Capacity Building to Diversify STEM

Realizing Potential among HBCUs

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS

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NSF

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Findings from the National Evaluation of the Historically Black Colleges and Universities Undergraduate Program

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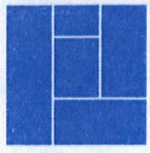

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The Urban Institute's Program for Evaluation and Equity Research (PEER) focuses on education research. PEER staff, who carried out this evaluation, conduct studies of educational attainment, educational access, minorities in mathematics and science, teacher education, teacher recruitment and retention, and educational assessments.

The opinions, conclusions, and recommendations expressed in this document are those of the authors and do not necessarily reflect the views of the National Science Foundation or the Urban Institute.

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Executive Summary

The Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), administered by the National Science Foundation (NSF) Directorate for Education and Human Resources, Division of Human Resource Development, began in 1998. The goal of HBCU-UP is to enhance the quality of undergraduate education and research in science, technology, engineering and mathematics (STEM) at HBCUs as a means to broaden participation in the nation's STEM workforce. Between 1998 and 2009, the program made 139 institutional awards for a total of over $200 million.

The external evaluation, commissioned by NSF in 2006, focused on the implementation projects funded under the HBCU-UP program, which are five-year, institutionwide STEM education and research capacity-building projects. Given great flexibility to design and implement strategies that address each institution's STEM needs and long-term goals, projects tended to focus on institutional capacity-building activities such as curriculum development and faculty professional development. NSF expected projects to produce "significant improvements in undergraduate STEM education and research programs" (National Science Foundation 2006). The evaluation of HBCU-UP measured changes carried out by grantees, and whether those changes were associated with the ultimate program outcome of contributing to the education and retention of minority students in STEM (as a means to broaden participation in the STEM labor force).

The Urban Institute evaluation of the HBCU-UP program included both process and summative components, seeking to understand the implementation of the program and to measure its ultimate outcomes. The process component relied mostly on qualitative methods (interviews and case studies) to study the characteristics of funded projects as well as the factors that may promote or inhibit the attainment of project goals. Results guided the definition of the HBCU-UP model of institutional capacity building and informed the thrust of this evaluation: the summative component. The summative evaluation relied on qualitative and quantitative methods to analyze the course revisions carried out by institutions, the experiences and opinions of participating faculty, the educational progression and career outcomes of graduates of HBCU-UP projects, and, most importantly, the efficacy of the HBCU-UP model. Through a quasi-experimental design that compared HBCU-UP faculty and graduates to nationally representative samples of each—the analysis led to five conclusions and recommendations.[1]

Conclusions

1. *HBCU-UP grantees succeeded in building an institutional infrastructure that supports the education of STEM majors.* Institutions carried out curricular and instructional reforms, provided faculty professional development, established academic support services for students, engaged in collaborative relationships with other institutions and entities, and upgraded their laboratory and STEM instructional equipment. Some succeeded in institutionalizing key project components.

2. *The HBCU-UP program yielded an intervention model characterized by a core set of strategies associated with successful student outcomes.* Core strategies include curricular reform, faculty professional development, and summer bridge programs. Alumni from institutions that employed all core strategies were more likely to stay in the STEM education pipeline, and those employed in STEM were more likely to have earned a graduate degree.

3. *Successful HBCU-UP projects shared elements that suggest that effective projects* (a) design interventions to address well-defined problems; (b) provide a comprehensive array of strategies that span institutional infrastructure improvement, faculty development, and student support services; (c) tailor their strategies and activities to their institutional mission and characteristics; and (d) institutionalize the key components of their projects.

4. *HBCU-UP graduates outperform national samples of STEM baccalaureate degree holders in degree completion and in participation in the STEM workforce with a graduate degree.* Compared to STEM graduates nationally, HBCU-UP alumni were more likely to have sought and obtained graduate degrees (overall and in STEM), equally likely to be in STEM jobs, and more likely to

hold graduate degrees while employed in STEM. Compared to African American STEM graduates nationally, HBCU-UP graduates (mostly African Americans) were more likely to be employed in STEM, and more likely to be employed in STEM and hold a graduate degree in any field and in STEM. This suggests that HBCU-UP graduates are making a double contribution to the STEM workforce: they are more likely to enter the STEM workforce than African Americans nationally and are also more likely to bring higher levels of academic training than STEM baccalaureate degree holders nationally.

5. *The HBCU-UP program has been successful in contributing to the education and retention of women, and minority women, in STEM.* Women HBCU-UP graduates outperform women nationally in educational attainment, overall and in STEM, and in STEM employment outcomes. These results also hold when restricting the comparison by ethnicity. HBCU-UP African American female graduates outpace a national comparison of African American female STEM bachelor's degree recipients. In addition, women HBCU-UP alumni have higher predicted probabilities of graduate degree completion (marginal and cumulative) than men and national benchmarks.

Recommendations

1. *Encourage the inclusion of core model components in proposals from HBCU-UP grant applicants.* Core model components are associated with successful student outcomes and seem crucial to transforming grantee institutions by enhancing their capacity to produce STEM graduates who go on to complete STEM graduate programs and enter the STEM workforce.

2. *Emphasize the inclusion of project components that strengthen the link to graduate studies, particularly in the early post-undergraduate years.* A higher share of HBCU-UP alumni completed graduate programs than national comparison students, particularly in the first two years after graduating with a bachelor's degree. Because this advantage declines with time, projects should emphasize activities that strengthen an early transition to graduate school.

3. *Consider characteristics of successful projects in selecting sites for grant awards under the HBCU-UP program.* Reviewers should look for the following characteristics in grant applications to make award recommendations: (a) a clear identification of problems to be addressed; (b) a comprehensive approach that encompasses student support, faculty support, and institutional infrastructure change; (c) an intervention tailored to the needs and context of the institution and its students; and (d) plans to institutionalize major project components.

4. *Encourage dissemination of findings and lessons learned to the HBCU community.* The evaluation identified critical components of an intervention model that is associated with successful STEM outcomes at HBCUs, and grantees possess a wealth of knowledge and experience in implementing model components that can be replicated by other institutions. Successful grantees should be encouraged and funded to share their experiences and assist in replicating the HBCU-UP core model.

5. *Use the knowledge gained through the HBCU-UP program regarding the production of African American STEM workforce talent to inform the policies and practices of predominantly white institutions (PWIs).* Successful HBCU-UP grantees can provide model policies and practices that can be adapted for use by PWIs, where the majority of African Americans are educated.

Introduction

Historically black colleges and universities (HBCUs) have a very special niche in the higher education system in the United States. Although the education of black slaves was banned in most Southern states, just 25 years after the Civil War approximately 100 colleges and universities for African Americans had been established, primarily in the South. All HBCUs addressed three primary goals of educating black youth, training teachers, and continuing the missionary tradition by educated African Americans (Allen and Jewell 2002).

A modification in 1890 of the Land Grant Colleges Act of 1862 resulted in the rapid establishment (by 1899) of several state-supported technical and industrial colleges for African Americans in the South (Allen and Jewell 2002; Wenglinsky 1997). These institutions—together with existing private colleges, which tended to provide a liberal arts education—became the core of black postsecondary education for the following 60 years (Wenglinsky 1997). This "separate but equal" system of higher education was severely underfunded at state and local levels (Allen and Jewell 2002). A combination of factors—among them lack of funding and outright hostility on the part of the white Southern establishment—conspired to limit the ability of these institutions to provide equal educational opportunity to their target populations.

After desegregation and *Brown v. Board of Education*, when previously restricted traditionally white universities reluctantly admitted African Americans, the national enrollment of African Americans in colleges grew significantly. Growth was accompanied by a shift in patterns of where African Americans attended college: whereas in 1950 the great majority of African Americans were enrolled in HBCUs, by 1975 three-quarters were attending traditionally white institutions. The share of black students enrolling in HBCUs declined over time (from about one-quarter in the 90s to 19 percent in 2007), but the share of degrees awarded to black students by HBCUs is consistently larger than their share of enrollment, suggesting higher student retention of black students at HBCUs than at other institutions (Allen and Jewell 2002; Wenglinsky 1997). Recent statistics suggest that HBCUs continue to educate large numbers of black students and enrollments experienced a 15 percent increase between 1990 and 2007.[2]

But HBCUs face a tremendous challenge in educating a large share of African American postsecondary students, as they continue to be underfunded and to lack adequate resources (Freeman, Perna, and King 1999; Suitts 2003; Wenglinsky 1997). Consequently, the National Science Foundation established a funding program to assist HBCUs in building their institutional capacity to educate students, called the Historically Black Colleges and Universities Undergraduate Program (HBCU-UP). This report is based on the Urban Institute's evaluation of the HBCU-UP program. The report consists of an introduction that describes the role of HBCUs as producers of minority scientists and engineers and identifies the goals and characteristics of the HBCU-UP program. Details regarding the methodology used to conduct the evaluation and findings from the process and summative components of the evaluation follow. The report ends with a summary of key conclusions and recommendations.

Role of HBCUs in Producing Scientists and Engineers

HBCUs have been praised for outperforming traditionally white institutions (TWIs) in educating black students for careers in several professions, including science, engineering, and business (Barthelemy 1984; Garibaldi 1984; Jackson 1984; Wenglinsky 1997). They have also contributed enormously to widening the pool of African American college students. Black HBCU students tend to come from families of lower socioeconomic status than their counterparts at TWIs, leading researchers to conclude that these institutions enroll students who might otherwise not be able to attend college due to economic, social, or academic barriers (Allen 1992; Bennett and Xie 2003; Wenglinsky 1997). In addition, HBCUs also have higher retention and graduation rates for black students than do TWIs, resulting in their producing a disproportionately large share of the bachelor's degrees awarded to African

Americans (Allen 1992; Astin, Tsui, and Avalos 1996; Bennett and Xie 2003). Studies of baccalaureate origins have consistently shown HBCUs to be significant producers of black doctoral recipients (Brazziel 1983; Pearson and Pearson 1985; Solorzano 1995). What are the implications of these findings for the role of HBCUs in the production of scientists and engineers for the U.S. workforce?

The higher graduation rates of HBCUs, coupled with the greater propensity of HBCU graduates to pursue STEM graduate degrees, suggest their potential as a major source of black professionals in science and engineering. And, indeed, HBCUs have made significant contributions to the pool of black science and engineering professionals in the nation. Research studies have found that African American students at HBCUs are more likely than their counterparts at TWIs to pursue majors in STEM fields (Thomas 1987, 1991; Wenglinsky 1997). The top five baccalaureate-origin institutions of black doctorate recipients from 1997–2006 were HBCUs, as were 20 of the top 50 (Burrelli and Rapoport 2008).

Most HBCUs suffer, however, from low levels of institutional resources and have student bodies that are economically, socially, and academically disadvantaged. They tend to have smaller endowments and fewer faculty with doctoral degrees than do TWIs (Freeman et al. 1999). The Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) was initiated by the NSF to address many of the challenges faced by HBCUs so that they may more fully realize their promise as major contributors to the pool of black science and engineering professionals.

Historically Black Colleges and Universities Undergraduate Program

HBCU-UP was begun in fiscal year 1998 and is administered by NSF's Division of Human Resource Development, which is in the Directorate for Education and Human Resources. The program, which encompasses four distinct areas of funding,[3] has as its goal enhancing the quality of undergraduate STEM education and research at HBCUs as a means to broaden participation in the nation's STEM workforce. The implementation projects under the HBCU-UP program, which are the subject of this evaluation, are five-year, institutionwide STEM education and research capacity-building projects. According to the program request for proposal, activities and strategies funded by the grant are to be designed specifically to address each institution's STEM needs, long-term goals, and mission. NSF, therefore, allows great flexibility in the design of these projects. Funded projects are expected to produce "significant improvements in undergraduate STEM education and research programs" (NSF 2006). Activities funded by HBCU-UP grants typically focus on institutional capacity building: course and curriculum development, revision, and enhancement; establishment of undergraduate student support services that promote academic success and educational enrichment; and faculty professional development.

Currently in its 11th year, the program has made 139 awards for a total of over $200 million. This evaluation includes institutions funded in the first five cohorts (a total of 31 sites) through grants awarded between 1999 and 2003 (see box 1 for a list of institutions

BOX 1. HBCU-UP Institutions

1999 Cohort
Albany State University
Alcorn State University
Bennett College
Clark Atlanta University
Florida A&M University
Hampton University
Howard University
Jackson State University
Miles College
North Carolina A&T State University
Oakwood College
Prairie View A&M University
Tuskegee University
University of the Virgin Islands

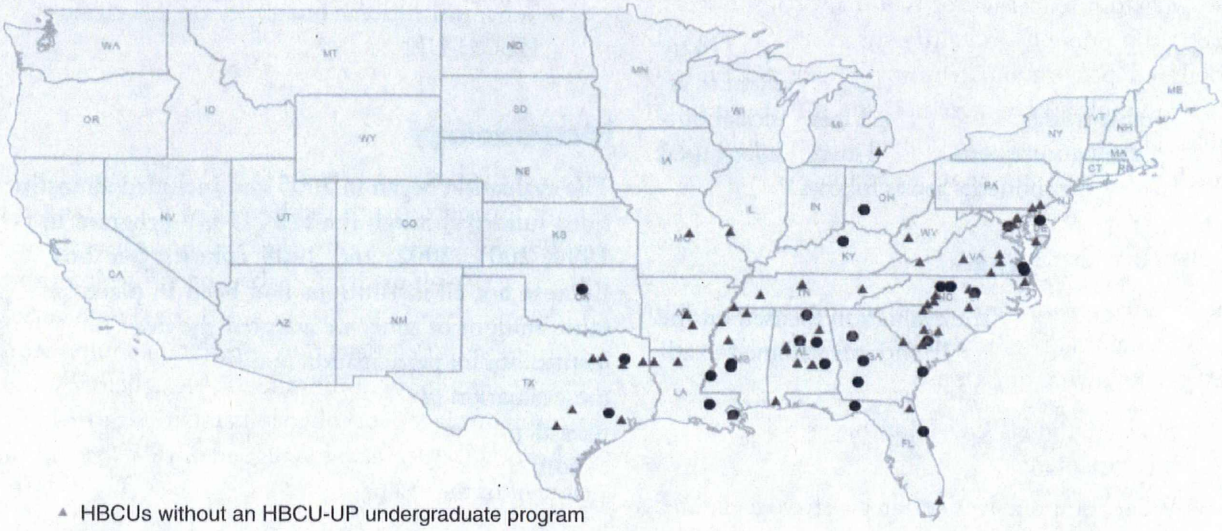
2001 Cohort
Fort Valley State College
Jarvis Christian College
Kentucky State University
Saint Augustine's College
Southern University New Orleans
Tougaloo College

2002 Cohort
Central State University
Claflin University
Norfolk State University
Talladega College
Wilberforce University

2003 Cohort
Bethune Cookman College
Delaware State University
Langston University
Savannah State University
Winston-Salem State University
Southern University, Baton Rouge

included in the evaluation). Figure 1 below shows the universe[4] of HBCUs, highlighting those participating in HBCU-UP. Note, however, that the outcomes component of the evaluation—which is based on data for STEM graduates, faculty, and courses—is restricted to the 18 institutions in cohorts 2 and 3 because these were the ones for which longer-term student outcomes could be measured.[5]

FIGURE 1. Historically Black Colleges and Universities



▲ HBCUs without an HBCU-UP undergraduate program

● HBCUs with an HBCU-UP undergraduate program

● University of the Virgin Islands

Evaluation Design

The evaluation consisted of two main components: a process component to identify strategies employed by HBCU-UP projects and a summative component to assess measurable student, faculty, and institutional outcomes. The evaluation questions and methodology used in each of these components are as follows.

Research Questions

The *process component* of the evaluation focused on the implementation of HBCU-UP and was designed to address the following questions:

- How are the HBCU-UP projects being implemented?
- What components or strategies have facilitated the attainment of project goals?
- What factors have inhibited the attainment of project goals?
- What mix of strategies has optimized linkages among activities and resources?

The *summative component* of the evaluation documents HBCU-UP outcomes in a number of areas in response to these questions:

- What student outcomes are associated with HBCU-UP?
- What faculty outcomes are associated with HBCU-UP?
- What institutional outcomes are associated with HBCU-UP?

Methodology

The evaluation began in 2005 and included all institutions funded through the HBCU-UP program in the 1999, 2001, 2002, and 2003 cohorts (see box 1).[6] Because not all institutions had been in place for the same amount of time, we adapted the design to select institutions for participation in different components of the evaluation as appropriate. Table 1 below summarizes all primary data collection activities carried out by cohort, with each activity aligned with a specific component of the evaluation.

The process component of the evaluation used qualitative methods—literature review, document review, telephone interviews with project directors, and case studies at four grantee institutions—to identify the strategies used by projects, the factors that may inhibit or enhance the achievement of project goals, and the characteristics of successful projects.

The summative component of the evaluation relied on qualitative and quantitative methods to analyze the course revisions carried out by institutions, the experiences and opinions of participating faculty, the educational progression and career outcomes of graduates of HBCU-UP projects, and, most importantly, the effi-

TABLE 1. HBCU-UP Evaluation: Data Collection Summary

				Primary Data Sources					Secondary Data Sources		
						HBCU-UP Surveys (%)			National Comparison Surveys		
									Graduates	Faculty	
HBCU-UP cohort	Academic years	Institutions included	Document review	Telephone interviews (%)	Case studies	Graduates	Faculty	Course revisions	SESTAT 06	NSOPF 99	NSOPF 04
2	1999–2004	13	Yes	92.9	3	64.9	80.0	72.2	✓	✓	✓
3	2001–2006	5	Yes	100.0	1						
4	2002–2007	5	Yes	100.0							
5	2003–2008	6	Yes	100.0							

Source: Urban Institute HBCU-UP Graduate Survey.
Notes: A number provides a count of participants in the given collection. A percentage indicates the response rate achieved for the given data collection. See endnote 6.

cacy of the HBCU-UP model. This component relied on a quasi-experimental design that compared HBCU-UP faculty and graduates to nationally representative samples of each.[7]

Specifically, we conducted a one-time, retrospective survey of HBCU-UP alumni (the "treatment" or "implementation" group) to compare their average outcomes to those of a nationally representative sample of STEM degree recipients—overall, by gender, and by ethnicity (the "comparison" groups). Because the survey sought to measure post-graduation outcomes among students enrolled in undergraduate programs during the time of the HBCU-UP project, the graduate survey population consisted of all HBCU-UP graduates with two or more years of "exposure" to program implementation and two or more years since graduation. We obtained a 65 percent response rate among the 2,030 HBCU-UP graduates surveyed. National benchmarks to compare against HBCU-UP graduate outcomes are based on an appropriate subset of the Scientists and Engineers Statistical Data System (SESTAT 2006) sponsored by the NSF.[8]

The analysis of faculty data also relied on a quasi-experimental design—comparing data on faculty at grantee institutions with those from nationally representative samples of faculty. The HBCU-UP sample was comprised of a census of faculty at baccalaureate institutions and a stratified (by rank and field) random sample of faculty at master's/doctoral institutions. From a population of 1,085 faculty at 18 HBCU-UP institutions, we sampled 451 and obtained an 80 percent response rate to our web-based survey. To construct national benchmarks to compare against HBCU-UP faculty demographic characteristics and opinions, we used the National Survey of Postsecondary Faculty (NSOPF) sponsored by the National Center for Education Statistics (NCES) of the Department of Education. The NSOPF is a nationally representative survey of faculty across institutions of higher education in the United States.

Lastly, we collected data on curricular revisions and, in response to recommendations from the Academic Council on Competitiveness (ACC) and the NSF, measured adherence to the following ACC criterion: courses had been created or revised to "integrate the use of instruments, methods, and procedures that are commonly used in academic, industry, and government laboratories." Through this survey we collected information on courses created or revised, and asked respondents to provide a description of the innovative technology used in the course as well as a course syllabus (for verification). The response rate to our course revision survey was 72.2 percent.

Process Evaluation Findings: Characteristics of HBCU-UP Projects

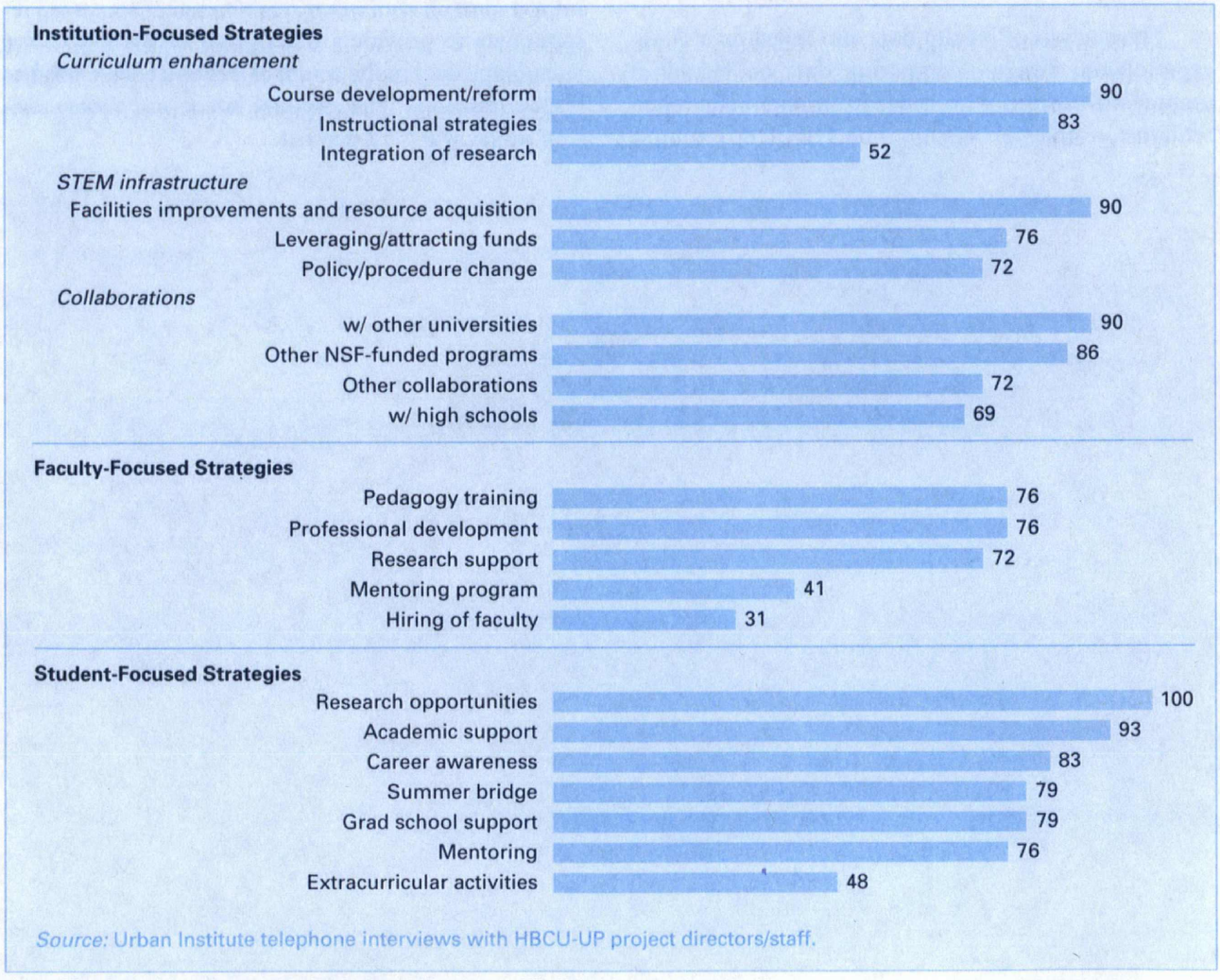
This section reports findings from the process component of the evaluation, based on data from telephone interviews with project directors and other project staff and on case studies of four HBCU-UP projects.

Project Components: How Is HBCU-UP Being Implemented?

HBCU-UP projects offer a wide range of services and activities, which can be organized under the broad categories of student support services, faculty research and development, and institutional infrastructure development. Figure 2 summarizes HBCU-UP components and gives the percentage of projects offering each component.

Is there an identifiable HBCU-UP model? Most projects funded through HBCU-UP engaged in a distinct set of activities—including student research opportunities, faculty professional development, and curricular reforms. These activities—carried out, on average, by at least 74 percent of institutions—constitute the "typi-

FIGURE 2. HBCU-UP Projects Offering Various Strategies (percent)



Source: Urban Institute telephone interviews with HBCU-UP project directors/staff.

cal" project (see figure 3).[9] Strategies implemented by a smaller subset of institutions are deemed supplementary and include faculty research support and institutional policy changes. A study of these typical and supplementary activities in light of observed student outcomes revealed that a subset of the typical activities comprises the "core" of the HBCU-UP model of institutional capacity building. The core is made up of those activities that characterize projects that had been most successful in achieving desired student outcomes—namely, institutional (curricular reform, facilities improvements, collaborations with other NSF programs, revised instructional strategies), faculty (pedagogy training, professional development), and student (research opportunities, academic support, summer bridge) activities.[10]

The core model was tested by comparing all institutions employing all strategies included in the core model with those not sharing the complete group of core strategies in terms of student retention in the STEM pipeline and alumni entry into the STEM workforce. The section on the summative evaluation findings provides details of this comparison. Figure 3 identifies core, typical, and supplementary components of the HBCU-UP model.

FIGURE 3. HBCU-UP Model for Capacity Building

Notes: Typical activities are those employed by at least 74 percent of institutions. Activities are listed in descending order of prevalence of use among HBCU-UP institutions.

Why Is the HBCU-UP Core Model Successful?

What support exists in the scholarly literature to explain the efficacy of the core model elements in achieving desired student outcomes? A preponderance of studies of HBCU effectiveness points to the success of these institutions in creating a nurturing environment that fosters psychosocial health among African American students, resulting in their satisfaction with and integration into the academic environment (Allen 1992; Astin 1975; Astin et al. 1996; Bonous-Hammarth and Boatsman 1996; Davis 1991; Fleming 1984; Outcalt and Skewes-Cox 2002). There have been few studies, however, of the mechanisms through which HBCUs achieve their beneficial effect.

Beating the odds: the HBCU paradox. Not only do HBCUs serve a population disadvantaged economically compared to the general student population, but these institutions are also underfunded and lack resources (Allen and Jewell 2002; Freeman et al. 1999; Perna 2001; Wenglinsky 1997). Lack of funding results in deficits in the services, learning systems and facilities, and academic support and opportunity networks available to students at HBCUs (Allen 1992; Perna 2001). Research has found that African American students at HBCUs, while reporting greater overall satisfaction with the college environment than counterparts at PWIs, also expressed lower levels of satisfaction with the quality of courses in their major field, the overall quality of instruction, library facilities, lab facilities, and stu-

dent services such as career counseling, financial aid, and housing (Outcalt and Skewes-Cox 2002). In other words, these students expressed greater general satisfaction *in spite* of perceived deficits in the resources and services provided by their institutions.

Lack of funding and resources has also affected the working conditions and professional development of faculty at HBCUs. Although few recent studies have been conducted on HBCU faculty (Johnson 2001), data suggest that these institutions tend to have smaller proportions of faculty with doctoral degrees (Freeman et al. 1999). HBCU faculty report heavy teaching loads and other extraordinary time demands due to their small numbers; the absence of institutional support systems for faculty professional development is yet another barrier to improving HBCU faculty status (Gregory 2003). The convergence of disadvantageous factors is exacerbated for the sciences, where faculty require even more time and resources than those in other disciplines to conduct research projects.

The HBCU-UP solution. The HBCU-UP program was established to assist HBCUs in building the institutional capacity to address many of the observed deficits due to lack of resources, identified above. The approach adopted by NSF was this: given the documented benefits of the HBCU environment, how could these institutions be supported and encouraged to build on their strengths and become even more effective in educating African American students in STEM majors?

While the HBCU environment provides a multitude of psychosocial benefits to African American students, what is required to achieve even more successful outcomes—given the lack of funding and resources experienced by these institutions and given the needs of their students—is exactly what the core HBCU-UP program model targets: an increase in the capacity of these institutions to (a) reform STEM curriculum and instructional delivery systems; (b) improve the professional status and pedagogical skills of faculty; (c) acquire and upgrade research and teaching facilities and equipment; and (d) provide adequate and appropriate academically oriented support services for students. There is support in the research literature for the effectiveness of most of the intervention strategies that comprise the core model elements.[11] By targeting the needs of a specific student demographic within the context of the institution where education is occurring, the HBCU-UP program model exemplifies a new generation of intervention programs in STEM, which strive to move beyond the question of what works to focus on the more complex question: "what works, for whom, and in what context?" (Clewell and Campbell 2002; Tsui 2007).

Characteristics of Successful Projects: Insights from the Case Studies

In addition to identifying the crucial components of the HBCU-UP intervention model, the process evaluation documented characteristics of successful projects, based on a cross-case analysis of four successful case study sites. These projects share four characteristics:

Problem-driven interventions. All four projects designed their interventions to address a specific problem that had been identified by the institution. In one case the problem was the high dropout and failure rate of STEM students within the first two years. In another, it was declining enrollment in specific courses and a pool of entering students that was increasingly less well prepared. A third institution wished to reduce a high STEM undergraduate attrition rate as well as time to degree in STEM undergraduate majors. The fourth institution wished to increase undergraduate enrollment in STEM, enhance career competitiveness of STEM graduates, and encourage more of them to pursue doctoral degrees in science or engineering. Interestingly, these projects designed to address specific problems through infrastructure change had a broader impact on the institution as a whole.

> "The project goals were a good fit with what we wanted to do to improve our teaching and curriculum in STEM. We had been talking about making these improvements for a long time."
>
> —Principal investigator

A comprehensive approach. Strategies to address the problems identified by each institution involved changes to institutional infrastructure, faculty development, and student support services. Each of the successful projects crafted a comprehensive response to the problem by developing a plan to improve each of these three areas. For example, one project transformed the institutional infrastructure to support the reform of its instructional program in STEM, undertaking curriculum and course enhancement activities, infusion of technology into instruction, and facility improvements. At the same time, faculty received training in pedagogy, research support, and funds to attend professional meetings. Student support services were increased to include a pre-freshman summer academy, a learning center pro-

viding tutoring and mentoring, financial support, research opportunities, and graduate school assistance.

> "The main focus of the project has been in three areas: course and curriculum reform and enhancement, student development and engagement of students in research, and faculty development."
>
> —Coprincipal investigator

Strategies and activities tailored to the institutional mission, characteristics, and functions. Although projects targeted similar areas for reform, strategies to address individual problems varied according to each institution's mission and goals, institutional context, and perceived deficiencies. Institutional mission and goals played a major role in determining the path to reform. In two cases, institutions that had a long tradition as teaching institutions made the difficult transition into research while still emphasizing their teaching role, motivated by the desire to improve enrollment, retention, and entry into graduate programs among their STEM majors.

> "HBCU-UP helped to push our agenda of undergraduate research."
>
> —Project director

> "The flexibility that the grant provided enabled us to do things that we might otherwise not have accomplished under another grant."
>
> —High-level administrator

Institutionalization of key components of HBCU-UP. Successful sites were able to institutionalize several components of their HBCU-UP projects. This institutionalization contributed substantively to strengthening the STEM education infrastructure. One of the case study sites, for example, has incorporated summer bridge and tutoring programs into its permanent offerings and has continued to offer courses developed under the auspices of the grant. The institutional culture has changed from one focused solely on teaching to reflect a research orientation as well.

> "When I came to [the institution] it was very much a teaching institution. Research was not institutionalized nor a focus. Since HBCU-UP there has been a paradigm shift. Every new faculty has been involved in research."
>
> —STEM department chair

> "It [the HBCU-UP grant] really changed things....I think we created an infrastructure set up [to facilitate infusing technology into instruction]."
>
> —STEM faculty member

Summary

This section presented the strategies employed by HBCU-UP projects, uncovered the core of the HBCU-UP model, and identified the characteristics of successful projects. Specifically, projects pursued multiple and concurrent strategies at different levels (students, faculty, and institution) to meet the needs of their particular contexts and circumstances. Among these strategies a few were commonly found in the most successful institutions, comprising the core of the HBCU-UP model. In addition to sharing this set of strategies, successful institutions also shared other characteristics, namely a clear definition of the problems to be tackled, a comprehensive approach involving multiple strategies tailored to institutional and student characteristics, and success in institutionalizing key components of their projects. The success of the HBCU-UP program model can be attributed to its support for focused institutional capacity building to facilitate the provision of appropriate support mechanisms for student learning and faculty development in STEM disciplines within the unique institutional environment of HBCUs.

Summative Evaluation Findings: Outcomes of HBCU-UP

Although the immediate goal of HBCU-UP projects is to improve their STEM education programs and build institutional capacity, the ultimate goal of these efforts is to improve student retention in STEM, both into graduate education and subsequent employment. The summative component of this evaluation assessed the extent to which HBCU-UP, as represented by its early funding cohorts, achieved these ultimate goals. We assessed achievement of ultimate goals through a survey of graduates of HBCU-UP programs. Results are discussed under Educational Outcomes and Workforce Outcomes of HBCU-UP Graduates.

To assess some of the intermediate capacity-building goals—which many projects pursued through improvements in institutional infrastructure and faculty support to improve the curriculum and conduct research—we conducted interviews with project directors and two surveys, one of project directors and the other of faculty at HBCU-UP grantee institutions. Through these interviews and surveys, we measured implementation of the HBCU-UP projects, faculty experiences and opinions, and curricular revisions. Results are presented in the sections Faculty Opinions and Perceptions and Institutional Capacity Building.

Last, we revisit the HBCU-UP model components, identify the critical strategies, and discuss evidence of their association with successful outcomes in the section Knowledge Base: HBCU-UP Model Core.

Characteristics of HBCU-UP Graduates

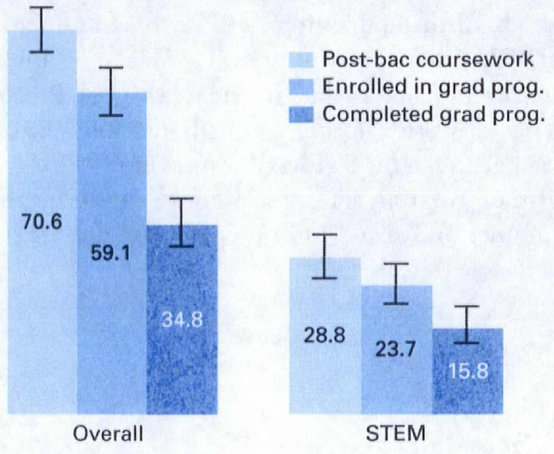
More than 80 percent of HBCU-UP graduates completed high school between 1996 and 2001, and all completed their bachelor's degrees between 2001 and 2004, obtaining an average GPA of 3.2. About 60 percent are female, and the vast majority is African American (92 percent). At least half of HBCU-UP graduates have parents who are not college educated. We used some of these demographic characteristics—such as gender and ethnicity—in the analyses of graduate outcomes that follow.

Educational Outcomes of HBCU-UP Graduates

Most HBCU-UP alumni continue on to graduate studies. About 70 percent (or 3,772) of HBCU-UP graduates pursued additional coursework after completing an undergraduate degree (see figure 4). Almost 60 percent eventually enrolled in a graduate degree program and 35 percent completed a graduate degree at the time of the survey (between three and six years after graduation with a bachelor's degree). Most alumni pursued and completed master's programs (42 and 30 percent, respectively), with a smaller share in doctoral (9 and 1 percent) and professional programs (8 and 4 percent) (see figure 5). Note that doctoral degrees take longer to complete and, given the timing of our survey, students were more likely to have had time to complete master's and professional degrees.

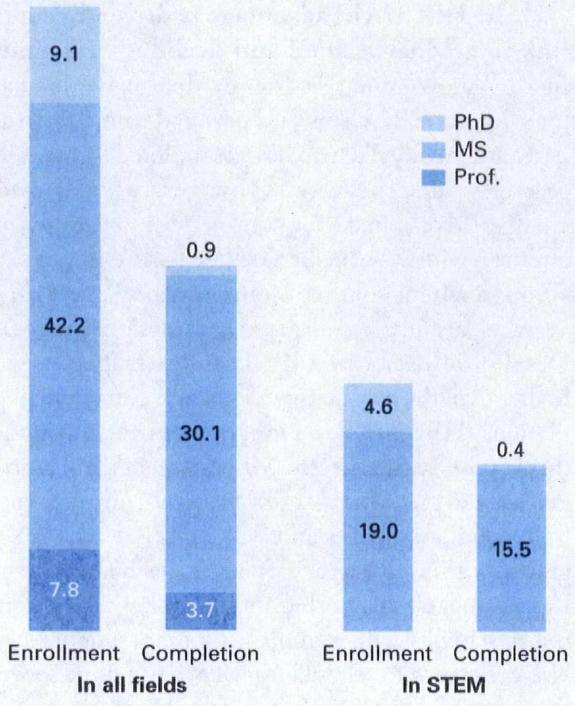
Over one-quarter of HBCU-UP alumni continue in STEM. Close to 30 percent of alumni pursued post-baccalaureate coursework in STEM, about 24 percent enrolled in a STEM graduate program, and 16 percent completed a STEM graduate degree

FIGURE 4. HBCU-UP Graduate Education



Source: Urban Institute HBCU-UP Graduate Survey.
Note: Lines depict the 95 percent confidence interval around the point estimate.

FIGURE 5. HBCU-UP Graduate Enrollment and Degrees (percent)



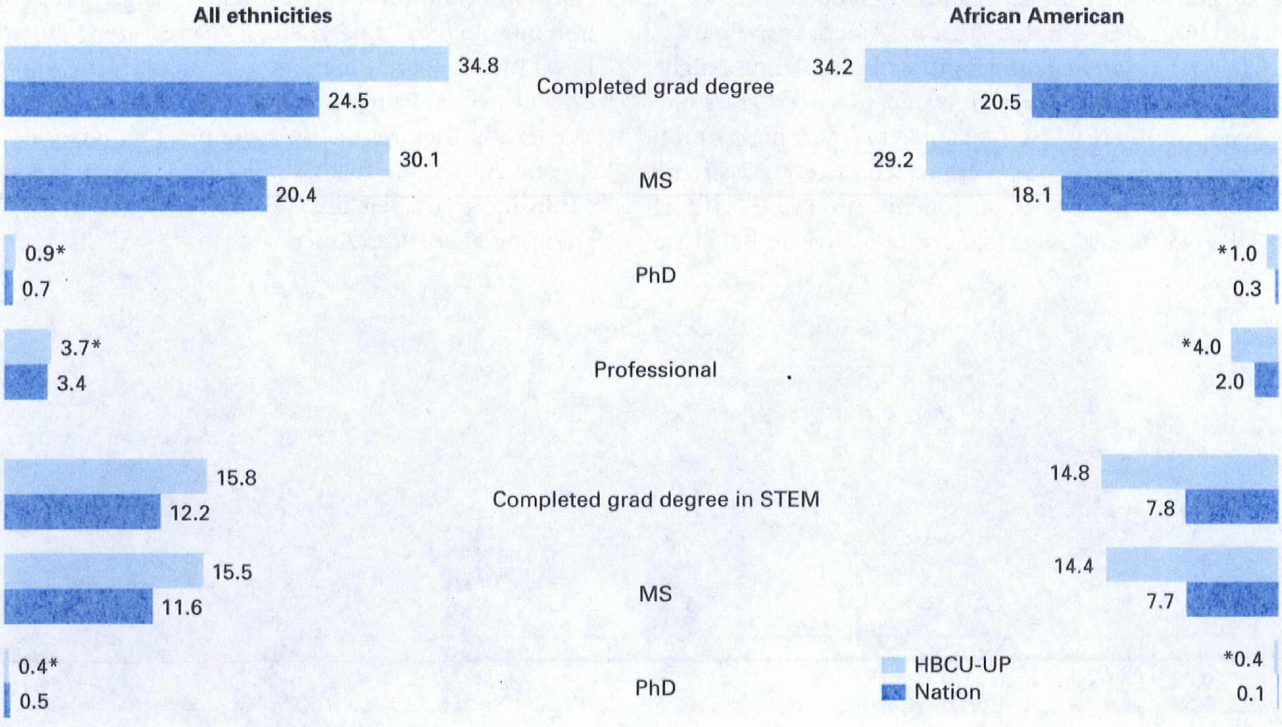
Source: Urban Institute HBCU-UP Graduate Survey.
Note: MS includes MBA.

(mostly master's degrees). Among alumni who pursued further coursework, over 40 percent did so in STEM, with 34 percent enrolling in, and about 23 percent completing, a STEM graduate program (mostly master's degrees).

HBCU-UP graduates outperform the national comparison in graduate degree completion. Approximately 35 percent of HBCU-UP graduates had completed a graduate degree by the time they were surveyed for this evaluation, versus about 25 percent among an appropriate national comparison group comprised of bachelor's degree recipients in STEM (see figure 6). Although narrowing, this difference holds when comparing the field of studies as well. About 16 percent of HBCU-UP graduates obtained degrees in STEM, versus 12 percent in the national comparison group.

HBCU-UP graduates are more likely to complete master's degrees and are as likely as the national comparison group to complete doctoral and professional degrees. HBCU-UP alumni were more likely to complete master's degrees in any field (30 versus 20 percent) and in STEM (16 versus 12 percent). This drives the earlier finding that HBCU-UP alumni outperform national comparisons in graduate

FIGURE 6. Graduate Education: HBCU-UP versus Nation (percent)



Sources: Urban Institute HBCU-UP Graduate Survey and NSF SESTAT 2006.
Note: MS includes MBA.
* Not significantly different from national estimate.

degree completion, as they were as likely as the national comparison to have completed doctoral and professional degrees.

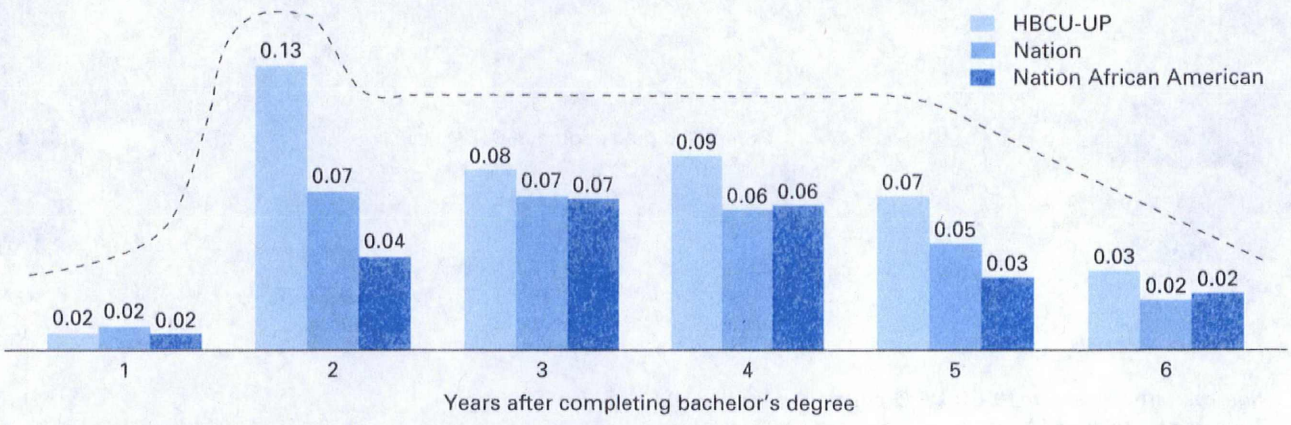
HBCU-UP graduates outperform the African American national comparison in graduate degree completion. Analysis controlling for ethnicity reveals that the differences reported above in graduate degree completion hold and grow by about 3 percentage points if the comparison, in both the HBCU-UP and the national samples, is restricted to African American students. About 34 percent of African American HBCU-UP graduates completed graduate degrees, compared to about 20.5 percent of African Americans nationally. The gap also grows in STEM, where 15 percent of HBCU-UP African American alumni versus 8 percent of African American alumni nationally completed graduate degrees in STEM.

The HBCU-UP graduate outcomes observed are underestimates due to a small time frame but are consistently higher than national benchmarks. Survival analysis results of the "hazard" of completing a graduate degree suggest that the *expected* HBCU-UP graduate outcomes, if given sufficient time, are somewhat higher than those reported above, which are the *observed* outcomes based on a limited amount of time since the completion of the undergraduate degree (three to six years). Most importantly, HBCU-UP estimates are consistently higher than national benchmarks, for all ethnicities and for African Americans. Figure 7 shows the marginal probabilities of completing a higher degree in the available time frame, two to six years since graduation. HBCU-UP graduates display higher probabilities of degree completions almost every year, and particularly in year 2. Consequently, over time, HBCU-UP graduates exhibit a higher cumulative probability of completing a graduate degree (.41 by year 6, versus .25–.30 in national comparisons).

The HBCU-UP advantage is driven by an early link to graduate school and declines with time. As figure 7 shows, one year after graduating with a bachelor's degree, HBCU-UP and national comparison graduates are equally likely to have completed a graduate degree. As time increases, however, a clear pattern emerges: a spike in degree completions in the early years after receiving a bachelor's degree (rising in year 2, declining and remaining constant in years 3 and 4) and an average decline in degree completions thereafter. Despite the fact that HBCU-UP average results are higher than those of comparisons, it is clear that all populations (HBCU-UP, national, and African American) display the same pattern. Most students will pursue a graduate degree within a few years of completing their undergraduate studies and will complete master's programs within five years of their bachelor's degrees. Results suggest that with time the probability of returning to school declines, indicating that students are less likely to return to school if they have not done so within five years of receiving a bachelor's degree.

Female HBCU-UP graduates outperform their male counterparts in enrollment, but not in completion of graduate programs or in STEM. Women outperform men, on average, in terms of pursuing further coursework and enrolling in graduate programs but not in terms of completing graduate degrees (see figure 8). In STEM, however, men *seem* to outperform women on all three measures, but none of the differences are statistically significant. Restricting the analysis to African Americans yields similar results, which is not surprising given that the vast majority of HBCU-UP graduates are African American.

FIGURE 7. Marginal Probability of Completing a Graduate Degree



Sources: Urban Institute HBCU-UP Graduate Survey and NSF SESTAT 2006.

Female HBCU-UP alumni outperform a nationally representative sample of female STEM bachelor's degree recipients, both overall and in STEM. On average, HBCU-UP women have higher average rates of completion of graduate programs—overall (37 versus 26 percent) and in STEM (13 versus 9 percent)—than a national comparison sample of women (see figure 9). Restricting the comparison to African American women in both samples leads to lower point estimates for the national benchmarks, which widens observed differences in favor of HBCU-UP by 6 and 3 percentage points, respectively. Results reflect completion of master's programs, as no differences are observed in doctoral and professional degrees.

Male HBCU-UP graduates also are more likely to complete graduate degrees than a national comparison group but are not more likely to do so in STEM. Male graduates of HBCU-UP programs also display greater completion of graduate degrees than a national comparison sample of male B.S. degree holders (30 versus 23 percent), but this advantage disappears when analyzing this outcome by field of studies (see figure 8). In STEM we detect no differences in degree completion in the two groups. In addition, comparing only African American males in both samples, HBCU-UP and national, widens the unrestricted seven-point gap in completion of graduate degrees by an additional 5 percentage points (29 versus 17 percent, respectively).

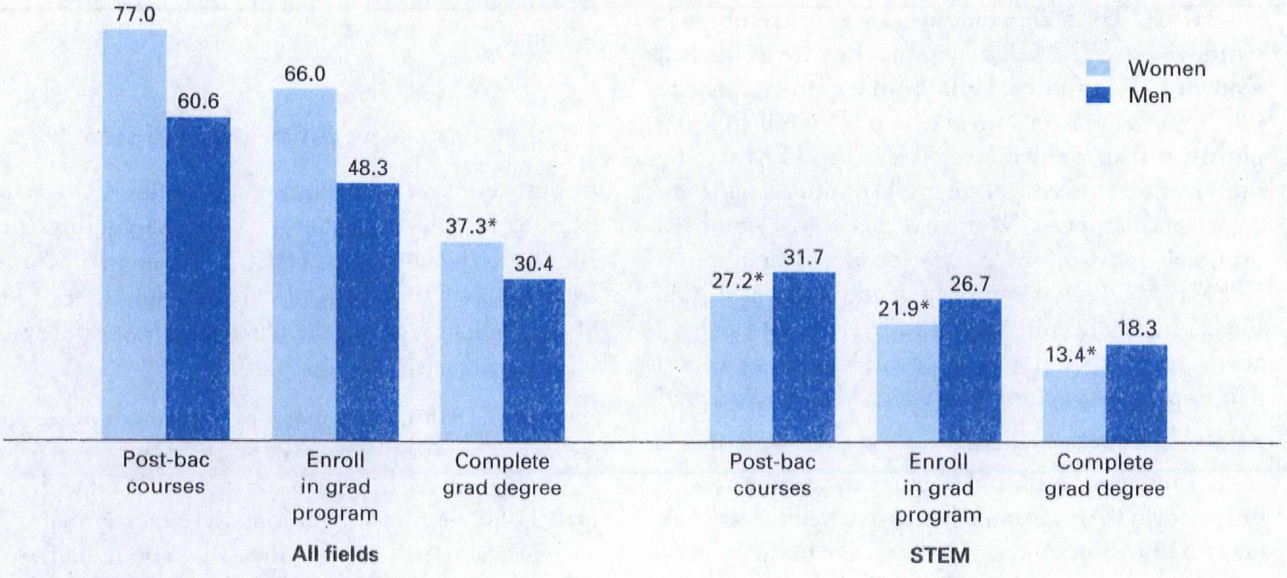
Workforce Outcomes of HBCU-UP Graduates

HBCU-UP alumni are as likely as the national comparison to be employed, overall and in STEM, but they bring higher average educational attainment. Three-quarters of HBCU-UP alumni reported being in full-time employment at the time of the survey, three to six years after graduation (see figure 10). This share is similar to, and statistically indistinguishable from, the national comparison estimate. But HBCU-UP alumni outperform the national comparison in terms of graduate education: about 25 percent of HBCU-UP graduates were employed with a graduate degree, compared to 20 percent nationally.

HBCU-UP alumni employed in STEM are more likely to hold a graduate degree but are equally likely to hold a graduate degree in STEM. Compared to a national sample of STEM graduates, HBCU-UP graduates are equally likely to be in full-time employment in STEM (35–38 percent) and are more likely to be employed full-time in STEM *and* hold a graduate degree (12 versus 8 percent), but are equally likely to be employed in STEM while holding a STEM graduate degree (9 versus 8 percent) (see figure 10).

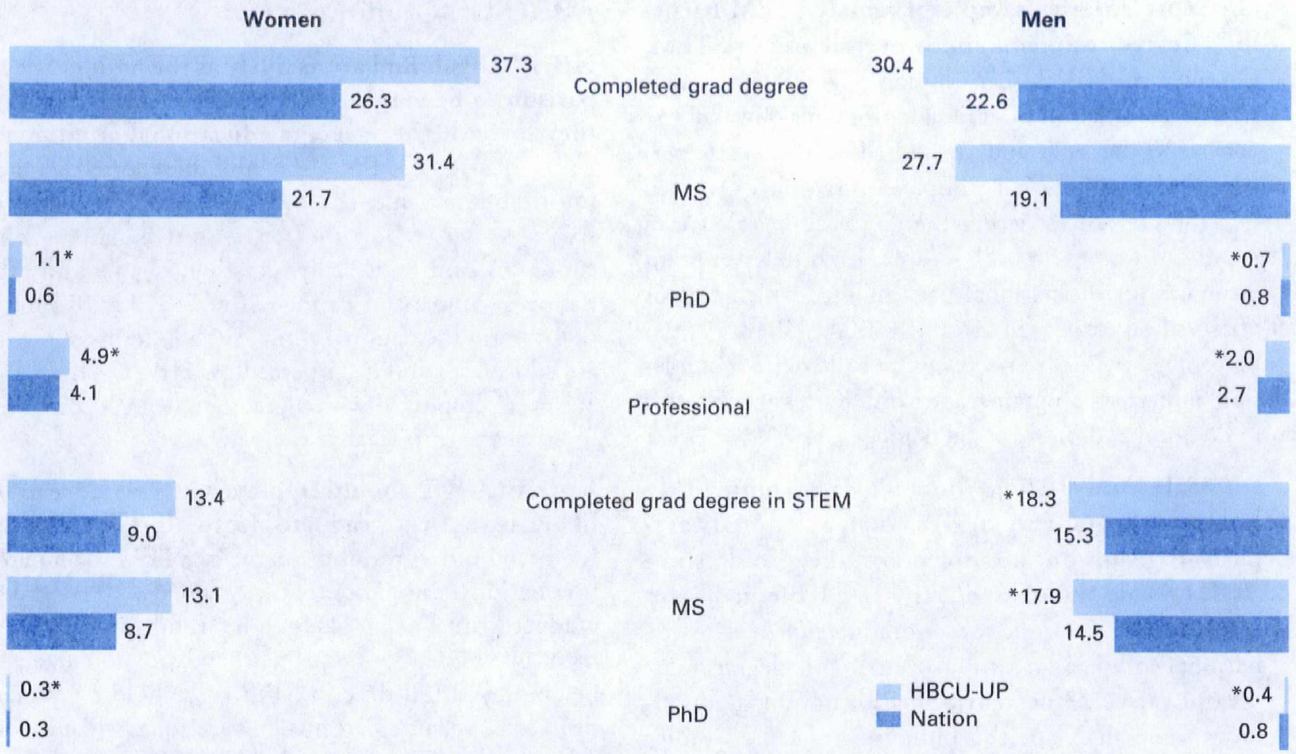
HBCU-UP *African American* graduates experience greater insertion in the STEM workforce than the national *African American* comparison. Restricting the national benchmark to African American STEM bachelor's degree recipients reveals that, on average, African

FIGURE 8. Graduate Education by Gender (percent)



Source: Urban Institute HBCU-UP Graduate Survey.
*Not significantly different from men.

FIGURE 9. Graduate Education by Gender: HBCU-UP versus Nation (percent)



Sources: Urban Institute HBCU-UP Graduate Survey and NSF SESTAT 2006.
* Not significantly different from national estimate.

American HBCU-UP alumni are more likely to be in full-time STEM employment (33 versus 25 percent), and to be employed in STEM *and* hold a graduate degree in any field (11 versus 4 percent) and in STEM (7 versus 4 percent), than the national comparison group (see figure 10).

HBCU-UP male graduates are more likely to be employed in STEM than women, but are as likely as women to be employed and hold a graduate degree. On average, men are more likely to be in full-time employment than women, overall and in STEM (see figure 11). But once education is taken into account, this advantage disappears. Women display equal "joint" educational and workforce achievement (overall and in STEM). About a quarter of men and women HBCU-UP graduates are employed full-time and hold a graduate degree (12 percent employed in STEM) and about 8 to 10 percent are employed in STEM and hold a graduate STEM degree.

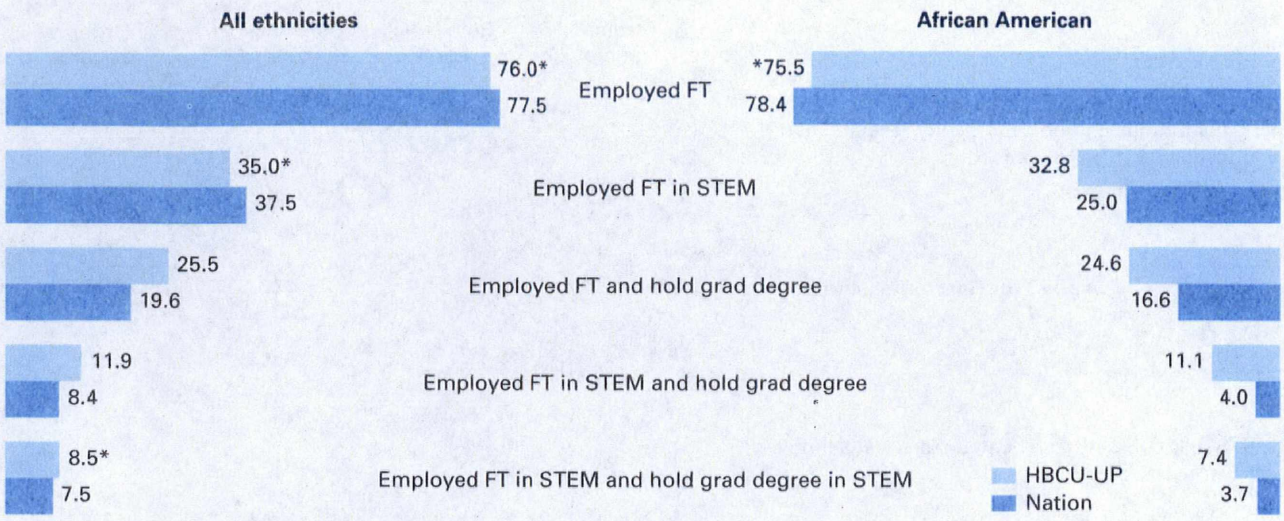
Unlike men HBCU-UP alumni, women tend to outperform their national benchmark in terms of average STEM outcomes. First, women graduates from HBCU-UP programs are more likely to be employed in STEM than the national benchmark (29 versus 20 percent), whereas male graduates from HBCU-UP programs are less likely to be employed in STEM (43 percent) than their national benchmark (55 percent) (see figure 11). Second, women are more likely to be in full-time STEM employment while holding a graduate degree (in any field and in STEM), an outcome not observed when comparing men in HBCU-UP versus men nationally.

Faculty Opinions and Perceptions

In this section, we provide some descriptive characteristics of HBCU-UP faculty and report findings that align with the emphasis of HBCU-UP on student research, faculty support, and curricular revisions. Most of the findings reported are based on pre/post HBCU-UP comparisons.

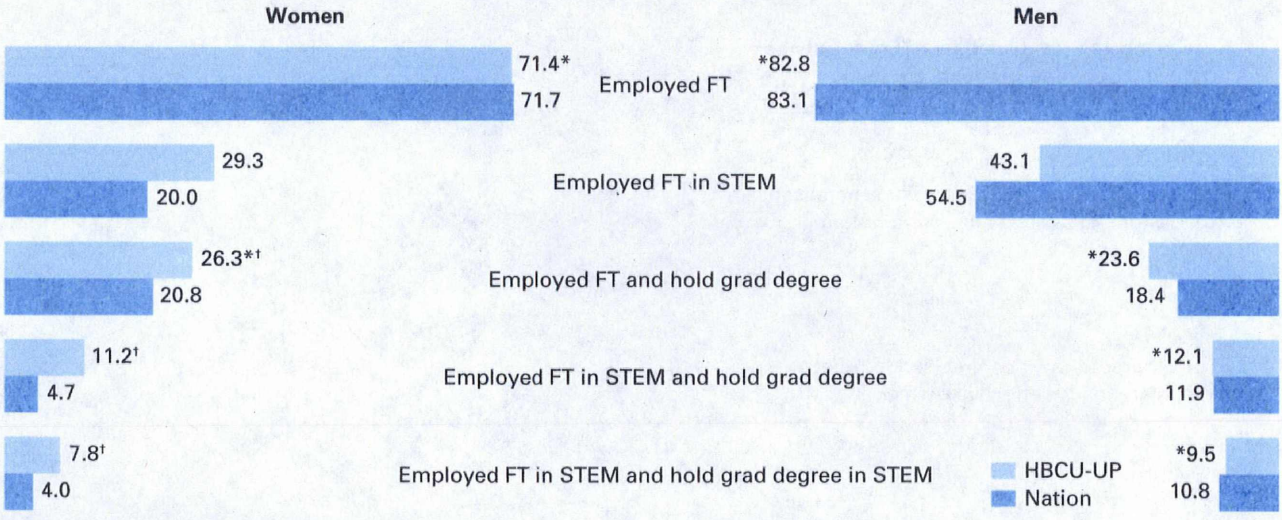
HBCU-UP faculty resemble faculty at other colleges and universities, except that they are more likely to be African American. STEM faculty at HBCU-UP grantee institutions were mostly male (70 percent), as is true nationally. But about half were African American, compared to 5 to 6 percent nationally among faculty at similar institutions,[12] and close to

FIGURE 10. Graduate Employment: HBCU-UP versus Nation (percent)



Sources: Urban Institute HBCU-UP Graduate Survey and NSF SESTAT 2006.
* Not significantly different from national estimate.

FIGURE 11. Graduate Employment by Gender: HBCU-UP versus Nation (percent)

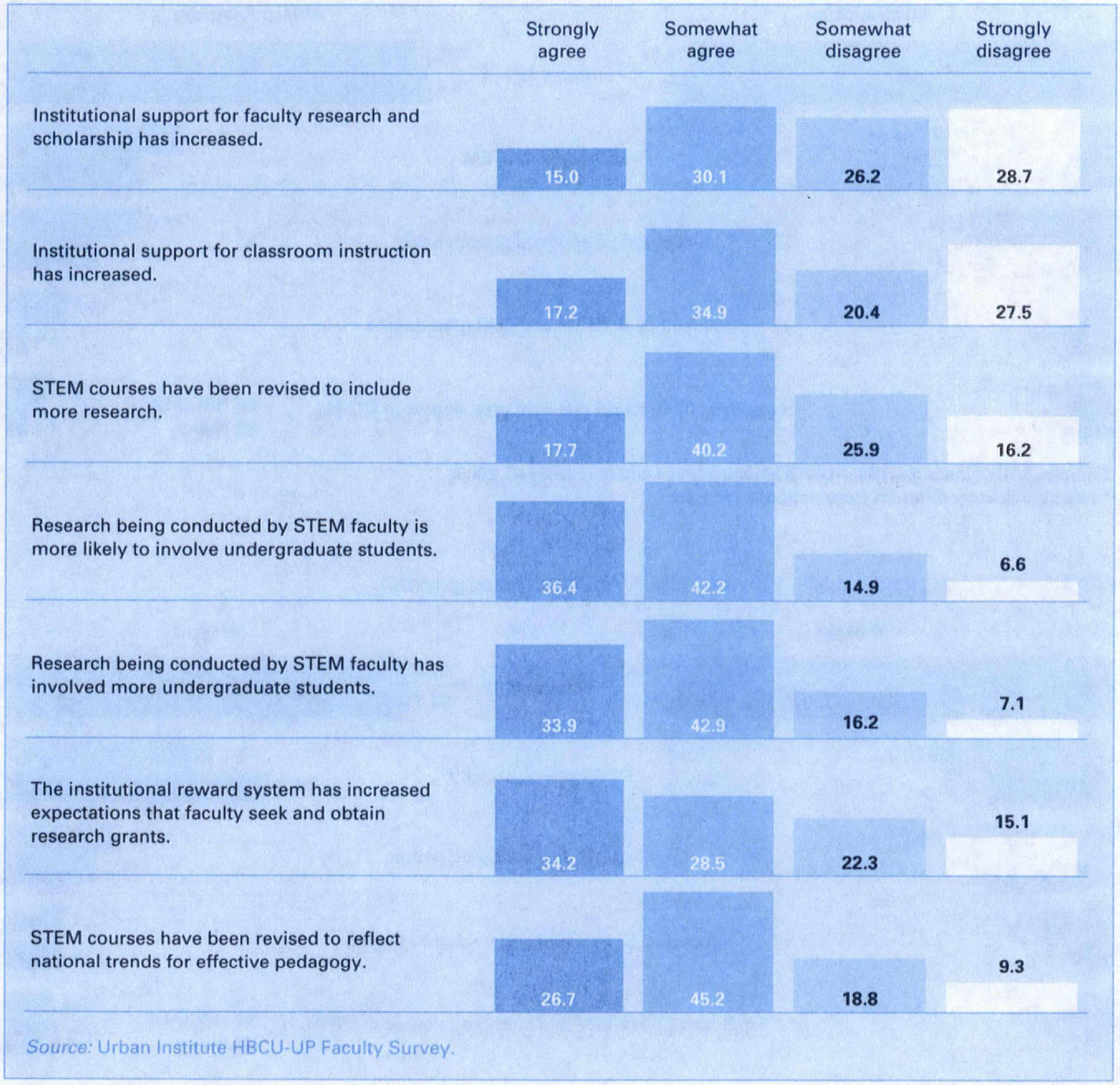


Sources: Urban Institute HBCU-UP Graduate Survey and NSF SESTAT 2006.
* Not significantly different from national estimate ($\alpha = .05$). † Not significantly different from men.

40 percent of faculty at HBCU-UP institutions had attended an HBCU in the past. They were, however, equally likely as faculty nationally to hold a doctoral degree (85–94 percent) and to be dedicated to teaching (80–83 percent). About 40 percent of them were associate professors, with the remainder equally split between full and assistant professors.

Faculty report being more likely to engage students in research. Faculty reported that they were more likely to consider involving undergraduate students in their research, and that they had indeed involved more undergraduates in their own research (34 percent of faculty strongly agreed and 43 percent agreed; see figure 12). A high share of faculty also reported that they perceived an increased expectation at their institutions that they should seek and obtain research grants. These results reinforce the case study findings regarding the emphasis on research fostered through HBCU-UP at grantee institutions, as well as telephone interview findings through which we learned that projects are emphasizing research opportunities for undergraduates, most of them with faculty.

FIGURE 12. Faculty Perceptions of HBCU-UP (percent)



Source: Urban Institute HBCU-UP Faculty Survey.

Faculty do not perceive increases in institutional support for research. Faculty did not report increased institutional support for research (see figure 12). Nor did they report, on average, revisions of STEM courses to include more research; only 15 percent strongly agreed with the statement asserting that such revisions took place. This finding corroborates results of the telephone interviews with project directors and is surprising given the focus on fostering student research of HBCU-UP projects in general.

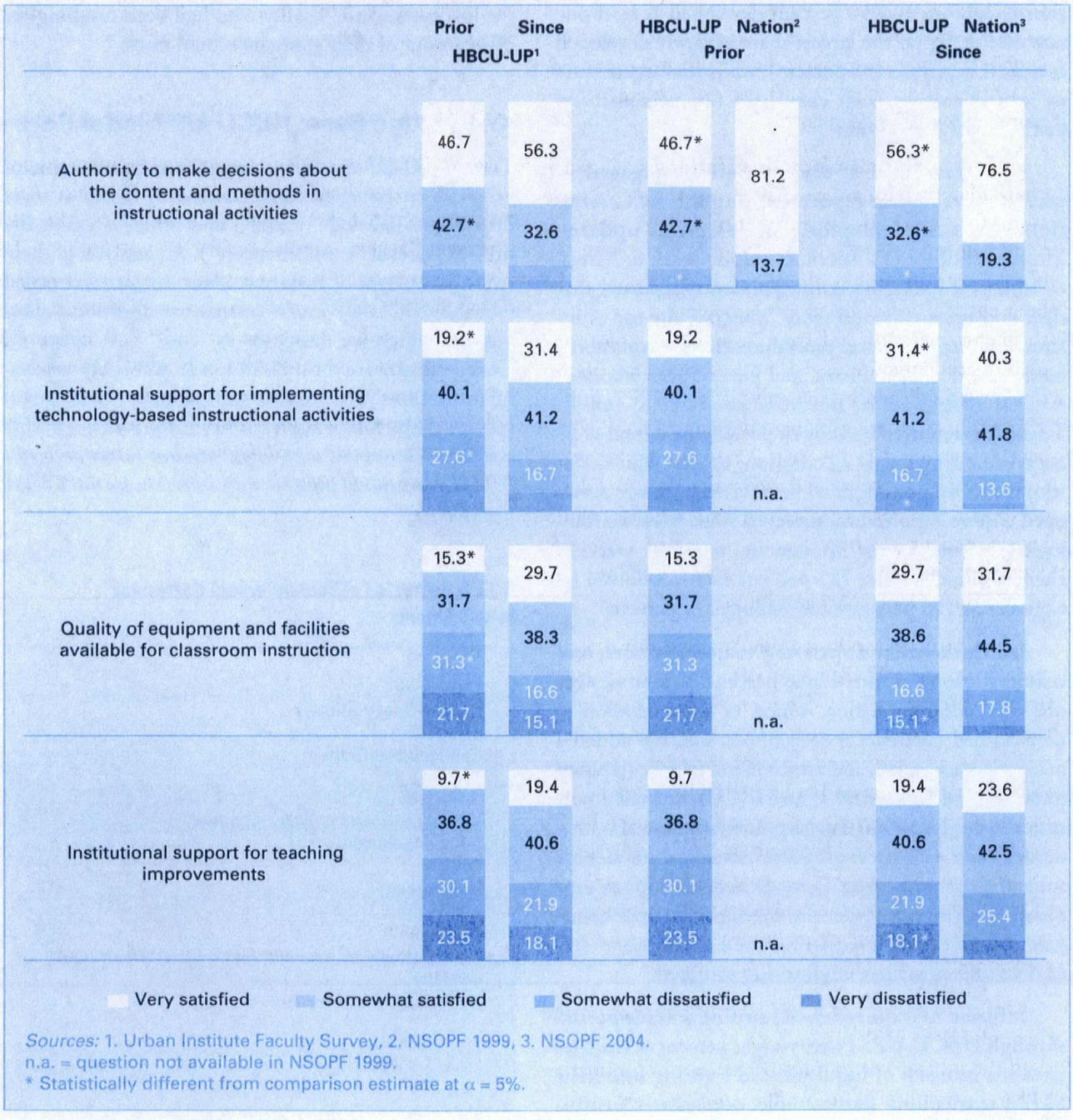
Faculty satisfaction with basic instructional support (equipment, facilities) increases to approximate or match national estimates, but the longer-term measure of general support for classroom instruction remains unchanged. Three indicators measuring institutional support for teaching improvements increased significantly in pre-post measures and in comparison with the nation (see figure 13). Specifically, the share of faculty reporting increases in institutional support for teaching improvements, as well as the share indicating that they were very satisfied with the quality of equipment and facilities for classroom instruction, doubled, rising to match national estimates (from about 10 to 20 percent, and 15 to 30 percent, respectively). The

share indicating that they were very satisfied with institutional support for implementing technology-based instructional strategies also rose significantly (from 19 to 31 percent), but not enough to eliminate the gap with the national benchmark estimate of 40 percent. But faculty did not report increased support for classroom instruction, which may be capturing a longer-term outcome than the other indicator (teaching improvements). Over a quarter of faculty strongly agreed and an additional 45 percent agreed that "STEM courses have been revised to reflect national trends in effective pedagogy."

Institutional Capacity Building: Curricular Enhancements

Projects engaged in different types of reforms, from restructuring the curriculum (resequencing of courses and modifying program requirements) to revamping the curriculum (creating new courses and revising existing

FIGURE 13. Faculty Satisfaction Before and After HBCU-UP: Participating Institutions versus Nationwide (percent)



Sources: 1. Urban Institute Faculty Survey, 2. NSOPF 1999, 3. NSOPF 2004.
n.a. = question not available in NSOPF 1999.
* Statistically different from comparison estimate at $\alpha = 5\%$.

ones to align with national standards or cover new content areas) to infusing new pedagogical techniques (such as inquiry-based learning or using technology in instruction). We highlight here some important findings.

Most institutions engage in curricular revisions. Information gathered on curriculum development and reform at HBCU-UP sites through a course-revision survey and telephone interviews shows that most colleges and universities pursued curriculum enhancement as part of their HBCU-UP project (16 out of 18 schools). These 16 schools collectively revised more than 50 courses and developed more than 20 new courses. Of all institutions, 78 percent worked on course revisions and 50 percent developed at least one new course. By far the largest share of newly developed courses is in physics (38 percent), while the largest share of revised courses is in chemistry (26 percent) and mathematics (24 percent).

More than half of the institutions engaged in curricular revisions report meeting the ACC criterion for methodological/technological updates. Most institutions (11 out of 13 respondents; or 11 out of 18 sites if including nonrespondents) reported that their curricular enhancements "integrate the use of instruments, methods, and procedures that are commonly used in academic, industry, and government laboratories," as established by the ACC (see boxes 2 and 3). This group reported revising or developing a total of 28 courses meeting the ACC criterion, courses which constitute over 40 percent of all the revised or newly developed courses reported by surveyed sites. Most technological enhancements to courses reported were in chemistry and physics (25 percent each), followed by engineering (18 percent) and biology (11 percent).

Institutions developed new majors, minors, and concentrations. Thirty-eight percent of interviewees discussed adding a major, minor, or concentration to their STEM curricula. For example, one site added a minor in space, earth, and atmospheric science (reputed to be the first of its kind at an HBCU), created a new major in computer engineering, and introduced both a master's and a doctoral program in medical physics for students seeking a career in medical fields with an emphasis on science. Another site developed an undergraduate concentration in environmental sciences and created an undergraduate engineering program.

Infusion of inquiry-based learning was supported through HBCU-UP. Twenty-eight percent of the sites cited the infusion of inquiry-based learning into their STEM curriculum. For example, one grantee institution targeted reform of gatekeeper courses and sought to inject "more relevant content, inquiry-based learning, and more opportunities for active learning" because the institution had "faculty who had been teaching for 30 years out of their graduate school notes."

BOX 2. General Technological Improvements

Many sites reported general technological improvements, including computer-based simulations (such as Virtual Labs), Smart-Board technology, and laptops in the classroom. One site used funds to set up 20 "electronic classrooms" with computers for each student and interactive projection equipment.

Knowledge Base: HBCU-UP Model Core

The HBCU-UP model is characterized by two types of activities or strategies, those commonly found at most institutions (labeled "typical") and others occasionally present (labeled "supplementary"). An analysis of these strategies in light of average student outcomes revealed that the HBCU-UP model contains an additional component, which we designate as "core" (see figure 3). Core strategies are those common to *all* highly successful institutions. Through the student survey data, we investigated the following hypothesis: *the presence of core activities is associated with higher student retention in the STEM educational pipeline and insertion in the STEM workforce.*

BOX 3. Examples of Technological Curricular Improvements

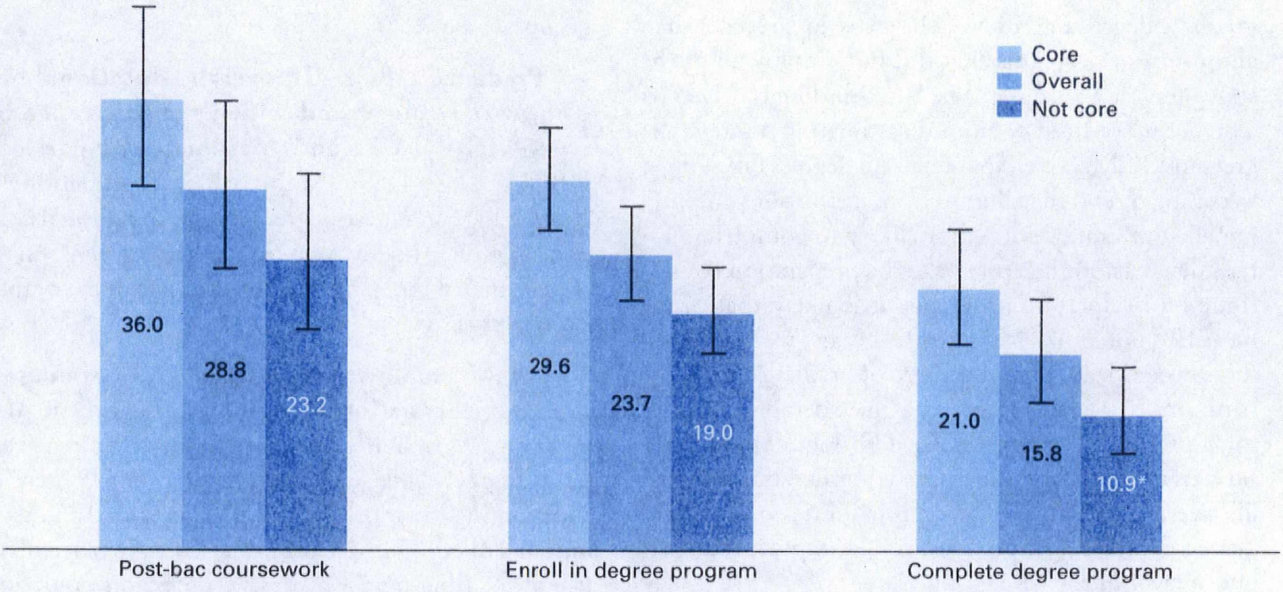
Chemistry
Spec20 Spectrometer
pH meter
Tabletop centrifuge

Biology
Immunohistochemical techniques
Light microscopy

Engineering
NXT robots
CNC lathe
Wind tunnel with a manometer for pressure measurement
SolidWorks CAD software

Mathematics
MyMathLab

FIGURE 14. HBCU-UP Core versus Not-Core Comparison: Graduate Outcomes (percent)

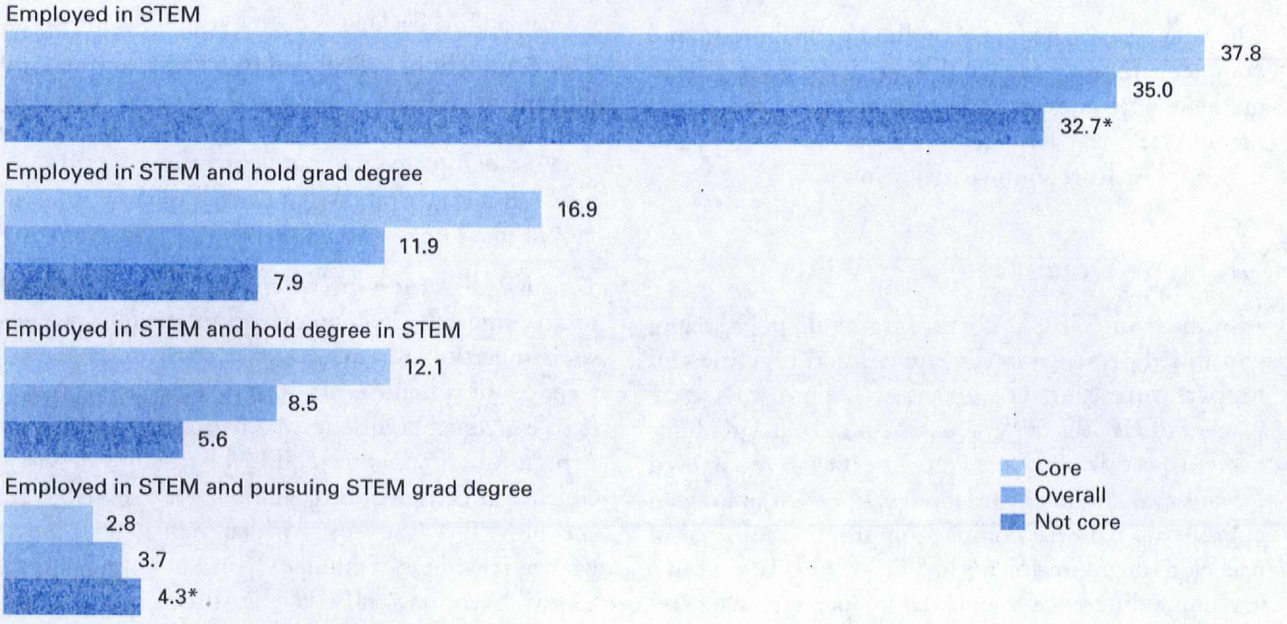


Source: Urban Institute HBCU-UP Graduate Survey.
* Statistically different from overall HBCU-UP estimate at $\alpha = 5\%$.

To test this hypothesis, we grouped institutions that employed the bundle of core strategies (irrespective of student outcomes) and compared their average performance to that of all other institutions (those not sharing all core strategies, but using one or more of them). This comparison is possible—that is, it is not reduced to comparing highly successful institutions to others—because the subset of core strategies is also present among institutions not considered highly successful in student outcomes. This "core" versus "not core" comparison led to the following findings.

Graduates from core programs are more likely to pursue graduate education. On average, alumni from institutions that employed all core strategies were more likely to pursue post-baccalaureate coursework in

FIGURE 15. HBCU-UP Core versus Not-Core Comparison: STEM Workforce Insertion (percent)



Source: Urban Institute HBCU-UP Graduate Survey.
* Not significantly different from core.

STEM (36 versus 23 percent), enroll in a STEM graduate program (30 versus 19 percent), and complete a graduate degree in STEM (21 versus 11 percent) than alumni from programs that did not employ all of the strategies (see figure 14). The latter finding is driven by a higher proportion of alumni completing master's degrees in STEM. Given that doctoral degrees take longer to complete, and that alumni from institutions employing all core strategies are more likely to complete master's degrees and therefore have the preparation to continue on to doctoral programs, it is likely that, if we measured outcomes again in a few years, we would observe a significantly higher share of graduates from institutions that employ core strategies completing doctoral programs in STEM. In addition, results from survival models like those discussed earlier, but comparing average core to not-core probabilities of graduate degree completion, mirrored results reported earlier, but in favor of the core group.

Graduates from core programs are equally likely to enter the STEM workforce but more likely to hold a graduate degree. As figure 15 shows, alumni from HBCU-UP programs that employed all core strategies appear more likely to be employed in STEM full-time, but the difference is not statistically significant (38 versus 33 percent). They were, however, more likely to be employed in STEM *and* hold a graduate degree in any field (17 versus 8 percent) and in STEM (12 versus 6 percent).

Summary

The summative evaluation findings contribute to and complement process evaluation findings in three areas: graduate outcomes, infrastructure change, and assessment of HBCU-UP model core effectiveness. Key findings from each are summarized below.

Graduate Outcomes

Alumni from HBCU-UP programs display strong continued presence in the educational pipeline and outperform national comparisons. Approximately 35 percent of HBCU-UP graduates completed a graduate degree (mostly master's) by the time they were surveyed for this evaluation, versus about 25 percent among an appropriate national comparison group comprised of bachelor's degree recipients in STEM. This 10-percentage-point difference widens to 14 percent when restricting the comparison to African American graduates but narrows when comparing by field of studies. About 16 percent of HBCU-UP graduates obtained degrees in STEM, versus 12 percent in the national comparison group.

Predicted HBCU-UP overall educational outcomes are stronger and widen the difference between HBCU-UP and national comparisons. HBCU-UP graduates exhibit a higher probability of completing a graduate degree than both national comparison groups (.41 by year 6, versus .30 and .25 in the overall and in the African American national comparisons, respectively).

STEM employment outcomes are similar to those of the national comparisons, except that HBCU-UP graduates are more likely to hold a graduate degree. This suggests that HBCU-UP may be contributing to a more academically prepared and technically skilled STEM workforce. This is particularly true if focusing on the African American population, where greater insertion in STEM among HBCU-UP graduates is observed. HBCU-UP African American graduates are more likely to be employed in STEM, and more likely to be employed in STEM and hold a graduate degree in any field and in STEM, than a national comparison of African Americans. This finding is driven by women HBCU-UP graduates.

Comparison to national benchmarks yields more favorable results for women than men in HBCU-UP, as women HBCU-UP graduates outperform women nationally in education and employment outcomes in STEM. HBCU-UP female graduates outperform a national comparison of women STEM bachelor's degree recipients in graduate degree completion, overall and in STEM, and in employment in STEM. Compared to their national benchmark, HBCU-UP male graduates are more likely to complete graduate degrees in all fields combined (but not in STEM) and are less likely to be employed in STEM.

Analysis of the intersection of gender and ethnicity, especially in comparison to gender- and race-specific national benchmarks, reaffirms earlier differences in outcomes. HBCU-UP African American female graduates outperform a national comparison of African American women STEM bachelor's degree recipients in completion of graduate programs, overall and in STEM (the gap is wider than that found for women regardless of ethnicity), and in employment in STEM. In contrast, HBCU-UP African American men outperform their national comparison only in overall completion of graduate degrees.

Infrastructure Change

Student participation in faculty research increased. Faculty report increased undergraduate student involvement in their own research and an increased expectation at their institutions that they seek and obtain research grants. These results reinforce the case-study and telephone-interview findings regarding the emphasis on research fostered through HBCU-UP at grantee institutions. But faculty did not report increased institutional support for research, which might have accompanied the increased fundraising expectations.

Institutional support for teaching improvements and use of technology in instruction increased. Indicators measuring satisfaction with institutional support for teaching improvements and with quality of equipment and facilities for classroom instruction doubled in pre-post HBCU-UP measures and rose to match the national estimates. Similarly, the share of faculty indicating that they were very satisfied with institutional support for implementing technology-based instructional strategies rose significantly, although not enough to eliminate the gap with the national estimate. But faculty did not report increased support for classroom instruction.

Curricular revisions involved technology use and curricular updates, but not research. Evidence from multiple sources—telephone interviews, case studies, and course revision surveys—indicated that sites focused on curricular revisions. In fact, most HBCU-UP institutions carried out curricular revisions, either by revising existing courses or creating new ones. Many of them also indicated, and provided supporting evidence, that their course revisions met the ACC "state-of-the-art" criterion of "integrat[ing] the use of instruments, methods, and procedures that are commonly used in academic, industry, and government laboratories" and most cited increased use of technology. But neither faculty surveyed nor project directors interviewed reported revisions to STEM courses to include more research.

HBCU-UP Model Core

Analysis of implementation and outcomes data revealed that there is a core set of strategies within the HBCU-UP model, and this core is associated with successful graduate outcomes.

Alumni from core HBCU-UP projects were more likely to stay in the STEM education pipeline. On average, alumni from HBCU-UP institutions that employed all core strategies were more likely to pursue post-baccalaureate coursework in STEM (36 versus 23 percent), enroll in a STEM graduate program (30 versus 19 percent), and complete a graduate degree in STEM, mostly master's (21 versus 11 percent).

Alumni from core HBCU-UP projects employed in STEM have higher educational attainment. Alumni from core projects were equally likely to be employed in STEM full-time compared to alumni in non-core programs, but were more likely to have achieved higher levels of education, that is, to be employed in STEM and hold a graduate degree in any field (17 versus 8 percent) and in STEM (12 versus 6 percent).

Conclusions and Recommendations

This section summarizes the main conclusions that emerge from our evaluation of the HBCU-UP program and provides a set of recommendations for its future implementation.

Conclusions

1. HBCU-UP grantees succeeded in building an institutional infrastructure that supports the education of STEM majors. Institutions carried out curricular and instructional reforms, provided faculty professional development, established academic support services for students, engaged in collaborative relationships with other institutions and entities, and upgraded their laboratory and STEM instructional equipment. In addition, case studies suggest that some HBCU-UP grantees succeeded in institutionalizing some key components of their reforms.

2. The HBCU-UP program yielded an intervention model characterized by a core set of strategies associated with successful student outcomes. Analysis of implementation and outcomes data revealed that there is a core set of institutional, faculty, and student strategies within the HBCU-UP model, and this core is associated with successful graduate outcomes. Core strategies include curricular reform, faculty professional development, and summer bridge programs. Alumni from HBCU-UP institutions that employed all core strategies were more likely to stay in the STEM education pipeline—pursuing further coursework, enrolling in graduate programs, and completing graduate degrees—than alumni from other (non-core) projects. Those employed in STEM were also more likely have earned a graduate degree, suggesting that HBCU-UP graduates from core projects may be contributing to the creation of a STEM workforce of individuals who are better prepared to make a contribution to their fields and who may be more likely to stay employed in STEM.

3. Successful HBCU-UP projects shared elements that suggest effective projects (a) design interventions to address well-defined problems; (b) provide a comprehensive array of strategies that span institutional infrastructure improvement, faculty development, and student support services; (c) tailor their strategies and activities to their institutional mission and characteristics; and (d) institutionalize the key components of their projects.

4. HBCU-UP graduates outperformed national samples of STEM baccalaureate degree holders in terms of degree completion and participation in the STEM workforce with a graduate degree. The goal of HBCU-UP is to strengthen institutional capacity to support the education and retention of students in STEM. Compared to recipients of STEM undergraduate degrees nationally, HBCU-UP alumni were more likely to have sought and obtained graduate degrees (overall and in STEM), equally likely to be in STEM jobs, and more likely to hold a graduate degree while employed in STEM. Compared to African American STEM graduates nationally, HBCU-UP graduates (mostly African Americans) were *more likely to be employed in STEM*, and more likely to be employed in STEM and hold a graduate degree in any field and in STEM. This suggests that HBCU-UP graduates are making a double contribution to the STEM workforce: they are more likely to enter the STEM workforce than African Americans nationally and are also more likely to bring higher levels of academic training than STEM baccalaureate degree holders nationally.

5. The HBCU-UP program successfully contributed to the education and retention of women, and minority women, in STEM. Women HBCU-UP graduates outperform women nationally both in educational attainment (overall and in STEM) and in STEM employment outcomes. These results also hold when restricting the comparison by ethnicity. HBCU-UP African American female graduates outpace a national comparison of African American women STEM bachelor degree recipients. In addition, women HBCU-UP alumni have higher predicted probabilities of graduate degree completion (marginal and cumulative) than men and national benchmarks. Indeed, women drive the overall results reported regarding greater STEM employment among African American HBCU-UP graduates, as HBCU-UP male graduates are less likely than the national comparison to be employed in STEM. The HBCU-UP program has been particularly successful in

contributing to the education and retention of women, and minority women, in STEM.

Recommendations

1. Encourage the inclusion of core model components in proposals from HBCU-UP grant applicants. The evaluation identified a set of core components associated with successful student outcomes. These core components seem crucial for transforming grantee institutions by enhancing their capacity to produce STEM graduates who go on to complete STEM graduate programs and enter the STEM workforce. Core components include specific activities or strategies within the broad categories of institutional infrastructure changes, faculty support, and student support services. These strategies focus on addressing challenges identified in the research as diminishing HBCUs' potential effectiveness while capitalizing on their unique contributions (Ayres and Bennett 1983; Gregory 2003; Outcalt and Skewes-Cox 2002).

2. Emphasize the inclusion of project components that strengthen the link to graduate studies, particularly in the early post-undergraduate years. HBCU-UP alumni showed higher rates of completing graduate programs than national comparison students, particularly in the first two years after graduating with a baccalaureate degree. This advantage, however, declines with time (particularly among male students), and disappears in the sixth year. Consequently, emphasizing preparation to apply to graduate school, undergraduate research experiences, and other preparatory activities that strengthen the connection to graduate school may help maximize continued education in the early post-undergraduate years, where the connection with graduate education is strongest.

3. Consider the characteristics of successful projects in selecting sites for grant awards under the HBCU-UP program. The evaluation identified a set of conditions that characterized successful projects. These can be summarized as (a) a clear identification of problems or barriers to be addressed by the project intervention; (b) a comprehensive approach that encompasses student support, faculty support, and institutional infrastructure change; (c) an intervention that is tailored to the needs and context of the institution and its students; and (d) the institutionalization of the major components of the project. Reviewers should be instructed to look for these characteristics in grant applicants and the presence or absence of these features should be a factor influencing award decisions.

4. Encourage dissemination of findings and lessons learned to the HBCU community. The evaluation identified critical components of an intervention model that is associated with successful STEM outcomes for HBCUs. Many of the grantee institutions possess a wealth of knowledge and experience in the development and implementation of model components that can be replicated by other HBCUs. HBCU-UP grantees that have successful outcomes should be encouraged and funded to share their experiences with other HBCUs to encourage replication of the HBCU-UP core model for capacity building.

5. Use the knowledge gained through the HBCU-UP program regarding the production of African American STEM workforce talent to inform the policies and practices of predominantly white institutions. HBCUs are a small fraction of institutions of higher education in the United States although they produce a disproportionate share of African American STEM baccalaureates. A greater share of African American STEM majors, nevertheless, is educated at PWIs. There is much that PWIs can learn from HBCUs regarding the education of African American STEM majors that will help them increase retention of these students, who tend to have high dropout rates from PWIs. Successful HBCU-UP grantees can provide model policies and practices that can be adapted for use by PWIs, where the majority of African Americans are educated.

Notes

1. The Urban Institute collected data through interviews with project directors (97 percent response rate); surveys of graduates (65 percent) and faculty (80 percent) keyed to national data from the Scientists and Engineers Statistical Data System (SESTAT, NSF) and the National Survey of Postsecondary Faculty (NSOPF, NCES); a survey of curricular revisions (72 percent); and case studies at four institutions.
2. NCES (Enrollment Data File, 2009). These statistics exclude 11 two-year colleges and 3 bachelor's/associates colleges, given our focus on four-year colleges.
3. Implementation projects, planning grants, education research projects, and targeted infusion grants.
4. Currently, there are 104 HBCUs, including 53 private institutions and 51 public institutions (Carnegie Foundation for the Advancement of Teaching, Carnegie Classifications Data File, June 19, 2009). Of the total, 92 are four-year institutions and the remainder are two-year colleges. HBCUs comprise 3 percent of institutions of higher education in the United States.
5. Southern University at New Orleans was not included because most of their records were lost due to Hurricane Katrina. Howard University was excluded because it was unable to respond on time. Also see endnote 6.
6. The early 1998 awards (cohort 1) were excluded, as these were pilot cases that later received grants and entered the evaluation through subsequent cohorts. The 2003 awards (cohort 5) were excluded because they had just been funded and, therefore, insufficient time had elapsed to observe outcomes.
7. All differences reported here have a significance level of at least .05. More details regarding the methodology used (including weighting and variance adjustments) are found in the full report.
8. The SESTAT data come from three national surveys: the National Survey of College Graduates, the National Survey of Recent College Graduates, and the Survey of Doctorate Recipients. We selected the appropriate comparison records by matching on time between graduation with a bachelor's degree and survey completion, which by design ranged between three and seven years for the HBCU-UP sample.
9. The cutoff of 74 percent is based on the average implementation of different activities across grantees.
10. These projects were located at Bennett College, Tougaloo College, Hampton University, North Carolina A&T State University, and Albany State University. Outcomes included enrollment in and completion of STEM graduate programs based on analysis of survey data from STEM graduates of grantee institutions.
11. For a review of this literature, see Clewell et al. (2006) and Tsui (2007).
12. The NSOPF data were restricted to faculty from the same types of institutions (liberal arts, baccalaureate, master's, and doctoral), the same ranks (assistant, associate, and full professors) and STEM fields.

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