1-1-2016

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Journal of Research Initiatives

Volume 2
Issue 1 *Anniversary Issue*

Article 6

1-31-2016

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Keywords
HBCUs, mathematics, higher education, Black mathematicians

Cover Page Footnote
N/A

Journal of Research Initiatives (2016) 2(1)

Available online at: http://digitalcommons.uncfsu.edu/jri/

THE ROLE OF BLACK COLLEGES IN THE DEVELOPMENT OF MATHEMATICIANS

Viveka Borum, Adriel Adon Hilton, and Erica Walker

Abstract

Historically Black Colleges and Universities (HBCUs) are home to almost 400,000 of the nation's college and university population and account for nearly 25% of degrees conferred to African Americans, according to Hale (2006). They have been the launching pads for three-fourths of African Americans who hold doctorate degrees, three-fourths of Black officers in the military, and four-fifths of African American federal judges (Hale, 2006). In addition, fifty percent of African American faculty in predominantly White research universities received their bachelor's degrees at an HBCU (Hale, 2006). These are significant percentages given the relatively small number of Black colleges and universities in the country.

While some attention has been paid to the success of historically Black colleges and universities in facilitating access to mathematics and science careers for their graduates, the mechanisms by which Black colleges promote this access have largely gone unexplored in the literature, with a few notable exceptions (Hilliard, 1995, 2003; Scriven, 2006; Southern Education Foundation, 2005; Tucker, 1996). These mechanisms are also often viewed as static, without emphasis on the traditions and practices that influence succeeding generations of mathematics students and faculty. These traditions and practices, we argue, are rooted in social, cultural, and historical contexts that are integral to Black colleges' success in facilitating mathematics success. We present a paper that explores the characteristics and practices of Black colleges that support mathematics development, incubate mathematical talent, and disseminate effective practices beyond the walls of these institutions and across generations of students.

Introduction

Although some attention has been paid to the success of HBCUs in facilitating access to mathematics and science careers for their graduates, the mechanisms by which Black colleges promote this access have largely gone unexplored, with a few notable exceptions (Hilliard, 1995, 2003; "Igniting potential," 2005; Scriven, 2006; Tucker, 1996). These mechanisms are often viewed as static, without emphasis on the traditions and practices that influence succeeding generations of mathematics students and faculty. The traditions and practices are rooted in social, cultural, and historical contexts, which are integral to what Black colleges have accomplished in facilitating mathematics access and success.

This article explored the characteristics and practices of Black colleges that support mathematics development, nurture mathematical talent, and disseminate effective practices beyond the walls of these institutions and across generations of students. Using a theoretical lens

that accommodates the unique cultural and historical characteristics of the HBCU, this narrative will seek to clarify: (a) how social and cultural capital operates within and across these settings; (b) how the influence of HBCUs contributes to a deeper understanding of mathematical identity, and (c) how HBCUs contribute to the development of mathematicians.

Theoretical Perspectives

Researchers have pointed out that "traditionally Black institutions produce disproportionate numbers of students who persist towards doctorates in the sciences and engineering, even though most African American students attend predominantly White institutions" (Cooper, 2004, p. 539). Indeed, the "eight colleges and universities that produced the most African-American graduates who went on to earn PhDs in mathematics or science in the 1997 to 2006 period are all historically Black colleges and universities (JBHE, 2008, p. 61)," with Harvard University and the University of Maryland ranked 9th and 10th, respectively.

HBCUs were created to provide educational opportunities for African Americans when other educational pathways were closed or limited. These institutions, developed with the assistance of the American Missionary Association and the Freedmen's Bureau, along with financial support from Black churches and private philanthropists, continue to educate African American leaders. Their mission, to provide a quality education to as many as possible, especially those who might not otherwise be given the opportunity, remains largely unchanged today. This mission of HBCUs is paramount to facilitating mentoring that extends beyond the baccalaureate degree.

Because Black mathematicians, like other Black academics and professionals, occupy a particular space at the intersection of notions of intellectual ability, merit, and perceived exceptionalism, it is important to understand the success of Black colleges within larger discourses about Black achievement, particularly in mathematics. Indeed, despite the success of HBCUs in fostering STEM achievement among Blacks, the dominant focus of mathematics education research has been on Black underachievement compared to other demographic groups, despite recent work that focuses on patterns of high achievement (Berry, 2008; Ellington & Frederick, 2010; Martin, 2000; Walker, 2006).

With Black colleges continuing to provide a significant share of the science and mathematics majors who enroll in graduate schools, it is important to consider the genesis of these institutions and the implications of their existence. Rooted in a strong community context for higher education, many Black colleges began as fundamental education programs designed to address the lack of literacy and formal education of Black Americans emerging from slavery and a Jim Crow existence in the segregated South (Anderson, 1988). Hampered by a lack of funding support and philosophical disagreements with state governments and foundation revenue sources about the appropriateness of a classical university education for Black Americans, Black colleges often struggled to develop research programs but demonstrated an unprecedented commitment to teaching (Pearson & Pearson, 1985; Winston, 1971).

These institutions, however, did not ascend from a vacuum. It would be ahistorical to consider these institutions, which are largely located in the southern US, without acknowledging the importance of their being situated within a unique milieu that is "historically considered the reservoir of African American culture in the nation" (Morris & Monroe, 2009, p. 21). The existence of Black colleges in the South provided a paradoxical example of Black intelligence and success when the region was mired in Jim Crow mores, practices, and legal discrimination that underscored a white-supremacist ideology that Blacks were inferior in every way and, most

certainly, intellectually (Winston, 1971). Black colleges existed, in many ways, as imperfect islands of opportunity by necessity, not by choice, for Black Americans across the South when Black opportunity was circumscribed legally and politically.

In addition, the impact that HBCUs have had on the mathematics and other STEM (science, technology, engineering, and mathematics) fields is significant. For example, for the years 2001-2009, HBCUs accounted for 39% of African American graduates in STEM (Owens, Shelton, Bloom, & Cavil, 2012). During this same time, HBCUs accounted for 46% of graduates with bachelor's degrees in mathematics (Owens, Shelton, Bloom, & Cavil, 2012). The characteristics that HBCUs define as being pivotal to their success rate of STEM graduates consist of: pre-college summer programs in STEM, online pre-college mathematics courses, peer mentoring programs, retention counselors for STEM majors, faculty mentorship/support, and supplemental instruction sessions for extra help in advanced mathematics and science courses (McNair, 2009; Palmer, Davis, & Thompson, 2010; Perna et al., 2009). These elements are just a few innovations that Black colleges have implemented in obtaining successful graduation rates for students in STEM.

Theory of Action

Two theoretical constructs were used in this research to explore the processes and mechanisms by which HBCUs support Black students in mathematics: (1) social capital (Bourdieu, 1986) and (2) mathematics identity and socialization (Martin, 2006). Together, these two constructs help bolster the theory that HBCUs have unique cultural and historical characteristics that help facilitate the development of mathematics talent, particularly and in unique ways, for Black mathematicians.

Bourdieu (1986) defined social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships" (p. 248). His interpretation emphasizes that the gains individuals reap are the result of their group membership. Putman (2000) revealed that the "presence of social capital has been linked to various positive outcomes, particularly in education" (p. 296). Social capital is important to this research because it provides a theoretical framework for the unique social networks and bonds established through HBCUs. Given that value is derived from social relations available to human agents, this framework was employed for this research.

Mathematical identity is defined by Martin as "one's beliefs about one's own mathematical abilities, about the instrumental importance of mathematics, about opportunities and constraints to participate in mathematics, and one's motivation to obtain mathematical knowledge" (Martin, 2000, p. viii). Martin sees mathematical identity as being rooted in cultural, community, school, sociohistorical, and interpersonal contexts. Further, one's core identity is also shaped by these contexts. Nasir and Saxe (2003) suggest that one's core identity and academic identity might be discrete and, further, that "identities are shaped, structured, and negotiated" (p. 14). The notion that one's mathematics identity might have to be reconciled with one's core identity—be it ethnic, gender, or otherwise—has also gained prominence in literature (Boaler & Greeno, 2000; Nasir & Saxe, 2003). In addition, for many Black scholars, others perceive their excellence as a "conflict" between race and merit, which is a reality that permeates their academic and professional lives (Hilliard, 2003; Winston, 1971). Thus, evidence is presented in this paper that the social and cultural capital afforded to Black mathematicians, who attended HBCUs, has a significant impact on the development of strong mathematics identities and contributes to their professional socialization as mathematicians.

Methods, Data Sources, and Evidence

Qualitative research methods were used to design this study and fulfill its objectives. In a study of Black mathematicians (Walker, 2009a, 2009b, 2010) who earned their PhD degrees in mathematics between 1941 and 2008, the theme of Black colleges as sites for mathematics learning, professional mentoring, and the development of generations of mathematicians emerged repeatedly in mathematicians' oral narratives, whether or not they attended HBCUs for their undergraduate education. The study comprised interviews with forty mathematicians who work in academic institutions, government, and private industry, eighteen of whom attended HBCUs during the 1960s, 1970s, 1980s, and 1990s. Semi-structured interviews were conducted using a protocol designed by Walker (2009) and averaged 1.5 hours in length. Questions during the interview focused on the mathematicians' early experiences with mathematics, in and out of school, as well as their later educational and professional experiences. Selected questions during the interviews included: How did you decide to major in mathematics in college? In what kind of out-of-classroom activities did you participate in college that supported your mathematics learning? How did you decide to continue your education to obtain a PhD in mathematics? Additionally, interviews were digitally recorded and transcribed and names of all interviewees replaced with pseudonyms.

Other evidence cited for this research, in addition to the interviews, included observation notes from site visits to conferences, professional meetings, colleges and universities. These notes were used to triangulate and augment findings from historical texts and interviews relating to Black mathematicians in the US. The interview transcripts were coded for themes relating to HBCUs, social capital, and mathematics identity. Given the narrative nature of the interviews, episodes in the life and professional histories of mathematicians were carefully read for links to HBCUs and for social and professional networks relating to mathematics that showed evidence of emerging at and/or from HBCUs. For example, major codes relating to these facets included: (a) faculty talk, (b) faculty/administration encouragement, and (c) mathematics experiences. Furthermore, the interviews were examined for descriptions of experiences that fostered mathematics socialization. Codes relating to these facets included: (a) exposure to mathematics—extracurricular, (b) exposure to mathematics—classroom, (c) expectations, (d) peer support—social, (e) peer support—mathematics, and (f) mentoring.

Findings

Significant influence of social networks and bonds on facilitating access to mathematics knowledge, opportunities, and practices was found surrounding mathematics within HBCUs. Further, evidence was realized that the networks developed at HBCUs permeate the graduate school and professional experiences of Black mathematicians. In this section, three key elements are described relating to HBCUs that facilitated mathematics excellence among the participants and fostered socialization beyond the undergraduate experience: (a) role of faculty; (b) interaction among students; and (c) returning to serve. After this general description, the focus will be on two HBCUs: Spelman College and Morgan State University (formerly Morgan State College).

These two specific institutions further illuminate these mechanisms and have demonstrated success in developing a pipeline from undergraduate mathematics to graduate level mathematics. Spelman and Morgan State, both small undergraduate institutions in predominantly Black cities—Atlanta and Baltimore, respectively—have had significant success in producing mathematicians from among their student ranks. They were most frequently mentioned as

"success stories" by Black mathematicians in interviews. The 2009 case study approaches delineated by Yin are used to describe elements of these two institutions' practices that relate to social capital and mathematics identity that inform institutional practices around teaching and learning to develop students' mathematics interest, potential, and excellence.

Before discussing factors promoting success for Black mathematicians, it is important to note important historical context brought to bear by three mathematicians interviewed for this study, who earned their PhDs in the 1940s—Dr. David Blackwell, Dr. Evelyn Granville, and Dr. Clarence Stephens. Blackwell, Granville, and Stephens attended University of Illinois, Smith College, and Johnson C. Smith College (now University), respectively, for their undergraduate degrees. Granville holds the distinction of being the third Black woman in the US to earn her PhD in mathematics. After earning their PhDs from Illinois, Yale, and Michigan, respectively, all began their university careers at Black colleges, due to the fact that White colleges were extremely unlikely—and largely unwilling—to hire Black faculty members (Donaldson & Fleming, 2000). Blackwell began his university career at Howard University, Granville at Fisk, and Stephens at Prairie View, initially, but soon left for Morgan State College. Winston (1971) states that until the last quarter of the 20th century, there was a "virtually impermeable racial barrier [that] excluded Negroes from White universities and their superior facilities for teaching and research" (p. 678). However, a number of Black mathematicians from this era eventually were able to work at White institutions. For example, Blackwell was eventually hired as a professor at the University of California-Berkeley; whereas Granville and Stephens were also hired by White universities. That said, this paper will demonstrate that the role of Black colleges in facilitating networks and professional opportunities for succeeding generations of mathematicians remained, and continues to remain, critical. Many of the Black faculty who seeded Black colleges' mathematics and science departments in the 1940s, 1950s, and1960s were among the first Blacks to earn graduate and doctoral degrees in their fields.

Roles of Faculty. HBCU graduates describe a very close and often family-like relationship with faculty and administrators. For Black mathematicians who attended HBCUs during the 1950s and 1960s, these close relationships were integral to their success in college and beyond. The faculty was committed to promising students' success, not just as undergraduates, but for their future graduate work, and in many cases saw their careers as faculty at Black colleges as being integral to the continued development of a Black intelligentsia and leadership. One interviewee recollected this about faculty influence on his decision to earn a PhD:

> There was a young man who turned out to be a mentor [for us]…He was an African American. He had a PhD in physics. At South College, the department wasn't big enough to have separate physics and math departments. Because he had a PhD, he was the chairman of that whole department—so he was our chair.
>
> He was very proud of his PhD. He would say, "There's only fifty of us in the USA." There were only fifty African Americans with PhDs in physics [at that time]. That was the number he would always quote—only fifty. So, he was called upon to do research here and there. He would be running all over the place. Wasn't much of a teacher, but a nice guy—really nice guy. We got to be his friends.
>
> When we got to be seniors, then we got to interact with the chair a little more. That's when he started preaching graduate school to us. It didn't matter that we weren't going in physics—we were going in math—as long as you go to graduate school. He almost insisted that we go. You know, you have a high regard for these guys. I said, "Okay. He

> wants me to go and get a PhD." So, he's going to help you get into graduate school. He showed us how to apply to this school and that school. He gave us the assistance in how to take the Graduate Record Examination. He mapped everything out for us. He would write recommendation letters to the schools to get you in. He pretty much took us under his wing. That's how we ended up deciding to go to graduate school.

Another mathematician recalls his experience in one of his first mathematics classes in college:

> We were in one of these calculus courses just for math majors. [Our professor] came in the first day, and he had a picture that he put on the bulletin board—a picture of a nice building. It was the Institute for Advanced Study at Princeton. That was the picture that he put up. And then he told us, "You are to aim for here; to get here at the Princeton Institute." You know, where Einstein was. He said, "Even if you miss, at a minimum, you will have a PhD. Because, to get there, you would have to have a PhD; so, if you aim here, you can miss." So, in other words, establish that and set your goals very high in aiming so that if you don't make it, you will be pretty well off.

Faculty who had high expectations and provided professional guidance were also mentioned by Black mathematicians, who attended HBCUs in the 1980s and 1990s. They, too, describe rich relationships with faculty, who were deeply committed to their success:

> [Taking that class] is when I met my advisor, Louisa Richards. I think that she definitely saw something in me. She began to tell me that I really had a knack for mathematics and started telling me about summer programs that I could attend. You know, some people felt like she was very, very demanding. So, in like her Calculus 1 and 2 classes, she had the lowest enrollment. You know, the rumors had already gotten out, so people did not want to enroll in her class. So, she was very demanding, but I knew that because I like math, I knew that she was really challenging us. I just felt like she knew what it would take. She was genuine. We talked about other things, not just mathematics.

It should be noted that these relationships are not just nurturing, encouraging, and supportive but that their primary focus is the mathematical development of future mathematicians. As such, HBCU faculty is committed to ensuring a rigorous mathematics curriculum. Several HBCU graduates speak about the rigor and toughness of their professors; and for some, the exposure to new kinds of mathematics by these professors helped them realize that they wanted to do mathematics as a career:

> When we got to [the predominantly White neighboring institution], we realized we had gotten more calculus with Dr. Ricks than they got there. He just demanded and expected more and did certain things they didn't do. They talked a good tough game; they flunked a lot of students out. They said, there are times when you have a responsibility to the entire class, that you can't just race ahead and leave everyone else in the dust.
>
> Probably during my sophomore year, I had one of those introductions of proofs classes. We had that where you learn about proof writing and things of that nature. Up until that point, of course, I thought that math was just a bunch of calculations, which I did like. But that is a misnomer, of course. So, when I took that class, I just loved it. I loved doing proofs. I just thought it was so magnificent. I thought that, "Maybe I don't want to teach high school. Maybe I can get into math."

Interactions with Other Students. HBCU faculty and administrators, perhaps inadvertently at times, facilitated the development of strong student networks. There is some

evidence that faculty and administrators deliberately set out to bring in strong students and establish a critical mass of intellectual talent:

> Harold Eckles [an administrator] comes down for a big meeting and was representing South College. He said, "I'm prepared to offer you a four-year, full scholarship." You could go to school for $1,800. That's about $450 a year or something like that. It's true. I went. I am a living witness. He said, "I will give you a full scholarship to come to South College—and not just you." He rounded up the best students in our senior class and offered [scholarships to] all of us. I wouldn't be by myself. I had my friends. There were at least ten of us from [the same high school]. He offered us these scholarships to go to South College. So we knew each other. "You going, man?" "Yeah, I'll go if you go." My parents didn't have any money, so they were happy and just wanted me to go to school. So that is how we ended up at South.

As Cooper (2000) notes in his study of programs that are successful in attracting and retaining Black students to graduate mathematics programs, faculty in these programs seek to ensure that Black students have access to networks that will support their mathematics success and reduce social isolation, and Black students seek and create communities that are both socially and academically supportive. Most often, however, students developed these relationships themselves, either completely on their own or supported by faculty and administrators:

> I was in the mathematics honors society, and I was the vice president of the Mathematics Club. Those were probably the biggest things that I did in college that were related to math. [My advisor] tells me now that I organized study groups as far as classes go. I know this, because she wrote this in my letter of recommendation that she thought that it was very good for me to do that. I would get the class together, and we would meet. One of the students was older, so she had an apartment. We would meet over there and have pizza and do math. The chair would leave the building open on like a Saturday so that we could do math problems and all of our upper-level classes. We were very close as far as a class unit. One of the students was from nearby, so we would go to his house and study. His parents would cook dinner for us. So we really...because the classes were small, it was kind of like, "We are all going to get through this." That is one of the things that I definitely like about my HBCU experience.

There were other respondents who felt that the faculty and students at HBCUs were supportive and encouraged success on every level. Addison Baker's experience at her HBCU was one that enabled her to graduate with a positive self-efficacy in mathematics, "I was totally supported, and I felt like the faculty there, they wanted me to succeed." Lydia Monroe also appreciated the support from her study groups. She claims that everyone in her study group brought their own strengths to share:

> It was a great experience because everybody was supportive of everybody. You did not feel bad for something that you didn't know, because you knew that somebody else understood and could explain it to you. We all had our different strengths, and we brought our strengths to the table. In that respect, I thought we had very effective groups.

Returning to Serve. Several Black mathematicians report that they have sought out employment opportunities at HBCUs to "give back" or to ensure that they assist in developing future mathematicians.

> I always liked teaching...I decided as a way of helping increase the numbers; it is just something I wanted to do. That is how I ended up at an HBCU. This HBCU has a strong tradition of producing African-American mathematicians. I felt like I could be a part of continuing that tradition. That is pretty much what keeps me here. I really wanted to come here. This HBCU was always my dream job. My roommate was like, "You have wanted to be [there] since [college]." I didn't realize that until [recently]. I really wanted to help to dispel that myth. So, for me, I feel like my calling is to mentor other women of color in math.

One mathematician describes the initial pressure she felt to *not* work at an HBCU and her later decision to return and pursue employment at an HBCU:

> For me, when I graduated [with my PhD], I wanted to go back to [her HBCU alma mater] and teach. You know? I felt like they helped me so much, and I wanted to go back and do for the students what [my advisor] did for me. But, most of my mentors and my PhD advisor, who was one of my mentors, too; I love them to death. He is a White male. They come in all races, of course. All of my mentors told me, "Don't do it. Don't go back to [an] HBCU. They don't have as much money. You have to teach too many courses. Your research will fall." That type of thing. "You can do it later." So, I went to a majority institution [first]. It was 10% minority and that is all minorities, so 90% White. The students actually were great. But, I did feel that I wasn't sure that this is what I was really meant to do. It was kind of like a calling type. Even though I loved the students and believed that they loved me, and I was still the same person; I would have a class with no minorities—no Asians, no African Americans, none. It just was so, you know, just had no diversity. It kind of wore on me. I think, even if it would have been kind of like Asian-Hispanic kind of mix in there, it would have been different. You know, a whole semester I could have maybe eighty kids and maybe three minorities. So, that really got me to thinking how I wouldn't be where I was if it weren't for someone and how I am sure there are other minorities that wouldn't be there.

Hence, returning to serve for these Black mathematicians was more of a "calling", where they wanted to continue the tradition in giving back to students at an HBCU. This speaks highly of the impact that attending an HBCU had on these individuals.

Thus, these interviews establish that Black colleges have important social and cultural meanings in the lives of Black mathematicians. They serve in many ways as a rebuke to historic notions of White intellectual superiority, especially in the South, and create opportunities for Blacks to demonstrate and attain mathematics excellence. Mathematics opportunities within Black colleges are largely unconstrained by coded discussions of intelligence and merit that may arise in predominantly White settings in which Blacks are a distinct minority. Indeed, a recent PhD graduate noted that at a Black college "no one is surprised that you do well in math." Some rich data from two sites—Morgan State University and Spelman College—will help substantiate this theory.

Morgan State University. Three mathematicians interviewed attended Morgan State College as undergraduate students, majoring in mathematics during the 1960s. They are uniquely positioned to describe the rigorous undergraduate mathematics program that they and others experienced. Their experiences are influenced by Professor Clarence F. Stephens, who was the ninth African American in the US to receive a PhD in mathematics (University of Michigan, 1943). Stephens' philosophy of teaching and learning mathematics was developed from his own

educational experiences in the segregated South, having attended the all-Black Harbison Institute Boarding School and Johnson C. Smith College in the 1920s and 1930s, respectively. Stephens, who was also interviewed for this study, was a professor of mathematics at Morgan from 1947 to 1962 and later had an equally influential career at SUNY-Geneseo and SUNY-Pottsdam, both predominantly White institutions. It is worth noting that Stephens' work at Pottsdam has been well chronicled (Datta, 1993; Megginson, 2003), whereas his work at Morgan State, which is where he first tried out his ideas, has been less fully described.

In an interview with Stephens, he described his recruitment strategy for talented high school students in Baltimore in the 1940s, which involved going to Black high schools and asking teachers about their top mathematics students. When colleagues at Morgan said the top students would only be frustrated by the lack of opportunity and employment they would eventually experience due to their being Black, Stephens replied, "Nonsense. If you're educated; you're educated, and that's a good thing."

Stephens' one-person strategy, with the support of colleagues, evolved into a successful undergraduate mathematics program during the 1950s and 1960s at a small Black college in rigidly segregated Baltimore. His work not only ensured that students learned rigorous content that would prepare them for graduate study in mathematics—and Stephens was very clear about the end goal—but also provided a blueprint to teaching mathematics as a profession. Here is how two Morgan State mathematicians, who earned undergraduate degrees, describe it:

> Now, I didn't know anything about PhDs. When I got to Morgan, there was Dr. Stephens, who has won all kinds of awards for his teaching…he found a way of identifying those students who seemed interested in math and who had a little bit of ability. So, he had a little group of us…in something like what we call today an REU [undergraduate research experience] program. So, we actually got some sort of stipend for doing some research during the summer. [The first summer] I got $600.00, and my job was to read the first three chapters of McShane and Botts' *Real Analysis*. This was a graduate level textbook. I was to summarize it and write an expository paper…Stephens really stretched us, and he started talking to us about the PhD.
>
> Stephens' program was really, I think, rather innovative. First of all, our students worked with each other a lot. We even tutored students who weren't as good as [we were]. We worked with each other a lot, and then we found ourselves competing for things. But, even from our sophomore year, he'd bring in a copy of the *American Mathematical Monthly*. *Mathematical Monthly* had two types of programs in it. They had problems in it. They had advanced problems and elementary problems. Supposedly, elementary problems were solvable by senior math majors and early grad students. But, the advanced problems were more for serious mathematicians, professional mathematicians. But, he would bring these problems in and we would just work, trying to solve all of them.

Although Stephens left Morgan State in 1962, several students who began studying with him went on to graduate school and had professional careers as mathematicians. Stephens' former students and their colleagues at Morgan State have developed a Stephens Scholars program for high school students to attract them to mathematics. What Stephens' program demonstrated—and what he later replicated at predominantly White institutions—was that all students could learn mathematics at a very high level. He exposed students to graduate level content during their undergraduate years and provided a space for them to learn with and from each other. One respondent noted that Stephens' extensive preparation meant that the "first year

of graduate school was a breeze." Very important to state, two of Stephens' students were among the first to desegregate the graduate program in mathematics at the University of Maryland.

Like the Morgan State mathematics alumni, Black student mathematicians attending other Black colleges in the 1960s describe faculty in the sciences at these institutions as also being integral to their success. Spelman College, for example, has been recognized as having an effective undergraduate mathematics program and is discussed in a more contemporary context as follows (Tucker, 1996).

Spelman College. The Albro-Falconer-Manley Building on Spelman's campus, also known as the Science Building, has immediate visual impact. The Science Building is named for three women in the sciences (two of whom are African American) with influential careers at Spelman: Dr. Helen Albro, Dr. Etta Falconer, and Dr. Audrey Forbes Manley. Upon entering the building, the first thing one sees in the atrium are display cases filled with photographs and other artifacts documenting the impressive history of women in the sciences at Spelman.

For Black women mathematicians, in particular, including five Spelman alumni and professors who were interviewed for this study, Falconer (1933-2002), who earned her PhD in mathematics in 1969 from Emory University, looms large over the science and mathematics programs at Spelman. Several faculty speak of Falconer's approach to ensuring that students and alumni of Spelman were successful in their graduate science programs.

Sylvia Bozeman, a long-time faculty member and administrator, began her career as a mathematics instructor at Spelman and credits Falconer's support for completing her PhD:

> You know, I had the best mentor for 30 years here at Spelman, Dr. Etta Falconer, and she was just incomparable as a mentor. So, I came as really green, right out, with a master's degree. And, so, I just learned so much from her. She had the just most wonderful, devoted following among all of us here in the sciences, because she didn't just mentor me, she mentored lots of faculty, lots of staff, and many more students. There were just lines of students outside her door all the time. Even her administrative assistants or secretaries, you know, they all went to school and left her. They all moved up. She mentored everybody.

A Spelman graduate who earned her PhD within the last 10 years was mentored both by Falconer and Bozeman, and, like others, also attributes Spelman's success in the sciences to Falconer and her colleagues' lasting influence:

> Etta Falconer mentored me. I mean, she was the oldest person at Spelman. She was really responsible for this sort of renaissance of science at Spelman. And she was old school. She just kind of told you what to do, like, "You're going to present here," and "You're going to do this," and "You're wrong; you're right." So, it wasn't a nurturing kind of mentoring; she just kind of told it.

Although the mathematics program at Spelman is rigorous and effective, its success is undoubtedly a result of the extensive mathematics socialization that its students experience at a very high level. One Spelman alumna notes:

> Spelman's precollege program in math and science was really important to me. We were able to sort of get a leg up coming in. But, the biggest thing was meeting these other scientists; other Black women interested in math and science and just studying. That social dynamic was just huge, huge, huge.

Another Spelman graduate, who is now a mathematician, describes her experience:

> Spelman was the first time I saw Black women with PhDs in math, which I think has a

> very interesting impact. I think I only recognized it in hindsight, because when I was there I sort of took it for granted. We had about five or six Black women on faculty that had PhDs, and I just thought, "Oh, they're a dime a dozen." And, it wasn't until my junior year that I realized there were fewer than one hundred Black women who had ever gotten PhDs in math. Not only that, to know that if I got one in five years, I would still be in the top one hundred. It was just blasphemy.

Most Spelman alumni and faculty interviewed for this study speak a great deal about the mathematics community at Spelman—how students work together and collaborate and how the faculty structures mathematics opportunities that are accessible to students. As one participant noted:

> It was easy to major in math at Spelman, because they're supportive. You know, we did our homework together. Nobody was like, you know, "I want to be the top student, and I won't help you or share it with you."

One former student recalled that she tended to work alone, but described, similarly to other students, the important influence of the Spelman College faculty and other Black mathematicians in her research fellowships as an undergraduate. A Morehouse College graduate, who is currently a faculty member at an HBCU, also remembers Falconer's influence:

> I regretted not taking Etta Falconer's number theory course when I could have squeezed it in. That would have been spring of my sophomore year, and I felt badly about that. But, I used to go by and see her. You look back and shake your head at things you did when you were a student, you know, "Oh no, I didn't do that; I can't believe I did that." I would feel I'm getting repaid now. And, so, I laugh. I may fuss sometimes, but I always try to be understanding and relaxed. Oh, she was so wonderful. I would just go stop by, you know. I used to like to go to Spelman and just visit. I would periodically just walk in, just pop in her office; and whenever she could, I'd take a seat, and she'd ask me how things are going? You know, we'd just talk a little. And, I didn't understand how busy professors are; I just didn't. I had no idea. So, anytime someone comes knocking on my door, I try to make a little time for them. If not on the spot, I'll tell them, you know, "Come back at 4:30," or whatever. But, I always try, because I think about how she was generous with her time and her wisdom.

Conclusion

The experiences described by the mathematicians in this study reveal that HBCUs have operated as sites that contribute to the development of Black students' mathematical knowledge and identity. In addition, these institutions have spawned networks that have also contributed substantially to their graduates' induction into the mathematics profession. Creating networks at traditionally White institutions (TWIs) can be a challenge for African American students. Bourdieu (1986) claims that African Americans and other students of color are at a disadvantage in their quest for upward mobility through advanced education by their lack of social capital at these institutions. Conversely, these networks at HBCUs seem to be more accessible, productive, and nurturing for Black students. The positive networks at HBCUs result in more Black graduates entering the STEM fields than Black graduates of TWIs (Lewis, Frierson, Strayhorn, Yang, & Tademy, 2008). One reason for this deals with the social or cultural norms established at HBCUs, or as Bourdieu (1977) describes them, habitus, the cultural norms or "rules of the game" that become a part of social capital.

Within HBCUs, African American students in mathematics have described the networks around mathematics as supportive, engaging, and encouraging. For example, many African American women mathematicians describe their undergraduate experiences at HBCUs as empowering, nurturing, and a collaborative effort towards success between faculty and students (Borum & Walker, 2012). African American women mathematicians recall their HBCU undergraduate experience as being enlightening and inspirational. Beyond the nurturing component, these women often mention the profound impact in seeing a Black male and/or Black female mathematician as their professor. In addition, the women who pursued advanced and terminal degrees at non-HBCU institutions would often return to their HBCU faculty for continued encouragement and nurturing, which ultimately helped them in completing their doctorate. Further, the characteristics of cultural, interpersonal, and supportive communities used to describe the features of an HBCU environment confirm Martin's (2000) view of mathematical identity. Mathematicians who were HBCU graduates speak powerfully about the importance of experiences that affirm their mathematics excellence, particularly the role of faculty who help them see themselves as talented mathematics doers. The interactions Black mathematicians report among faculty and fellow students during and after their HBCU attendance contribute to the important socialization processes that facilitate their entry into the mathematics profession. These relationships as described by Black mathematicians encompass mathematical learning, but also incorporate durable mentoring relationships that promote continued professional development, graduate school admission, attendance, and retention, and career success.

Most important, it should be acknowledged that HBCUs have made contributions beyond the development of strong mathematics majors under their auspices. Their boundaries are permeable and expansive. Their practices, disseminated through faculty and alumni, continue to influence graduates and the development of networks that facilitate development of mathematical talent, and not just for Black Americans. For example, Sylvia Bozeman from Spelman College and her colleague Rhonda Hughes of Bryn Mawr designed and developed EDGE (Enhancing Diversity in Graduate Education) to attract and retain talented women in graduate study in the mathematics sciences (Bozeman and Hughes, 2004). EDGE continues to address the attrition rate of women and people of color from graduate programs. EDGE has a myriad of objectives focusing on the academic, psychological, political, and social aspects of graduate education and attempts to bring awareness to women as to how educational structures operate. Further, Black colleges directly and indirectly influence Black mathematician organizations, successful mathematics graduate programs, and interventions for underrepresented students within predominantly White institutions in that these programs often incorporate community and peer networks to facilitate mathematics learning.

Arguably, however, what contributes most greatly to the successful work of Black colleges, Black mathematician organizations, and certain graduate programs as incubators for Black mathematical talent is the presence of key individuals—Black and non-Black—who are committed to developing mathematical talent and excellence. Much of the research describing factors that contribute to the high achievement of underserved students in mathematics, in particular, points to the importance of relationships that have personal dimension and relate to the content (Berry, 2008). Whereas it is certainly true that mathematicians belonging to other demographic groups may experience similar mentoring and support, the narratives of the Black mathematicians in this study suggest they feel: (1) high expectations for their success; and (2) access to mentoring and networking in predominantly Black environments were essential to their mathematical development and induction into the profession that cannot be taken for granted.

Further, because most Black mathematicians earn their graduate degrees and have post-graduate experiences in institutions and settings where they are the sole Black mathematician, this context permeates their professional experiences. HBCUs serve as institutions that continue to provide important support for talent development and also serve as models and inspiration for younger generations of mathematicians. One young mathematician, who attended an HBCU, describes the impact of her mentor:

> Definitely, the first important thing for me is this continuing to add more African American PhDs and women to mathematics. Probably, people will be saying that I am too young for this to be my most important thing; but, because I was so influenced, I feel obligated to pass that on.

The contention is that the most successful Black colleges are structured in deliberate ways to foster the development of rigorous mathematical knowledge, building socialization and identity, and transitioning into careers of professional mathematicians. Of particular interest is that most Black colleges, in and of themselves, have little formal responsibility for graduate training in mathematics—their graduates, for the most part, earn their PhDs from predominantly White institutions. (Certainly, further research could be warranted regarding graduate programs at the doctoral level in mathematics at Howard University and Delaware State University, for example). However, despite their role being primarily undergraduate-degree-granting institutions, at least in mathematics, Black colleges maintain strong relationships between undergraduate faculty and alumni that continue throughout their professional careers (Cooper, 2004). Cooper's statement is corroborated by participant interviews in this study.

At a time when some question the relevance of HBCUs in a supposed post-racial era, there are important lessons to be learned from these institutions, which have traditionally promoted education for the underserved, as well as fostered academic excellence and increased access to professions. Given the need for models to develop strong mathematics and science talent, it is unclear why institutions of higher learning continue to try new methods of attracting and retaining students to mathematics, particularly when a number of Black colleges have demonstrated such long-lasting and pervasive success through their explicit and intentional crafting of mathematical opportunity. Perhaps the research in this paper will help to open a broader dialogue about the rich traditions, worthy work, and best practices of Black colleges and universities, particularly in the area of mathematics.

References

Berry, R. Q. (2008). Access to upper-level mathematics: The stories of successful African American middle school boys. *Journal for Research in Mathematics Education, 39* (5), 464-488.

Boaler, J., & Greeno, J. (2000). Identity, agency, and knowing in mathematical worlds. In J. Boaler (Ed.) *Multiple perspectives on mathematics teaching and learning,* (pp. 171-200). Stamford, CT: Ablex.

Borum, V. O., & Walker, E.N. (2012). What makes the difference? Black women's undergraduate and graduate experiences in mathematics. *Journal for Negro Education,* 81 (4), 366-378.

Bourdieu, P. (1986). The forms of capital. In J. Richardson (Ed.) *Handbook of Theory and Research for the Sociology of Education,* (pp. 241-258). New York: Greenwood.

Cooper, D.A. (2000). Changing the faces of mathematics PhDs: What we are learning at the University of Maryland. In M. Strutchens, M. Johnson, and W. Tate (Eds.) *Changing the*

Faces of Mathematics: Perspectives on African Americans (pp. 179-192). Reston, VA: National Council of Teachers of Mathematics.

Cooper, D. A. (2004). Recommendations for increasing the participation and success of Blacks In graduate mathematics study. *Notices of the AMS, 51* (5), 538-543.

Datta, D. (1993). *Math education at its best: The Potsdam Model*. Framingham, MA: Center for Teaching/Learning of Mathematics.

DuBois, W. E. B. (1903). *The souls of black folk.* New York: Signet Press.

Donaldson, J.A. (1989). Black Americans in mathematics. In P. Duren (Ed.) *A Century of Mathematics in America, Part III* (pp. 449-470). Providence, RI: American Mathematical Society.

Ellington, R. M., & Frederick, R. (2010). Black high achieving undergraduate mathematics majors discuss success and persistence in mathematics. *The Negro Educational Review, 61*, 61-84.

Hale, F. (2006). *How Black colleges empower Black students: Lessons for higher education.* Sterling, VA: Stylus Publishing.

Herzig, A. H. (2004). Becoming mathematicians: Women and students of color choosing and leaving doctoral mathematics. *Review of Educational Research, 74* (2), 171-214.

Hilliard, A. (1995). *The maroon within us.* Baltimore, MD: Black Classics Press.

Hilliard, A. G. (2003). No mystery: Closing the achievement gap between Africans and excellence. In T. Perry, C. Steele, & A.G. Hilliard. *Young, gifted, and black: Promoting high achievement among African-American students.* Boston: Beacon Press.

Houston, J. L. (1999). *The history of the National Association of Mathematicians (NAM): The first thirty years-1969-1999*. Elizabeth City, NC: NAM.

Igniting potential: Historically black colleges and universities and science, technology, engineering, and mathematics. (2005). Atlanta, GA: Southern Educational Foundation.

Kenschaft, P. (2005). *Change is possible: Stories of women and minorities in mathematics*. Providence, RI: American Mathematical Society.

Lewis, N., Frierson, H., Strayhorn, T., Yang, C., & Tademy, R. (2008). Gender and college type differences in Black students' perceptions and outcomes of a summer research program. *The Negro Education Review, 59*(3-4), 217-238.

Martin, D. B. (2000). *Mathematics success and failure among African American youth: The roles of sociohistorical context, community forces, school influence, and individual agency.* Mahwah, NJ: Lawrence Erlbaum Associates.

McNair, L.D. (2009). HBCU perspectives and research programs: Spelman College as a model for success in the STEM fields. *In Memoriam.* New York: Grafton Press.

Mehan, H., Hubbard, L., & Villanueva, I. (1994). Forming academic identities: Accommodation without assimilation among involuntary minorities. *Anthropology and Education Quarterly, 25* (2), 91-117.

Megginson, R. E. (2003). Yueh-Gin Gung and Dr. Charles Y. Hu Award to Clarence F. Stephens for distinguished service to mathematics. *American Mathematical Monthly, 110* (3), 177-180.

Nasir, N. S., & Saxe, G. B. (2003). Ethnic and academic identities: A cultural practice Perspective on emerging tensions and their management in the lives of minority students. *Educational Researcher, 32* (5), 14-18.

Owens, E. W., Shelton, A. J., Bloom, C. M., & Cavil, J. K. (2012). The significance of HBCUs

to the production of STEM graduates: Answering the call. Educational Foundations, 26(3), 33–47.

Palmer, R.T., Davis, R.J., Thompson, T. (2010). Theory meets practice: HBCU Initiatives that promote academic success among African Americans in STEM. *Journal of College Student Development,* 51(4), 440-443.

Perna, L., Lundy-Wagner, V., Drezner, N.D., Gasman, M., Yoon, S., Bose, E., & Gary, S. (2009). The contribution of HBCU's to the preparation of African American women for STEM careers: A case study. *Research in Higher Education*, 50(1), 1-23.

Scriven, O. A. (2006). The politics of particularism: HBCUs, Spelman College, and the struggle to educate Black women in science, 1950-1997. (Unpublished doctoral dissertation). Georgia Institute of Technology.

Tucker, A. (1996). Models that work: Case studies in effective undergraduate mathematics programs. *Notices of the AMS, 43* (11), 1356-1358.

Walker, E. N. (2009a). "A border state": A historical exploration of the formative, educational, and professional experiences of Black mathematicians in the United States. *International Journal of History in Mathematics Education, 4* (2), 53-78.

Walker, E. N. (2009b). (Un)limited opportunity: The experiences of mathematically talented Black American students. In M. Tzekaki, M. Kaldrimidou, & H. Sakonidis (Eds.), *Proceedings of the 33rd Conference of the International Group for the Psychology of Mathematics Education: In Search for Theories in Mathematics Education, Volume 1* (pp. 1-199—1-203). Thessaloniki, Greece: PME.

Walker, E. N. (2010). Reimagining mathematical spaces: Cultivating mathematics identities in and out of school and in between. (Working Paper). Teachers College, Columbia University.

Walker, E. N. (2014). *Beyond Banneker: Black mathematicians and the paths to excellence.* Albany, NY: SUNY Press.

Winston, M. R. (1971). Through the back door: Academic racism and the Negro scholar in historical perspective. *Daedalus, 100* (3), 678-719.

Yin, R. K. (2009). *Case study research: Design and methods*. Los Angeles, CA: Sage.

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