An Unlikely Cohort

Disrupting the Stereotypes about Mathematicians and their Careers

*Taryn Butler Lewis, Tasha R. Inniss, Monica Jackson,
and Calandra Tate Moore*

We must reject not only the stereotypes that others hold of us, but also the stereotypes that we hold of ourselves.

—Shirley Chisholm

Introduction

Euphemia Lofton Haynes (1943), Evelyn Boyd Granville (1949), Marjorie Lee Browne (1949), Sadie Gasaway (1961), Georgia Caldwell Smith (1961 posthumously), Gloria Conyers Hewitt (1962), Thyrsa Anne Frazier Svager (1965), Vivienne Malone-Mayes (1966), Shirley M. McBay (1966), Eleanor Dawley Jones (1966), Annie M. Watkins Garraway (1967), Geraldine Darden (1967), Mary Love-nia Deconge-Watson (1968), Etta Zuber Falconer (1969), Elayne Arrington (1974), Rada Higgins McCreadie (1974), Fern Y. Hunt (1978), Karolyn Ann Morgan (1978), Fannie Ruth Gee (1979), Emma R. Fenceroy (1979).¹

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¹<http://www.math.buffalo.edu/mad/wohist.html>; <https://www.mathad.com>

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What do all of these people have in common? They are all mathematicians and Black women. These are the first 20 Black women to earn doctoral degrees in mathematics in the United States.²

When you picture a mathematician, what image comes to mind? Chances are a vision of an African American woman is not your first image. We are all familiar with the stereotype of a mathematician.

Since 1943 when the first Black woman, Dr. Euphemia Lofton Haynes, earned her doctorate, Black women continued to excel in the mathematical sciences, even if they did not earn a Ph.D. Case in point, the famous book, *Hidden Figures*, highlighted Katherine Johnson who served as a research mathematician at NASA³ [Shetterly, 2016]. Did you know that she is considered the first African American to pursue graduate studies in mathematics; integrated West Virginia University; and pursued a master's degree in mathematics there, but did not earn the degree?⁴ Yet she is one of the most famous mathematicians of our time given her groundbreaking research in the space race of the 1950s. She is also “the first female mathematician to be awarded the highest civilian honor in the U.S., the Presidential Medal of Freedom”, which she was awarded by President Barack Obama in 2015 [Walker, 2017]. In addition, she and the other “computers” from NASA received a Congressional Medal of Honor in 2019.⁵

²During this same timeframe, Black women were also “firsts” for earning doctoral degrees in mathematics education (e.g., Louise Nixon Sutton https://en.wikipedia.org/wiki/Louise_Nixon_Sutton).

³<https://www.nasa.gov/content/katherine-johnson-biography>

⁴<https://www.nytimes.com/2020/02/24/science/katherine-johnson-dead.html>

⁵<https://www.nasa.gov/feature/hidden-figures-honored-at-us-capitol-for-congressional-gold-medal>

Though African American women have made an impact with their work in mathematics (in industry, government, and academia), the numbers of those who earn doctoral degrees in mathematics remain very low. According to the Mathematical and Statistical Sciences Annual Survey administered by the American Mathematical Society,⁶ no more than 1% of all mathematics/statistics doctoral degrees in a given year were awarded to Black women (US Citizens or Permanent Residents) between 1990 and 2017. If we were to consider raw numbers during these years, the highest number ever awarded in an individual year was 14 (in 2008 and 2010). The average number is seven. Thus, the data reveals that Black women who earn doctoral degrees in the mathematical sciences are very rare.

Given these statistics, it is remarkable that a few universities have been effective at recruiting African American women in their graduate programs in the mathematical sciences, and providing an environment in which they are able to thrive as mathematicians. One such institution is the University of Maryland at College Park. During the 1990s, it is widely believed that the department had the largest number of Black students pursuing degrees in the mathematical sciences in the entire country.

Here is another list: Angela Grant, Asia Wyatt, Calandra Tate Moore, Danielle Middlebrooks, Hatshepsitu Tull, Jhacova Williams, Joycelyn Wilson, Karamatou Yacoubou-Djima, Kimberly Sellers, Kimberly Weems, Monica Jackson, Naomi Cameron, Roselyn Marsa Abbiw-Jackson, Shelby Wilson, Sherry Scott, Stacey O. Nicholls, Tamara Singleton-Goyea, Taryn Butler Lewis, Tasha R. Inniss, and Toni Watson. These are the 20 Black women who earned either a Master's or Doctoral degree or both in mathematics from the University of Maryland, College Park (UMCP) from the mid-1990s to 2020. It is interesting to note that in the first year that Black women earned doctoral degrees from UMCP (2000), there were three that finished at the same time! [Kellogg, 2001]. This is extremely rare, especially given that the statistics reflect that there might not be three in the entire country who earn Ph.D.s. in the mathematical sciences in a given year. Just one year later, in 2001, Howard University conferred Ph.D.s to four African American women.⁷

We the authors are among those who earned advanced degrees from UMCP during the twenty-year time period between 2000 and 2020. To capture as many of the stories of the Black women as possible, we developed an informal questionnaire⁸ and reached out to our colleagues to gather background information and their thoughts on pursuing an advanced degree in mathematics and a career in the

mathematical sciences. We were interested in their personal histories, career trajectories, and reasons they decided to pursue mathematics and an advanced degree in the mathematical sciences at UMCP. Additionally, we sought to understand the factors that contributed to their success. We asked questions such as: "Who were your inspirations to pursue and attain an advanced degree in the mathematical sciences?"; "As a student at UMCP, who do you feel supported you in your pursuit of an advanced degree in the mathematical sciences?"; "While matriculating at UMCP, did you feel a sense of community?"; and "While at UMCP, what was your area of study?" From those who responded to the questionnaire, 80% (16/20) studied applied mathematics at UMCP. Later in this article, we will discuss the breadth of careers that resulted from studying different areas in the mathematical sciences.

From the questionnaire responses, it is interesting to note that 75% of us are the first in our families to earn an advanced degree in mathematics and the majority (90%) of us earned our undergraduate degrees in mathematics at a Historically Black College or University (HBCU). Not only are we disrupting educational systems that use stereotypes to limit who can succeed in math, we are also disrupting the perception about the academic potential of students from HBCUs.

According to the National Science Foundation report, *Women, Minorities, and Persons with Disabilities in Science and Engineering*, in the top 15 baccalaureate institutions for Black or African American doctorate recipients in the sciences between 2015–2019, nine of them are HBCUs, with Spelman College and Howard University ranking first and second, respectively⁹ [NSF NCSES, Table 7–8]. For some, this might be a startling statistic given the fact that HBCUs only make up a small percentage (3%) of all institutions of higher education (IHEs).¹⁰ In their study and publication, "What Makes the Difference? Black Women's Undergraduate and Graduate Experiences in Mathematics," Borum and Walker [2012] stated "it is evident that for women who attended HBCUs, smaller class sizes and a more nurturing environment contributed to them proceeding and receiving their doctorate in mathematics." All four of us (authors) attended HBCUs as undergraduate students. Based on our experiences, we hypothesize that there are several factors that contributed to our success and that of our community of Black women mathematicians from UMCP. First, many of us attribute the supportive community for Black graduate students at UMCP to the former department chair, Dr. Raymond Johnson, who was the first African American to earn a Ph.D. in mathematics from Rice University.¹¹ It

⁶<https://www.ams.org/profession/data/annual-survey/annual-survey>

⁷www.jstor.org/stable/3134128

⁸*Surveys of the UMCP Math Sistahs*

⁹<https://nces.nsf.gov/pubs/nsf21321>

¹⁰<https://uncf.org/the-latest/the-numbers-dont-lie-hbcus-are-changing-the-college-landscape>

¹¹<https://news.rice.edu/news/2020/task-force-hosts-conversation-rices-first-black-student-raymond-johnson>

Figure 1. Black women who pursued advanced degrees in the mathematical sciences at UMCP.

should be noted that Dr. Johnson was also the only African American chair of a mathematics department at a Predominantly White Institution (PWI) in the country at the time. As chair of the Department of Mathematics at UMCP, he was committed to increasing the diversity of the graduate student body and was intentional about recruiting strong students, particularly from HBCUs. He understood the systemic or structural racism that is present in Institutions of Higher Education (IHEs), especially in Science, Technology, Engineering or Mathematics (STEM) departments. He endeavored to create a productive learning community for Black students, instill a “sense of belonging,” [Herzig, 2006] and implement structures that facilitated equitable treatment of all students. It is clear that Dr. Johnson was effective at achieving these goals because 90% of the respondents said that they felt a sense of community in the department at UMCP.

In addition to a sense of community with other Black women, the other factors we exuded that contributed to our success was our doggedness/perseverance, advocacy, and resilience. The rigorous academic training and mentoring that we received during our undergraduate education (primarily at HBCUs) coupled with high expectations of mentors motivated and inspired us to persist to the finish line of attaining advanced degrees in the mathematical sciences. Since most of us engaged in undergraduate research and participated in summer Research Experiences for Undergraduates (REUs), we had that foundation on which to

build, to develop, and to complete theses and dissertations. At UMCP, we had the opportunity to be advised by professors who were also supportive and had confidence in our abilities to earn mathematics graduate degrees. We caution the reader against “blaming” anyone who did not earn an advanced degree in mathematics because most often the reason is not due to a lack of talent, but the structural racism they encountered at PWIs.

We accepted education as the means to rise above limitations that a prejudiced society endeavored to place upon us.

—Evelyn Boyd Granville, 2nd African American Woman to earn a Ph.D. in Mathematics¹²

Now let’s consider the prevailing notion about what mathematicians do. Often when one shares that someone is pursuing a degree in mathematics, the first question posed is “What will you do...teach?” We feel teaching is a noble profession, and as a matter of fact, 60% of the respondents spent their entire career or some of it in academia. The beautiful and remarkable thing about the mathematical sciences is that there is a breadth of career options in different sectors. Thirty-five percent (35%) of respondents have or have had careers in government and 30% in industry.

The following three sections focus on the experiences and the personal histories of three UMCP mathematicians

¹²https://www.azquotes.com/author/46214-Evelyn_Boyd_Granville

because each one represents a different career sector: industry, government, and academia.

Mathematics Careers in Industry

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I was raised in southern Prince George's County, Maryland, as the only child of a federal government employee and an elementary school teacher. They both stressed good grades and good behavior, and that they expected me to go to college; but they didn't push me in any particular career direction. I somewhat fell into STEM on my own. I remember enjoying science and math classes in school but never considered majoring in either. I loved sports and wanted to be a sports commentator, one of the few females in that role in the 1980s. STEM felt more like a hobby than anything else to me. I did not personally know any Black women in STEM at the time.

After high school, I attended Morgan State University (MSU) on an undergraduate honors scholarship. I planned to earn a degree in Communications (remember, I wanted to talk about sports). After learning that I had to take only one math class and spending my freshman year in liberal arts classes, I changed my major to mathematics because I could not fathom not taking more math classes. That was a decision that I am so happy I made. MSU's math department was filled with faculty and students who challenged me and supported me along the way.

While at MSU, I was encouraged by professors, classmates, and family to consider graduate school, and I decided during my senior year that I would pursue an advanced degree in math at UMCP. I received a fellowship/teaching assistantship to attend UMCP and chose pure math as my study area, with plans to pursue a career in cryptology. My second choice was actuarial science, but I was uninterested in the real analysis that I would need to be successful in that field.

I was very familiar with UMCP and the campus because my mother grew up within walking distance of the university—in a small, then all-Black neighborhood called Lakeland. After my mom graduated from high school, she chose to earn her undergraduate and graduate degrees in elementary education from Bowie State University because she didn't feel UMCP was an option for her and most college-bound Blacks in her circle chose to attend HBCUs. Note that the first Black UMCP undergraduate student, Hiram Whittle, was admitted in 1951,¹³ but didn't graduate. The first Black UMCP undergraduate to obtain a four-year degree was a woman, Elaine Johnson, in 1959.¹⁴ The first Black UMCP

graduate student, the then-future U.S. Congressman from Maryland, Parren J. Mitchell,¹⁵ graduated in 1952. One of my mom's younger siblings did eventually go on to earn an undergraduate degree from UMCP.

With my family's experience growing up in the shadows of UMCP, attending UMCP and receiving a fellowship gave me a great sense of satisfaction and a sense of pride. I joined UMCP's math department at a time when several other women and men of color were joining the department, thanks to the efforts of Dr. Raymond Johnson. This definitely made the introduction to graduate school easier. After one year, I found my pure math courses to be anything but enjoyable. While I appreciated this area, I did not relish living in an abstract world. I enjoyed learning how to apply math to real-world problems. I changed my study area to applied math and chose operations research (OR) as my area of concentration. I opted to pursue a master's degree and selected Professor Michael O. Ball as my thesis advisor. I found his research and work in air traffic management intriguing. The more I worked with him and met his other students and peers, the more I knew I had made the right choice.

I started my career working for a few years for defense contractors on asset scheduling projects. These projects provided great learning experiences and an introduction to what's possible with a degree in applied math/OR. Eventually, I accepted an opportunity at Metron Aviation, a small, boutique government contractor with whom my UMCP advisor collaborated on air traffic management problems. This became the place where I learned a lot about R&D, analysis, business, government contracting, and project management.

Working at Metron Aviation introduced me to mathematicians and OR analysts working in a variety of roles. The CEO had an advanced degree in OR, and the CEOs of the parent company had mathematics PhDs. My colleagues and I worked on interesting global air traffic management problems in roles such as prototype software development, requirements development, development of concepts of operations, analytics (before the term became popular), and data analysis. We developed innovative solutions that were deployed around the world. Some of us used this experience to segue into leadership positions. This was a defining moment in my professional career and the type of professional experience that taught me about the union of R&D and business. I moved on to work for a couple of other government contracting companies after this, further developing my business and leadership skills.

I also spent nearly three years working for the Institute for Operations Research and Management Sciences (INFORMS) leading the development and oversight of products, programs, and activities that promoted the field

¹³Hiram Whittle, UMCP—University Libraries Digital Collections

¹⁴Elaine Johnson, UMCP—University Libraries Digital Collections

¹⁵Parren J. Mitchell UMCP College of Behavioral & Social Sciences

of operations research, analytics and its related areas. My primary focus was finding ways to provide membership value for industry members through mentoring, professional development, and leadership opportunities. However, I was also responsible for supporting our academic audience, which included students and faculty, by providing opportunities to showcase their research and learn from others. INFORMS provided a platform for all of these individuals to demonstrate their thought leadership in operations research, analytics, and the like. Prior to joining the staff at INFORMS, I was a member. I joined while in graduate school, based on the recommendation of Professor Ball, and remained a member throughout my career. Membership in professional organizations can help those in industry stay current, and develop and grow their professional reputation.

As a Black woman in STEM, I was always the only Black woman in the room. There were occasionally Black men, but that was rare. I routinely dealt with issues such as microaggressions, being marginalized, not considered for growth opportunities, sexual harassment—essentially, all the things you hear about from women who work in majority-male environments. Getting a seat at the table is always challenging. Speaking up or demanding to be heard is frequently interpreted as being confrontational, angry, emotional, or some other negative adjective used to describe Black women in the workplace. If I was quiet, this would be misinterpreted as a lack of interest or understanding. It has been a stressful place to be, but I've persevered.

My experiences helped me to develop a passion for encouraging and supporting young Black women and men to pursue STEM degrees. I believe we deserve not just a seat at the table, but also an opportunity to participate in the discussions at the table. We all have something to offer. Studies have shown that increased diversity in STEM generates more innovation and improves the success of companies who are intentional about being inclusive.^{16, 17} To this very day, I experience some of the same slights that I did over twenty years ago, but I've learned to challenge the status quo and stand up for myself and those that I lead.

Industry, usually thought of as for-profit, corporate-like organizations, is not for everyone; but it can be a rewarding career choice. The need to generate profits or satisfy stockholders and key stakeholders can sometimes obscure the good work of employees and lead to work that is unfulfilling or lacks deeper purpose. Not-for-profit, non-academic organizations are also an option. There are many organizations that benefit from the mathematician skill-set. Ultimately, it is extremely important to find organizations that

mirror your values, provide continuous learning opportunities, and have a reputation for doing meaningful work while also maintaining financial health and operational excellence. You are not looking for the perfect company (it does not exist), but instead for a company for which you are proud to work.

Many other Black UMCP women followed the industry career path as well, but for a wide variety of reasons. Jhacova Williams parlayed a UMCP Masters in mathematics into a Ph.D. in economics, following her desire to marry STEM and economic and community policies, which she is able to do as an Associate Economist at the RAND Corporation. Shelby Wilson is using her Ph.D. in a career as a Senior Data Scientist at Johns Hopkins Applied Physics Laboratory. Hatshepsitu Tull is using her degree as the Sr. Manager of Administration in the family business and as an adjunct math professor. Part-time teaching is very common among industry professionals with STEM degrees and is a good way to give back and also stay current in the chosen subject. Other career possibilities include starting a business that provides consulting services to other businesses or the government, and doing research and development in hopes of innovating the next big solution. Create the company for which you would want to work!

Corporate environments can be challenging, so you always need to remember who you are, maintain your moral and ethical standards, and lean not unto your own understanding (Proverbs 3:5-6). It helps to have sources of motivation that keep you in a positive space and keep you on your God-given path. In addition to prayer and surrounding myself with people who genuinely have my best interests at heart, I have a few inspirational quotes that I find uplifting:

- "I am more than enough"—unknown
- "When someone shows you who they are, believe them the first time."—Maya Angelou
- "Sweet are the uses of adversity."—William Shakespeare

One of the lessons that I grew up with was to always stay true to yourself and never let what somebody else says distract you from your goals.

—Mrs. Michelle Obama

Most of my career in industry has been spent supporting the government (federal and local). While there may be similarities in the type of work, government agencies have vastly different strategic goals and objectives, so being a government contractor is a different experience from being a government employee. As such, Calandra Tate Moore explains her experience in the government sector in the next section.

¹⁶*4 Ways Diversity Is Directly Linked to Profitability*, Entrepreneur, February 14, 2020

¹⁷*Getting Serious About Diversity: Enough Already with the Business Case*, Harvard Business Review, Nov–Dec 2020

Mathematics as Federal Service

Calandra Tate Moore, Ph.D.

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MS '03, PhD '07, Applied Mathematics (Statistics and Natural Language Processing), UMCP

I was raised just outside the city limits of Zachary, Louisiana. I have always loved math and over the years, teachers would comment on my mathematical abilities; yet I became a math major haphazardly. This is partly attributed to the fact that I had such a limited view of what it meant to major in math or even further, what such a career path would entail. Additionally, growing up in a small town where being “smart” often equates to, “you should be a doctor” and having an older cousin whom I looked up to in medical school; seeds were planted to become a doctor. In fact, I wanted to be an anesthesiologist, and thus enrolled as a pre-medicine major at Xavier University of Louisiana, an HBCU known for sending the most African Americans to medical school [Hannah-Jones, 2015]. After being convinced by a fellow student and undergraduate faculty advisor to consider changing majors, a brief stint as math pre-med major followed, but eventually becoming a full-fledged mathematics major.

It was in college that I learned about the underrepresentation of minorities and women in STEM disciplines. This sparked my desire to pursue an advanced degree in mathematics with the intention of a career in the academy. I participated in multiple programs designed to bridge this gap such as the Summer Mathematics Program for Women held at Carleton College and the Mellon Minority Undergraduate Fellows Program at Emory University, which is sponsored by the Social Science Research Council via the Mellon Foundation. In my junior year, I received a graduate fellowship supported by the U.S. Army Research Laboratory, which initially unbeknownst to me was a recruiting initiative. This fellowship propelled an unintended more than 15-year career in federal service. Although my tenure in government began with a scholarship acceptance, I have had a rewarding career as a mathematician across various government agencies to include time as a visiting scientist in the Department of Mathematical Sciences at the U.S. Military Academy and currently as Research Team Lead for the video, image, speech and text analytics group in Computer and Analytic Sciences Research at the DoD.

In order for the U.S. to ensure production of a sufficient number of STEM experts, it has been stated that the government needs to take more actions to motivate US students [Hossain & Robinson, 2012]. One way in which the government does this outside of funding STEM-related educational and scholarship opportunities is through active recruitment and formal career programs for federal service implemented across many government agencies.

According to Go Government,¹⁸ there are nearly 17,000 federal employees in the mathematics field with the largest employers consisting of the Departments of the Army, Navy, and Air Force.¹⁹

Government mathematicians tackle some of the most challenging problems applicable to our nation's operations, defense, and security. And although the U.S. Department of Defense accounts for about 81% of mathematicians employed by the Federal Government,²⁰ they are prevalent across many other agencies. The National Institute of Standards and Technology (NIST), for example, has long employed mathematicians to develop standards and measurement techniques, including history-making mathematician Fern Hunt,²¹ who was listed above as one of the first twenty Black women to receive a doctoral degree in mathematics. Katherine Johnson, as mentioned earlier, was one of the pioneering mathematicians at NASA where successful space shuttle operations and data processing fundamentally rely on mathematics. With the rise in analytic needs due to increasingly large amounts of available data, government labs, research offices, and agencies are hiring mathematicians, statisticians, and computational scientists at expanding rates.

A significant cohort of UMCP African American women mathematicians have begun careers in government through either fellowship or post-doctoral positions. Some have then transitioned into either industry or academic appointments, while others have made lifelong careers as public servants. Nonetta Pierre is a signals analyst who originally pursued federal service because it was in line with her husband's career path. That trail developed into research and leadership positions in cryptography, risk management, and systems engineering. Danielle Middlebrooks is currently a postdoc at a government lab working in theory, analysis, and modeling of networks. A great opportunity with the chance to collaborate with highly esteemed colleagues in her field led to her post. Government work offered a great intersection between industry and academia. Tamara Goyea realized her government laboratory of choice provided the best probability to utilize math skills for solving real-world problems while continuing research in mathematics. Her interest lies in the realm of data science, modeling and simulation, and data visualization. Lastly, Valerie Nelson became dissatisfied with the private sector and its underlying goal of making money. She also wanted to return to school while working to achieve life balance. As an applied mathematician, she's pursued assignments ranging from department head for math, cryptanalysis and

¹⁸<https://gogovernment.org/career-guides/mathematics/>

¹⁹https://www.federaljobs.net/Occupations/gs-1500_jobs.htm

²⁰<https://studentscholarships.org/salary/484/mathematicians.php?p=2>

²¹<https://www.thehistorymakers.org/biography/fern-hunt>

data science to technical director for the cybersecurity office of cryptographic solutions.

"There's no greater challenge and there is no greater honor than to be in public service."

—Condoleezza Rice,
former United States Secretary of State

"When you have good ideas, you need to follow through, and if somebody tells you it's not your turn, but you're sure you're right – then you got to be unbought and unbossed."

—filmmaker Shola Lynch, producer of the documentary,
"Chisholm '72: Unbought & Unbossed"

Similar to my initial plan to pursue a career in academia, many mathematicians who receive advanced degrees choose this career pathway. In the next section, Monica Jackson shares her personal history and about being a research mathematician and climbing the ranks in academia.

Careers as Academic Mathematicians

Monica Jackson, Ph.D.

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I was born and raised in Kansas City, Missouri. I come from a family of educators. Both of my parents taught high school; my mother taught English and my father taught history. My aunt and cousins were educators too. Therefore education was always important in my family. There was not much diversity in my hometown. In my neighborhood we were one of very few Black families. I attended a private high school for girls in Kansas City where there were only two other Black students in my class. Therefore it was important for me to attend an HBCU for college. I was anxious to just "blend in". My love for math started at an early age. I recall doing math races with my dad when I was young. I would use a calculator and he would use his brain. I was fascinated that he could beat a calculator! I was only somewhere around 8 years old. But I knew then that I would not do anything but math.

I attended Clark Atlanta University (CAU), an HBCU, for undergraduate school and received a B.S. in mathematics. My older brother was nearby studying engineering at Georgia Tech at the same time. So it seemed like the perfect place. CAU truly became my family. I stayed there for graduate school and obtained a Master's degree in Applied Mathematics. To this day, I am very connected to the faculty at CAU, who have remained my mentors. My decision to attend UMCP was based on the recommendation from the faculty at CAU. Until I attended CAU, I had little exposure to Black mathematicians. They became my role models and I valued their opinions. Two other students in the math department at CAU enrolled at UMCP the same

year that I did. In fact, the department chair at CAU found us all housing together. And he spoke with Dr. Raymond Johnson, the chair of the department at UMCP, about us and informed him that we were coming. The baton was passed and Dr. Johnson became an instrumental part in our success at UMCP. Dr. Johnson was one of the first Black mathematicians to chair a department at a primarily white institution. His recruiting and mentoring efforts resulted in a large cohort of Black students attending UMCP during this period. At one point, there were about 30 Black students in the program. Dr. Johnson mentored us heavily and ensured that we knew one another and supported each other.

I graduated from UMCP with a Ph.D. in Applied Mathematics and Computational Science. After leaving Maryland, I decided to do a postdoc at Emory University in the department of Biostatistics, where I spent two years. I became interested in statistics at UMCP and was eager to do more applied work in public health. I worked under a spatial statistician. I studied disease surveillance with applications to developing, investigating methods for detecting cancer clusters, global clustering patterns, and developing simulation algorithms for spatially correlated data. My research still focuses in this area. I also now study health disparities. I knew I wanted a career as an academic mathematician. Therefore, I only applied for academic jobs. The autonomy of an academic career where I could choose the hours of my work, who I worked with, and on what topics appealed to me and allowed me to be creative. I have spent 17 years at American University in the Department of Mathematics and Statistics. I am a tenured professor and recently I was promoted to full professor. I have over 25 publications, 8 grants totaling over 800K. I have spent sabbaticals at UCLA, the National Institutes of Health, and Statistical and Applied Mathematical Sciences Institutes.

Three years ago, I decided to move into administration. It was not a career path I was seeking. Instead it found me. I was on sabbatical when the Dean of the College of Arts and Sciences at American University asked me to become the Associate Dean of Undergraduate Studies at the time. I have always loved being a faculty member and never even considered doing anything else. I truly believe it is the best job on the planet. But after many conversations, I decided to give administrative work a try. I surprised myself at how quickly I picked up this new role. My mathematics background equipped me with the critical thinking skills and the analytical mind that was crucial for this role. Recently, I was promoted to Deputy Provost and Dean of Faculty at American University, which is a critical position at my institution. This role requires that I oversee all faculty matters, including hiring and grievances, as well as consult with the Provost on various university concerns.

Despite my transition to academic leadership, I have maintained an active research agenda even through the last

three years as I served as a full-time administrator. Since becoming Deputy Provost last July, I have received three federal grants, published three manuscripts (one focused on the early stages of the pandemic in NYC when it was the epicenter in the U.S.) and published the first edition of my statistics textbook (which has already been adopted at two universities). I also continue to engage with the broader research community. This past year I gave four research presentations and currently serve major roles in professional societies that include the American Statistical Association and the American Mathematics Society.

Of the experiences that I am most proud are my co-organization of the Conference for African American Researchers in the Mathematical Sciences (CAARMS); establishment of AU's first Research Experience for Undergraduates (REU), the Summer Program in Research and Learning (SPIRAL) in which students and faculty from across the country spend eight weeks conducting scientific research at AU- (I participated in a similar program as an undergraduate student at CAU which fueled my support for REUs); and my previous role as Associate Dean of Undergraduate Studies in the College of Arts and Sciences, which was instrumental in developing my passion for academic leadership positions.

I have succeeded in academia but like any career, it has had its challenges. I found that true success in academia requires mentoring at all levels and all stages of your career. It is important for an early career mathematician to find mentors that are supportive and can provide critical feedback to help a faculty member manage the many expectations and workload of an academic mathematician. While the autonomy of an academic career is appealing, it does require a person to be self-motivated to succeed. I am grateful to have had excellent mentors and a supportive family throughout my career, even while I was an undergraduate. This helped pave the path that I am on now.

Other Black women mathematicians from UMCP share similar stories and passion for life as an academic as I do. There is a theme around the reasons why we selected to go into academia. Karamatou A. Yacoubou Djima who is currently an Assistant Professor of Mathematics at Amherst College feels as if the mix of research and teaching in academia is ideal for her. Joycelyn Wilson always wanted to teach on the collegiate level and is doing precisely that in her role as Senior Mathematics Instructor at Spelman College. Also at Spelman College, Naomi Cameron, who was recently promoted to Full Professor, really wanted research and teaching to be major portions of her job. Both Kimberly S. Weems, Associate Professor of Mathematics at North Carolina Central University, and Kimberly Sellers, Professor of Statistics at George Washington University, indicated that flexibility was one of the main reasons they selected a career in academia. They enjoy the flexibility of teaching, conducting research, and mentoring students. One of my co-authors, Tasha R. Inniss, who is currently serving as

Associate Provost for Research at Spelman College is the only one of us who has spent time in all three sectors during her career. She initially chose academia because of her passion for teaching and desire to mentor other women of color in STEM. She parlayed her experiences with grant writing and serving on proposal review panels into a rotation at the National Science Foundation (NSF). Subsequent to that, she worked as an inaugural director at a non-profit organization. It is evident where her heart lies because she is now back in academia at the place where she earned tenure, making contributions in academic leadership.

Lessons Learned: Strategy of Supporting and Being Supported

Disrupting the stereotypes of mathematicians may not have come easy nor been the declared intention of the women featured in this article. Yet, with various starting points and trajectories, it has been precisely what they have done. So, for those considering pursuing a career in mathematics, this cohort of women brings multiple perspectives of valuable measures for overcoming hurdles, roadblocks, and challenges that may arise. It is possible to create safe spaces and support networks to thrive in math departments and mathematical careers.

When surveyed, almost all the women attributed network and relationship building with classmates as key to feeling connected. They noted that identifying with peers going through similar experiences helped them not to feel alone in their pursuits. Specifically, many mentioned the power of this very community and network of Black women mathematicians from UMCP. Regardless of the distance between cohorts, there always seemed to be a steady stream of support flowing between these women and connecting them for life.

This unlikely cohort credited family and friends as key to inspiring them in the pursuit and attainment of their advanced degrees. Also, finding appropriate mentors with whom they could meet regularly to discuss career goals and options was important. It should be noted for those following this path that allies may not necessarily be within your department, so don't hesitate to seek outside support. Never be afraid to be your own advocate and don't let others determine your path for you.

The Black women mathematicians from UMCP contributed many words of wisdom that we can all keep in mind. Be prepared to sacrifice and understand there will be hurdles, but don't let those steer you away from pursuing your goals and dreams. Learn from those experiences and let them motivate you. Practice being patient with yourself; it takes time to learn. Mathematics isn't easy. Take good care of your mental and physical health at all stages, they come first and impact your ability to do well professionally, so balance is vital. Have an outlet you enjoy such as cooking, exercising, juggling, anything you can do on a daily or

consistent basis that allows you to decompress. Set boundaries for yourself and show others how to treat you. Tell people your value, show them your value, and then tell them your value again. If you're not invited to the decision-making table, invite yourself; you deserve to be there!

Lastly, early support has proven to be a strong indicator of survival in graduate work and beyond. The impact and influence of HBCUs in producing strong math majors who go on to graduate school cannot be overstated. Out of the number of Black women from UMCP who responded to the questionnaire, 90% of us are graduates of a Historically Black College or University. These include Clark Atlanta University, Dillard University, Howard University, Morgan State University, Prairie View A&M University, Spelman College, and Xavier University of Louisiana. The AMS Task Force Report²² stated as one of its findings "[HBCUs] have an outsized influence on the production and the support of Black mathematicians, and providing outstanding models of successful mentoring".

Conclusion

Systemic racism has resulted in many barriers and challenges that Black women have had to overcome. This brilliant and amazing cohort of women has exerted mounds of energy constantly trying to prove that they belong and are qualified. African American mathematician, Erica J. Graham, in "How (and How Not) To Be an Anti-Racist in Mathematics",²³ identifies many forms of racism in mathematics, including perfectionism; defensiveness of power structure; paternalism, and censorship of those who cause discomfort. Graham also highlights that we must resist being pushed from the spaces that afford even marginal privilege by a white supremacy culture. As underrepresented minorities, we endure regular traumas in this space, all for the love of mathematics. While our experiences are unique, this shared love of mathematics and STEM formed the perspectives of the Black women mathematicians from UMCP.

We, this unlikely cohort of Black women mathematicians, demonstrate that we are not the stereotypes placed upon us. We provide proof that HBCUs produce future educators, leaders, researchers, and scientists in academia, government, and industry. Whether we are the first to earn advanced degrees in our families or continuing educational traditions, we represent and carry forward the intelligence and abilities that are frequently denied to Black women. We acknowledge that we are special and unique, but that was not our goal. We just love mathematics and the many doors it has opened and continues to open for us.

²²Toward a Fully Inclusive Mathematics Profession: <https://www.ams.org/about-us/understanding-ams-history>

²³How (and How Not) To Be an Anti-Racist in Mathematics, Erica J. Graham, MAA Focus, April/May 2021

We are grateful to those who paved the way before us, who encouraged us, who gave us a shoulder to cry on, and who were patient with us when we just couldn't solve that mixed integer programming model or get our code to run. We hope that the perspectives of the Black women mathematicians from UMCP encourage young Black women (and men) to realize their mathematical potential and become the future of this field. In closing, we leave the reader with this poem by Dr. Dionne L. Price, an HBCU alumna who is the first African American to earn a Ph.D. in Biostatistics from Emory University, and currently serves as the Director of the Division of Biometrics IV in the Office of Biostatistics at the Food and Drug Administration. She is also the first African American to be elected President of the American Statistical Association (President-Elect 2022, President 2023).

*The Journey*²⁴

*I am that woman and that woman is me,
Acquiring knowledge, I've learned is the key,
I stand on the foundation planted long ago,
I'm rooted in numbers and love how they flow
Now is the present and data abounds,
Quantitative inclinations will need to astound,
And as we look to tomorrow and days to come,
May we solve global challenges, and still have some fun.
I am that woman and that woman is me.*

References

- [1] American Mathematical Society, Mathematical and Statistical Sciences Annual Survey, 2018, accessed May 19, 2021. <https://www.ams.org/profession/data/annual-survey/annual-survey>
- [2] Viveka O. Borum and Erica N. Walker, *What Makes the Difference? Black Women's Undergraduate and Graduate Experiences in Mathematics*, Journal of Negro Education 81 (2012), no. 4, 366–378.
- [3] Bettye Anne Case and Anne M. Leggett, eds., *Complexities: Women in Mathematics*, Princeton University Press, Princeton, NJ, 2005.
- [4] G. Finley, *Early success, Encouragement Add Up to Math Ph.Ds*, Diverse Issues in Higher Education 19 (2002), no. 14, 8.
- [5] Nikole Hannah-Jones, *A Prescription for More Black Doctors: How does tiny Xavier University in New Orleans manage to send more African-American students to medical school than any other college in the country?*, The New York Times (September 9, 2015). <https://www.nytimes.com/2015/09/13/magazine/a-prescription-for-more-black-doctors.html>
- [6] Abbe H. Herzig, *Women Belonging in the Social Worlds of Graduate Mathematics*, unpublished manuscript, 2006.
- [7] M. Hossain and M. G. Robinson, *How to Motivate US Students to Pursue STEM (Science, Technology, Engineering and Mathematics) Careers* (ED533548), ERIC, 2012. <https://files.eric.ed.gov/fulltext/ED533548.pdf>

²⁴<https://mathematicallygiftedandBlack.com/honorees/dionne-price/>, by permission of the author

HISTORY

- [8] Shelly M. Jones and Veronica Martins, *Women Who Count*, American Mathematical Society, 2019.
- [9] Alex P. Kellogg, *A University Beats the Odds to Produce Black Ph.D.'s in Math*, *Chronicle of Higher Education* 47 (2001), no. 23, A14–A15.
- [10] Report of the Task Force for Understanding and Documenting the Historical Role of the AMS in Racial Discrimination, *Toward a Fully Inclusive Mathematics Profession*, American Mathematical Society, 2021, accessed June 1, 2021. <https://www.ams.org/about-us/understanding-ams-history>
- [11] Margot Lee Shetterly, *Hidden Figures: The American Dream and the Untold Story of the Black Women Mathematicians Who Helped Win the Space Race*, Harper Collins Publishers, New York, 2016.
- [12] E. N. Walker, *Excellence and Devotion: Black Women in Mathematics in the United States*, in: J. Beery, S. Greenwald, J. Jensen-Vallin, M. Mast (eds.), *Women in Mathematics*, Association for Women in Mathematics Series, vol 10, Springer, 2017.

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Credits

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