduate student was more common among Black U.S. citizens, women, and first-generation college students than Black STEM PhD recipients who were non-U.S. citizens, men, or had at least one parent with a college degree.*
- *Low levels of graduate funding and tuition support and high levels of graduate debt were more common among Blacks who earned doctoral degrees from an HBCU than among Blacks who earned their doctorates from a PWI.*

² The National Science Foundation's Survey of Earned Doctorates is an annual census conducted since 1957 of all individuals who receive a research doctorate from an accredited U.S. institution for a given academic year. For more information on the Survey of Earned Doctorates, please see <http://www.nsf.gov/statistics/srvydoctorates/>.

³ The Integrated Postsecondary Education Data System is a system of interrelated surveys conducted annually by the U.S. Department of Education's National Center for Education Statistics. The Integrated Postsecondary Education Data System gathers information from each college, university, and technical and vocational institution that participates in federal student financial aid programs. For more information on the Integrated Postsecondary Education Data System, please see <http://nces.ed.gov/ipeds/>.

⁴ Groups of individuals who are considered to be underrepresented minorities in STEM education are Blacks or African Americans, Hispanics/Latinos, and Native Americans.

Definition of Terms

PWI: Institution of higher education in which Whites generally account for 50 percent or more of the student enrollment (Brown & Dancy, 2010)

HBCU: Institution of higher education in the U.S. that was established prior to 1964 and was created with the intention of serving the Black community⁵

Institutional pathway: Type of undergraduate and type of graduate institution (HBCU or PWI) through which Black STEM PhD recipients passed in the course of earning a doctorate. Four institutional pathways of Black STEM PhD recipients are examined in this brief:

1. HBCU undergraduate degree and HBCU graduate degree
2. HBCU undergraduate degree and PWI graduate degree
3. PWI undergraduate degree and HBCU graduate degree
4. PWI undergraduate degree and PWI graduate degree

Citizenship status: PhD recipients who identified as U.S. citizens or permanent residents were defined as U.S. citizens in this brief. PhD recipients who identified as non-U.S. citizens and nonpermanent residents were defined as non-U.S. citizens.

First-generation college status: College students whose parent(s) had not attained a college degree

Graduate funding: Funding received while in graduate school from research assistantships, teaching assistantships, graduate fellowships, grants, or graduate traineeships (Graduate funding does not include other external sources of funding such as student loans.)

Tuition support: The level of tuition remission a student received during his or her graduate program tenure (“No tuition support” means a student did not receive any tuition remission; “partial tuition” means less than one third tuition remission, between one third and two thirds tuition remission, or more than two thirds tuition remission; and “full tuition” means 100 percent tuition remission.)

Four levels of graduate student funding and tuition support are defined in this brief:

1. No funding and no tuition support⁶
2. Funding but no tuition support
3. Funding and partial tuition support
4. Funding and full tuition support

Graduate debt: Four levels of graduate student debt, or the amount of debt accrued during graduate school, by a student at the time of earning the degree:

1. No graduate debt
2. Less than \$20,000 graduate debt
3. Between \$20,001 and \$30,000 in graduate debt
4. Greater than \$30,000 in graduate debt

Methodology

STUDY DESIGN

When focusing on Blacks or other minorities, within-group designs provide several advantages over studies that compare outcomes across separate racial and ethnic groups. A within-group design is a study that examines a single ethnic group or several ethnic groups that are considered a unit, such as Asian Americans (McLoyd & Steinberg, 1998). Thus, to more fully explore Black STEM PhD recipients’ pathways to the doctorate, this study used a within-group design rather than a race-comparative design. The within-group design allowed us to examine Blacks as a racial group on its own terms and explore the variation in characteristics and pathways to the doctorate of Black STEM PhD recipients.

DATA SOURCES

The data analyzed in this brief are drawn from the National Science Foundation’s (NSF) 2005–2010 Survey of Earned Doctorates (SED)⁷ and the National Center for Education Statistics (NCES) 2010 Integrated Postsecondary Education Data System (IPEDS).⁸ The SED provided data on student-level demographics and graduate student funding and indebtedness. The 2010 IPEDS data were used to categorize the type of institutions (e.g., HBCU, PWI) from which SED respondents reported earning their undergraduate and graduate degrees.

⁵ Definition taken from the White House Initiative on Historically Black Colleges and Universities (<http://www.ed.gov/edblogs/whhbcu/>).

⁶ Because of low cell frequencies, we combined Black STEM PhDs who received no graduate funding and either no tuition, partial tuition, or full tuition into a single category.

⁷ For more information on the NSF’s SED survey, please see <http://www.nsf.gov/statistics/srvydoctorates/>.

⁸ For more information on the National Center for Education Statistics (NCES) IPEDS data, please see <http://nces.ed.gov/ipeds>.

SAMPLE

The initial sample included 4,037 SED respondents who were of any citizenship status, who met the criterion of identifying as Black or African American on the SED, and who had earned a STEM degree between 2005 and 2010. This initial sample was limited to a final sample size of 2,713⁹ (1,294 respondents were removed because their undergraduate institution was located outside the U.S.,¹⁰ and an additional 30 respondents were removed because they reported that they did not receive an undergraduate degree¹¹). About 13 percent of the PhD recipients in the final analytic sample were not U.S. citizens, meaning they were either temporary U.S. residents or non-U.S. citizens whose visa status was unknown.

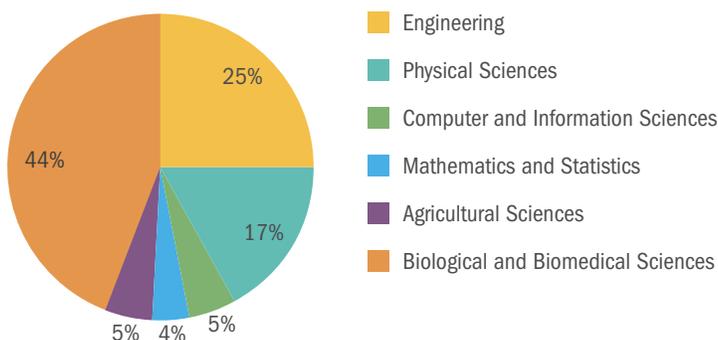
ANALYTIC APPROACH

Descriptive statistics and chi-square tests of independence were used to examine the extent to which the characteristics of Black STEM PhD recipients differed by the type of institutional pathway taken to the doctorate. Statistically significant results are reported at the .05 alpha level.

Black STEM PhD Production

Research shows that the number of bachelor's degrees attained in mathematics and the agricultural sciences is disproportionately low for Blacks and other racial and ethnic minorities (American Institutes for Research, 2012). Studies also show that Black students complete doctoral degrees in STEM fields overall at disproportionately low rates; yet few studies disaggregate and examine Black STEM PhD production by specific STEM disciplinary fields and the institutions that produce the most Black STEM PhD recipients in specific STEM disciplinary fields. As noted earlier, slightly more than 4,000 STEM doctoral degrees were awarded to Black PhD students between 2005 and 2010. Among the 2,713 Black STEM PhD recipients who met the criteria for inclusion in our analyses, slightly less than one half (44 percent) earned PhDs in the biological and biomedical sciences and slightly more than one quarter (25 percent) earned PhDs in engineering. Most of the remaining PhD recipients in the sample earned degrees in the physical sciences (17 percent); few earned degrees in the computer and information sciences, agricultural sciences, or mathematics and statistics (Figure 1).

Figure 1. Distribution of Black STEM PhD Recipients, by Discipline of Study: 2005–2010



⁹ A primary question of interest was to examine STEM PhD recipients' institutional pathways (i.e., whether PhD recipients attended HBCUs or PWIs for their undergraduate and doctoral degrees). Hence, we removed individuals who reported earning no bachelor's degree or no bachelor's and no master's degree prior to receiving their PhDs.

¹⁰ Because the study focused on comparing PhD recipients who attended HBCUs and PWIs in the United States, respondents who earned their bachelor's degree from an institution outside the United States were removed from the analyses.

¹¹ The SED variable "Banone" was used to determine whether Black STEM PhD recipients earned no bachelor's degree or no bachelor's and no master's degree prior to completing their doctorates.

Top-Producing HBCUs of Black STEM PhD Recipients

Approximately 12 percent of Black STEM PhD recipients earned their doctoral degrees from an HBCU. The majority of Blacks who received a STEM doctoral degree from an HBCU received their PhD from Howard University (33 percent), Meharry Medical College (14 percent), or Florida A&M University (9 percent; Table 1).

Table 1. Top Ten HBCU Producers of Black STEM PhDs: 2005–2010

Institution	Percentage of STEM Degrees Awarded Among HBCUs
Howard University	33
Meharry Medical College	14
Florida A&M University	9
Alabama A&M University	8
Morgan State University	7
Clark Atlanta University	6
Jackson State University	6
North Carolina A&T University	4
Morehouse School of Medicine	4
Tennessee State University	3

The top-producing HBCUs by STEM disciplinary group reveal slightly different results than Table 1 shows and provide a more nuanced understanding of the roles HBCUs play in graduating Black STEM PhD holders in the various STEM disciplines.¹² Howard University was one of the highest HBCU producers of Black doctoral degree recipients in the biological and biomedical sciences, in the physical sciences, and in the mathematics and statistics and computer and information sciences. Meharry Medical College also generated more than one quarter of the Blacks earning doctorates from HBCUs in the biological and biomedical sciences (27 percent). Morgan State University and Florida A&M University were the top HBCU producers of Blacks graduating with engineering degrees, however; and Alabama A&M University produced nearly 50 percent of all Black STEM PhD recipients who received an agricultural sciences PhD from an HBCU (see Table 2).

Table 2. Top HBCU Producers of Black STEM PhD Recipients, by Discipline of Study: 2005–2010¹³

Institution	Percentage of All Degrees Awarded
Biological and Biomedical Sciences	
Howard University	45
Meharry Medical College	27
Morehouse School of Medicine	8
Tennessee State University	7
Clark Atlanta University	6
Engineering	
Morgan State University	30
Florida A&M University	24
North Carolina A&T University	22
Tuskegee University	11
Howard University	11

¹² Because of low cell frequencies, we combined mathematics and statistics and the computer and information science disciplines when examining the top HBCUs that produced Black STEM PhDs.

¹³ We provide data for the number of top producers to the point where cell frequencies become too low to report data. When cells are small, percentages for only one HBCU are provided for Black STEM PhDs in mathematics and statistics and the computer and information sciences.

Institution	Percentage of All Degrees Awarded
Physical Sciences	
Howard University	42
Jackson State University	17
Clark Atlanta University	15
Florida A&M University	12
Alabama A&M University	8
Agricultural Sciences	
Alabama A&M University	49
Jackson State University	27
Florida A&M University	14
Mathematics and Statistics and Computer and Information Sciences	
Howard University	50

Institutional Pathways of Black STEM PhD Recipients

More than one third of Blacks who received a STEM PhD between 2005 and 2010 earned their undergraduate degrees at an HBCU, but most of these students went on to earn their graduate degrees from PWIs (88 percent). Approximately 9 percent of the Black STEM PhD recipients in the analytic sample earned both an undergraduate and a graduate degree from an HBCU. Few (3 percent) earned an undergraduate degree from a PWI and then went on to earn a graduate degree from an HBCU. A more common institutional pathway to the STEM degree for Black PhD recipients was earning an undergraduate degree at an HBCU and a graduate degree from a PWI (26 percent). The most common pathway was earning both an undergraduate degree and a graduate degree from a PWI (62 percent; Figure 2).

Black STEM PhD recipients were most likely to attend the same type of institution for both their undergraduate and graduate education than to move from one type of institution to another type of institution. Specifically, of those who received a STEM PhD at an HBCU, approximately 72 percent earned their undergraduate degree from an HBCU (in comparison with 28 percent who earned an undergraduate degree at a PWI). Among those who received a STEM PhD at a PWI, 71 percent earned their undergraduate degree from a PWI (relative to 29 percent who earned an undergraduate degree at an HBCU). Thus, Black students who received their undergraduate degree from an HBCU were more likely to go on to earn a PhD from an HBCU and vice versa (Figure 3).¹⁴

Figure 2. Institutional Pathways of Black STEM PhD Recipients: 2005–2010

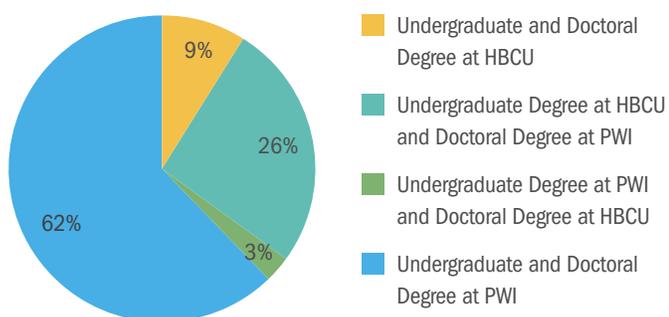
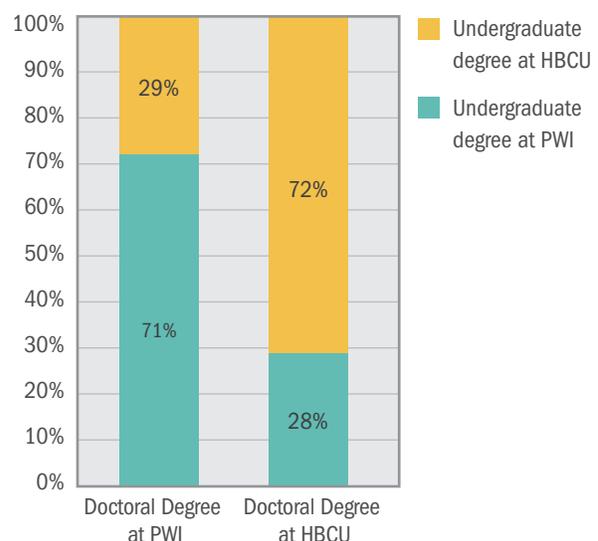


Figure 3. Undergraduate and Doctoral Degree Institutions Attended by Black STEM PhD Recipients: 2005–2010



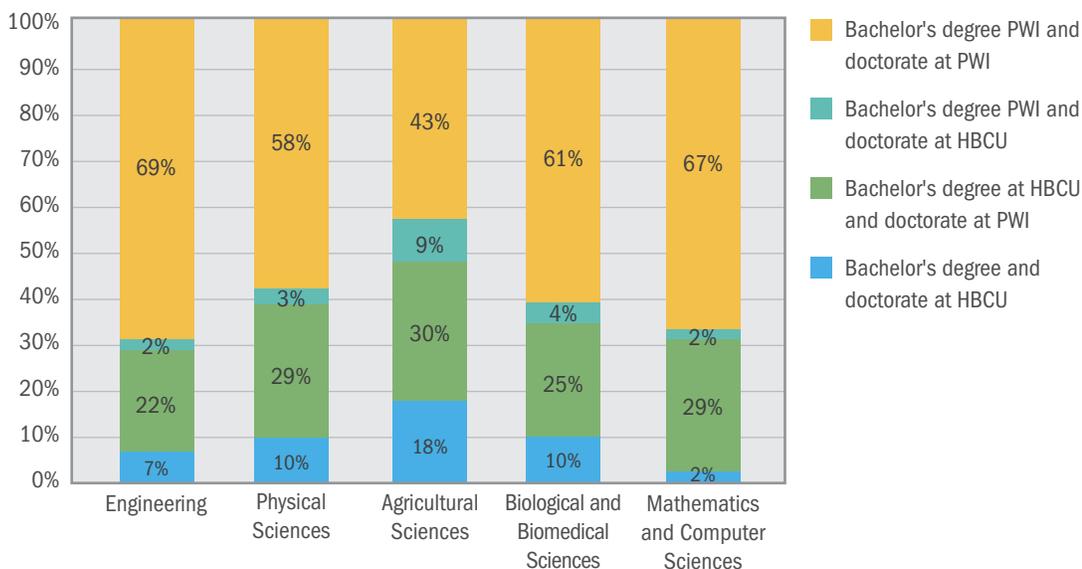
¹⁴ Results from a chi-square test of independence showed that there was a significant relationship between the type of undergraduate and doctoral institution STEM PhD recipients attended, $\chi^2(1, N = 2,713) = 232.1, p < .001, \phi = .29$.

INSTITUTIONAL PATHWAYS BY DISCIPLINE OF STUDY

The institutional pathway patterns discussed provide an overall picture of Black STEM PhD recipients' pathways to the STEM doctorate but do not account for possible variation in pathways by discipline of study. As discussed earlier, at least among HBCUs, the top producers of Black PhD recipients differed in the discipline of study that their students followed to earn their degrees.

Across most STEM disciplines, the majority of Black PhD recipients earned both their undergraduate and graduate degrees from PWIs; primarily following a PWI pathway was especially common among those who graduated with degrees in engineering or in mathematics and statistics and computer and information sciences. It was somewhat more common among Black STEM PhD recipients in the agricultural sciences than degree recipients in the other disciplines to earn an undergraduate degree from an HBCU (48 percent).¹⁵ A considerable percentage of Blacks who earned degrees in the physical sciences also earned their undergraduate degrees from an HBCU (39 percent; see Figure 4).

Figure 4. Institutional Pathways for Black STEM PhD Recipients, by STEM Discipline: 2005–2010



INSTITUTIONAL PATHWAYS BY CITIZENSHIP STATUS

As noted earlier, the majority of the Blacks in the analytic sample were U.S. citizens, but approximately 13 percent were not U.S. citizens. Black STEM PhD recipients who were U.S. citizens were more likely to earn both their undergraduate and graduate degrees from HBCUs than Black non-U.S. citizens.¹⁶ Whereas slightly more than one third of Black U.S. citizens with STEM degrees earned an undergraduate degree from an HBCU, nearly one quarter of Black non-U.S. citizens began their pathway to the doctorate at an HBCU (Figure 5). Moreover, while 10 percent of Black STEM PhD recipients who were U.S. citizens earned both their undergraduate and graduate degrees from HBCUs, just 3 percent of Black non-U.S. citizens took this same institutional pathway to the doctorate.

INSTITUTIONAL PATHWAYS BY GENDER

Slightly more than half of the Black STEM PhD recipients in the sample were female (52 percent). Female and male Black STEM PhD recipients differed slightly in the institutional pathways to the doctorate, with an HBCU undergraduate degree more common among Black women than among Black men. Although the majority of both females and males

¹⁵ Results from a chi-square test of independence showed that there was a significant relationship between discipline of study and Black STEM PhD recipients' institutional pathways, $\chi^2(12, N = 2,713) = 75.1, p < .001, V = .10$.

¹⁶ Results from a chi-square test of independence showed that there was a significant relationship between citizenship status and Black STEM PhD recipients' institutional pathways, $\chi^2(3, N = 2,713) = 32.6, p < .001, V = .11$.

earned both their undergraduate and graduate degrees from a PWI, a higher percentage of men than women took this route to the doctorate (68 percent, in contrast with 57 percent;¹⁷ see Figure 6).

Figure 5. Institutional Pathways for Black STEM PhD Recipients, by Citizenship Status: 2005–2010

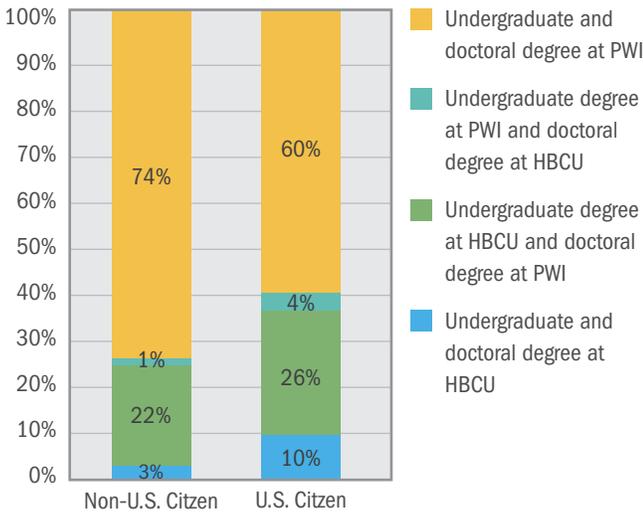
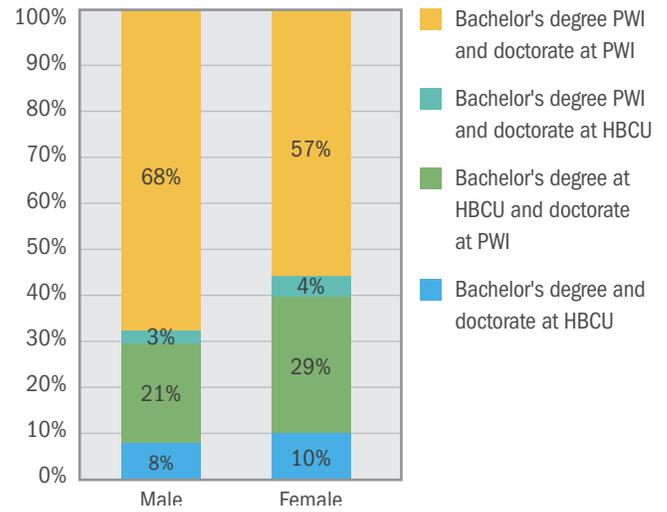


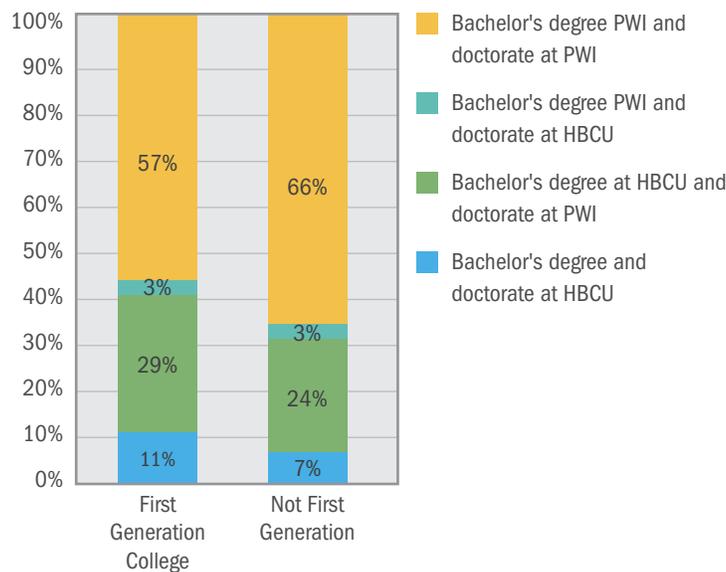
Figure 6. Institutional Pathways for Black STEM PhD Recipients, by Gender: 2005–2010



INSTITUTIONAL PATHWAYS BY FIRST-GENERATION COLLEGE STATUS

Nearly 40 percent of the total sample of Black STEM PhD recipients identified as first-generation college students. Earning an undergraduate degree from an HBCU was more common among first-generation Black STEM PhD recipients than among Black STEM PhD recipients who had at least one parent with a college degree. Nearly 30 percent of first-generation Black STEM PhD recipients attended an HBCU as an undergraduate before completing their doctoral degrees at a PWI, in contrast with 24 percent of their non-first-generation peers. In addition, a slightly higher percentage of the first-generation college students in the sample attended only HBCUs on their pathways to the STEM doctorate (11 percent, in comparison with 7 percent; see Figure 7).¹⁸

Figure 7. Institutional Pathways for Black STEM PhD Recipients, by First-Generation College Status: 2005–2010



¹⁷ Results from a chi-square test of independence showed that there was a significant relationship between gender and Black STEM PhD recipients' institutional pathways, $\chi^2(3, N = 2,713) = 35.2, p < .001, V = .11$.

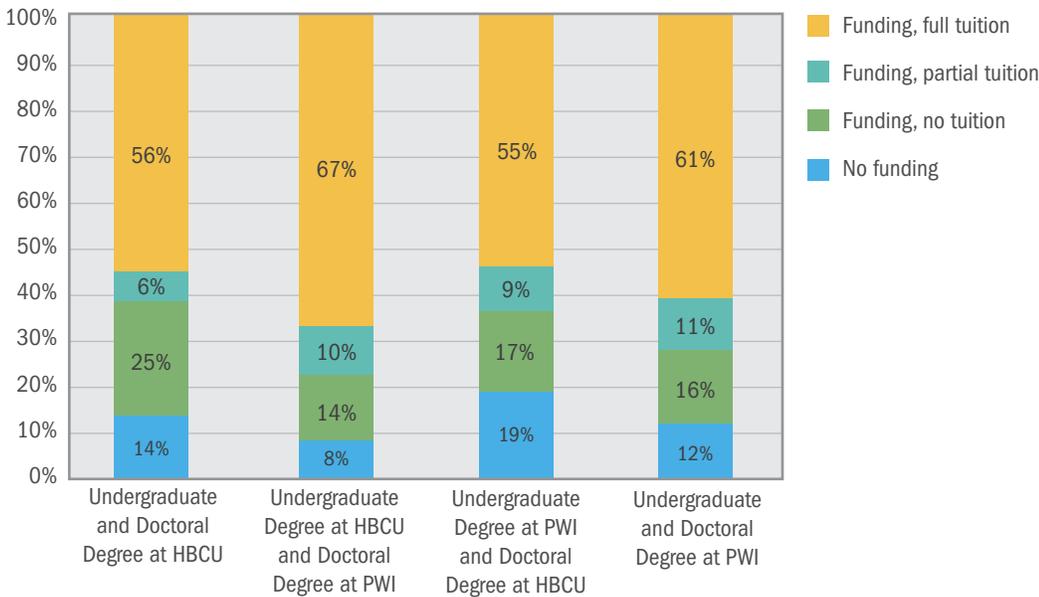
¹⁸ Results from a chi-square test of independence showed that there was a significant relationship between first-generation college status and Black STEM PhD recipients' institutional pathways, $\chi^2(3, N = 2,528) = 27.2, p < .001, V = .10$.

Graduate Student Funding and Graduate Student Debt by Institutional Pathway

Across institutional pathways, most Black STEM PhD recipients received full tuition support for their graduate education, but this level of support was most common among those who had earned their undergraduate and graduate degrees at PWIs: 67 percent of Black STEM PhD recipients who earned undergraduate degrees at HBCUs but graduate degrees from PWIs received funding and full tuition support, in comparison with 55, 56, and 61 percent of doctoral degree recipients who took other institutional pathways to the doctorate.

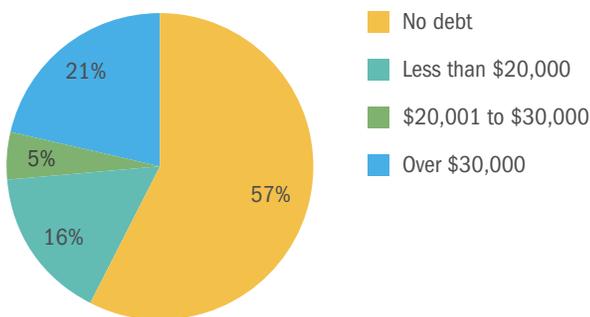
Notably, Black STEM PhD recipients who earned their graduate degrees at a PWI had the smallest percentage of graduates reporting no graduate funding and no tuition support (8 percent). Black STEM PhD recipients who earned their doctorates from HBCUs had the highest percentages of graduates reporting no support. Fourteen percent of HBCU undergraduate degree holders who went on to earn their graduate degrees at an HBCU received no funding and no tuition support, as did 19 percent of those who attended a PWI as an undergraduate but earned their graduate degree from an HBCU¹⁹ (see Figure 8).

Figure 8. Institutional Pathways for Black STEM PhD Recipients, by Level of Graduate Funding: 2005–2010



Most Black STEM PhD recipients reported having no graduate student debt after completion of their doctoral program (57 percent). A sizable proportion of Black STEM PhD recipients (approximately 21 percent), however, had more than \$30,000 in graduate student debt (see Figure 9).

Figure 9. Level of Graduate Student Debt for Black STEM PhD Recipients: 2005–2010

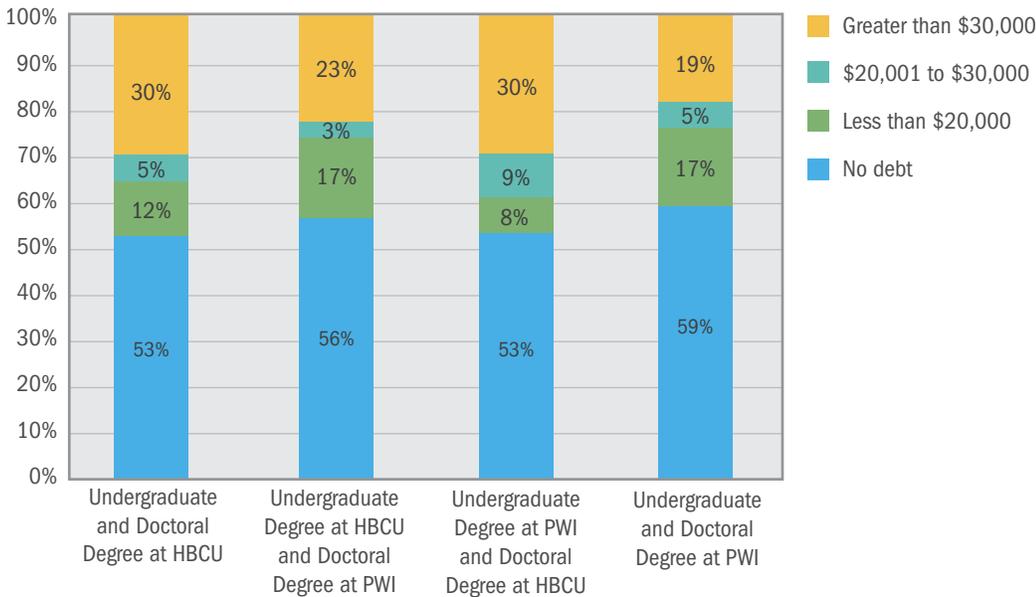


¹⁹ Results from a chi-square test of independence showed that there was a significant relationship between level of graduate funding and tuition support and Black STEM PhD recipients' institutional pathways, $\chi^2(9, N = 2,430) = 30.2, p < .001, V = .06$.

Similar proportions of Black STEM PhD recipients on all institutional pathways graduated with no debt—ranging from a low of 53 percent to a high of 59 percent. PhD recipients who attended only PWIs were the most likely to graduate with no debt.

Black PhD recipients who attended only PWIs also were least likely to have high debt, with only 19 percent of graduates reporting greater than \$30,000 of graduate student debt. In comparison, 30 percent of Black STEM PhD recipients who earned their doctoral degrees from HBCUs, regardless of undergraduate institution attended, reported having more than \$30,000 in graduate student debt²⁰ (Figure 10).

Figure 10. Institutional Pathways for Black STEM PhD Recipients, by Level of Graduate Funding: 2005–2010



Discussion

The data in this brief reveal the important role HBCUs play in the institutional pathways of Black STEM PhD recipients, particularly at the undergraduate level. Approximately one third of Black STEM PhD recipients who earned their doctoral degrees between 2005 and 2010 reported starting their STEM education at an HBCU. Howard University, Meharry Medical College, Florida A&M University, and Alabama A&M University consistently stood out as the top HBCU producers of Black STEM PhD recipients, across many of the specific STEM disciplines of study. Morgan State University and North Carolina A&T University were identified as top HBCU producers of Black STEM PhD recipients in engineering.

Although most Black STEM PhD recipients took PWI institutional pathways to the doctorate, earning at least an undergraduate degree, if not both undergraduate and doctoral degrees, from an HBCU was most common among Black STEM PhD recipients who were U.S. citizens, females, and first-generation college students; all groups of individuals who are presently among the most underrepresented in the STEM academic and broader workforce.

One possible reason that the success of HBCUs in producing Black STEM PhD recipients has continued, particularly among U.S.-born Blacks, females, and first-generation students, is their focus on student supports and their ability to better foster academic and social integration in science and engineering among Blacks than PWIs. Another possible reason that HBCUs succeed in generating Black STEM graduates is that HBCUs generally avoid the traditional model of STEM education that promotes the competitive, “survival of the fittest” mentality that is more common at PWIs (Gasman & Nguyen, 2014). HBCUs also require fewer “weed-out” courses than most PWIs;

²⁰ Results from a chi-square test of independence showed that there was a significant relationship between level of graduate debt and Black STEM PhD recipients’ institutional pathways, $\chi^2(9, N = 2,570) = 34.2, p < .001, V = .07$.

provide more encouragement for persistence in STEM, even when additional academic support or remedial education is needed; and are more likely to facilitate peer mentoring and relationship building among students and faculty (Allen, 1992; Allen & Jewell, 2002; Gasman & Nguyen, 2014). Another factor that may contribute to HBCUs' success in moving Black students through STEM degree pathways is that they typically provide Black students more access to same-race and same-sex mentors, and Blacks at HBCUs report collaborating with STEM faculty and report fewer incidents of racial stereotyping than Blacks at PWIs (Allen, 1992; Allen & Jewell, 2002; Gasman & Nguyen, 2014). Furthermore, research indicates the transition from HBCU undergraduate programs to PWI graduate programs can be difficult for Black women in STEM, who are likely to report academic difficulties and social isolation at PWIs after leaving a supportive HBCU environment (Brown, 2000; Joseph, 2007; MacLachlan, 2006; Ong, Wright, Espinosa, & Orfield, 2011).

Prior research and our data also suggest some of the disadvantages of HBCUs. PWIs generally enjoy larger endowments, provide more academic and financial resources for students, and often lead to stronger career prospects for graduates (Allen, 1992; Allen & Jewell, 2002; Strayhorn, 2008). For example, students who graduate from PWIs tend to have higher average earnings than students who graduate from HBCUs (Strayhorn, 2008). This may be of critical importance because prior research suggests that Blacks in higher education settings, particularly those who attend HBCUs, have more economic barriers and financial need and are at high risk of accumulating graduate debt (Allen, 1992; Freeman, 1999). Certainly, our results confirm that this is the case among Black STEM PhD recipients. The most extreme level of graduate student debt—greater than \$30,000—was most common among Black STEM PhD recipients who earned their doctoral degrees from HBCUs. Likewise, the lowest level of graduate funding and tuition support was most commonly observed among Blacks who earned their STEM doctorate from an HBCU. Notably, Blacks who earned undergraduate degrees at HBCUs but their STEM doctorate at PWIs had the highest percentage of individuals reporting that they received graduate funding and full tuition support for their graduate education (67 percent). PWIs generally obtain more academic funding and institutional resources than HBCUs, which might explain, in part, HBCU doctorates' low level of graduate funding and high level of graduate debt. Indeed, students who attend graduate school with no graduate funding supports or tuition assistance are at greater risk of accruing graduate debt than students who receive such supports; especially if they have limited access to other external sources of funding or the financial resources to pay out of pocket for their educational pursuits.

This mix of advantages and disadvantages for Black students taking HBCU rather than PWI institutional pathways to STEM doctoral degrees provides important insight into the continued role of HBCUs in producing Black STEM PhD recipients and the characteristics of the students whose pathway to the doctorate and include at least one pass through an HBCU.

Additional research may examine further the graduate funding and graduate debt among those attending HBCU PhD programs and mechanisms that could be put in place to increase funding and tuition support for Black students attending HBCUs. Further research also is needed to explore the experiences of Black STEM PhD recipients who take these various institutional pathways to the doctorate and investigate what demographic factors and institutional pathways are associated with increases in Blacks' academic persistence and success in STEM fields. Questions future research can examine include factors associated with Black HBCU STEM doctorates' reporting lower levels of graduate funding and higher levels of graduate debt than their counterparts at PWIs and the ways that institutional- and individual-level factors (e.g., attending an HBCU or a PWI, having same race/sex mentors, having a sense of academic belonging) affect Black STEM PhD recipients' retention and PhD completion.

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