

QnAs: Black voices in STEM

Melissa Suran, *Science Writer*

As the Black Lives Matter movement continues sweeping across the nation, it amplifies diverse voices from all corners of academia. In an effort to continue the dialogue about representation in science, technology, engineering, and mathematics (STEM), PNAS spoke with Black scholars from a range of disciplines.

Angela Byars-Winston is the first Black faculty member to achieve the rank of tenured full professor of medicine at the University of Wisconsin–Madison. She served on the Board on Higher Education and Workforce at the US National Academies of Sciences, Engineering, and Medicine (NASEM) between 2015 and 2020 and chaired a 2019 NASEM study on mentoring in STEM (1). Former US President Barack Obama selected Byars-Winston as a “Champion of Change” for her efforts to diversify STEM fields.

Theoretical physicist Jim Gates served on the President’s Council of Advisors on Science and Technology during the Obama administration. Now director of Brown University’s theoretical physics center and 2021 president of the American Physical Society, Gates cowrote an authoritative and comprehensive book on supersymmetry (2) and was awarded the National Medal of Science. He is the first African American theoretical physicist elected to the US National Academy of Sciences (NAS). During his tenure at the University of Maryland, College Park, Gates became the first African American to hold an endowed chair in physics at a major research university in the United States.

Evelynn Hammonds is chair of the Department of the History of Science and professor of African and African American studies at Harvard University. She served as the first African American and the first female dean of Harvard College from 2008 to 2013. Under President Obama, Hammonds was on the President’s Board of Advisors on Historically Black Colleges and Universities as well as the President’s Commission on Excellence in Higher Education for African Americans. She was elected to the US National Academy of Medicine in 2018 and is currently a member of the NAS Committee on Women in Science, Engineering, and Medicine.

Economist Kaye Husbands Fealing is dean of the Ivan Allen College of Liberal Arts at the Georgia Institute of Technology. She is a member of the



Mentorship and a welcoming environment are essential for retaining diversity in STEM. Image credit: Alex Boersma/PNAS.

American Academy of Arts and Sciences and the former president of the National Economic Association. Husbands Fealing has served on several committees and panels for the NAS, including one focused on developing indicators for assessing the quality of undergraduate STEM education.

Here, these scholars reflect on racial disparities in STEM and offer recommendations for increasing STEM diversity.

PNAS: What has been your experience as a Black individual in STEM?

Hammonds: The experience of pursuing my undergraduate degree in physics at Spelman College was wonderful. I had demanding teachers, but they were

caring and set a high bar for achievement. I spent two summers in a research program for undergraduates at Bell Telephone Laboratories that gave me the opportunity to do experimental science at a very high level, which prepared me well for graduate school. In the Bell Labs program, I got to study with senior physicists in the field of laser physics and to develop my technical and presentation skills.

As a part of the dual-degree program between Spelman and Georgia Tech, I also earned an undergraduate degree in electrical engineering at Georgia Tech. My time at Georgia Tech was very difficult because I was one of three women and three African Americans in my class. The White male students and some of the professors weren't welcoming to us African American students, nor to women. White students did not invite us to join study groups, and many professors wouldn't take the time to meet with us if we needed help understanding the course content. We were left to solve problems by ourselves. It was a very difficult experience shaped by sexism and racism.

From Georgia Tech, I went into the graduate program in physics at MIT [Massachusetts Institute of Technology]. My teachers and mentors at MIT were very committed to my development as a scientist. However, after I completed my Master's degree, I realized that as an African American woman studying physics, socially, I found the experience very isolating. I wanted to understand why there were so few African Americans studying physics and other scientific and engineering disciplines at MIT and at other top universities. This question and my own undergraduate and graduate experiences led to my longstanding personal and professional interest in understanding the factors that contributed to the longstanding and persistent underrepresentation of African Americans, Hispanics, and Native Americans in STEM fields in the United States.

Byars-Winston: I always had the experience of being the "lonely only" or "the first" as I progressed and completed my promotion to tenured full professor. And I'm still the first, I'm still the only, in so many things. Yes, there are challenges around maintaining my boundaries to reduce what's called the "cultural tax," where, because I'm one of the few, I am asked to be on numerous committees and mentor numerous faculty members and mentor numerous students from underrepresented racial and ethnic backgrounds. I think the biggest thing is making sure that I still have space and time to do my research.

Gates: In the 1950s, my father was in the US Army, and the military services were essentially the only places where diversity actually existed in the country. So, at 4 years old, on a US base in Canada, I started dreaming about becoming a scientist. I enrolled in first grade in 1957 as one of two or three African American children in a class with about 25 other students. But it was a very diverse class: mostly, of course, European Americans, but also some Asian Americans and Hispanic Americans. It wasn't until sixth grade that I



Angela Byars-Winston. Image credit: Alex Boersma/PNAS.

moved to Orlando, Florida, in 1963 and attended segregated schools.

One of my first encounters was with a Black student named Michael, who was in my class. We had an exchange in which I came to understand that segregation was a way to teach African Americans they are intellectually inferior. This was stunning to me because, up until then, I had always been among the best students in my classes. Even though I was in sixth grade, I was well aware that the comment lacked validity; but, by the time I was in 12th grade, I wasn't so sure. And even though I'd dreamed for years about going to MIT, when I graduated from high school in 1969, my father literally had to force me to apply there. We live in a system that causes African Americans to question their abilities. So, when African Americans talk about systemic racism, which oftentimes other people don't seem to get, this is part of it. I have seen variations of this intellectual disparagement throughout my entire career. A 2020 PNAS study, "The diversity–innovation paradox in science," documents its cost in STEM fields (3).

Husbands Feeling: We're inspired by the people we see; if we're in school and do not see people who are similar to ourselves—who look like us—in STEM, then we don't necessarily think we can do STEM. Now, in my case, my mom was a nurse and my dad was an economics professor, so I had those role models in the home. A lot of people do not have the opportunity to have close family members in STEM fields and occupations. But, looking back on my career, there are things that I didn't have. And I found out, even 10 or 20 years later, that there were some opportunities and intangible benefits that some of my colleagues in grad school had that I did not have. For example, that special closeness with your advisor. I had a wonderful advisor, but we didn't work on exactly the same types of economics frameworks or data. And it wasn't because I was going against the grain; I just did not know formulaically what should happen. Similarly, the process

of getting out of grad school and positioning yourself well in the marketplace is critical for early success. I wasn't advised on some of the finer points on how to position myself for success in academia. Early success is tied to true academic mentorship, and I think that's still an issue for students of color in academia today.

PNAS: Why do certain STEM fields have greater racial disparities than others (4)?

Hammonds: The main issues have to do with the culture of STEM departments in the academy not providing the support and mentoring that students of color require. Departments need to provide serious, consistent mentoring of students of color in order for them to succeed in STEM fields. At this time, there are many successful models that departments can use to create an inclusive environment for students of color. I feel very strongly that many African American students don't receive sufficient mentoring or exposure to research in their undergraduate years. Many STEM fields don't do enough to orient undergraduates and to welcome students who might feel isolated or unsure about how to progress in a given field. For example, many graduate programs in physics are quite small. Therefore, an African American student who majors in physics might be the only student of color in the department or in a specific subfield. Almost 30 years after I studied physics, students still come up to me and say, "Thank you for your talk, Professor Hammonds. I'm the only African American student in my department, and it is hard to be here." I can tell you that being the only African American woman in a physics department at a major research university can be a very difficult experience. Departments have a responsibility to reach out to such students and provide them with support and mentoring to help them succeed.

Husbands Fealing: Members of underrepresented groups want to come to welcoming climates, and we want them to stay and progress. But, if you say, "We want to hire a diverse STEM faculty, but we cannot find

them," you probably didn't try hard enough. Have you contacted individuals at institutions that have very different networks from yours? You have to make sure that your networks are broad when you're trying to recruit. You also have to put money behind it; you can't hire one person of color at a time and think they're going to stay. You may have to do cluster hires or bring in a number of people, not just in one department but across different departments. You also have to make sure that mentorship is there for progression. It comes down to not only bringing people in and creating a welcoming environment where people want to be, but also ensuring that when they're here they're successful and not siloed in the organization. Oftentimes, people like myself are, in a sense, obligated to make sure that underrepresented researchers understand that they're supported and welcomed in their department or laboratory. One of the things that gets in the way—and I see this with both faculty and students—is when they don't feel welcome. Whether based on intentional actions or unconscious bias, it translates to feelings of isolation and a sense of not really belonging. I always want to lead with, "I understand the feeling, but you belong here. And don't second-guess that."

PNAS: Black individuals in STEM are about four times as likely as White individuals in STEM to report that their workplace does not pay enough attention to increasing diversity (5). How can workplaces improve in this area?

Byars-Winston: There's interesting research examining STEM fields where people believe we've made progress on diversity; that is, there are more people from underrepresented groups, particularly from underrepresented racial and ethnic groups, around now compared to the 1980s. But that doesn't mean we have achieved equity or inclusivity; just more faces from underrepresented groups, which is known as symbolic diversity. One study, in particular, found that when people from well-represented groups in leadership positions believe that diversity is no longer a problem in the workplace, they stop attending to things like inclusion and equity, which can retrench progress (6). It's an interesting irony. Specifically, what the authors found—they were looking at the veterinary sciences, which used to be male-dominated and is now at gender parity—was that managers who believed that women no longer face discrimination were more likely to be discriminatory in their hiring practices, in their mentoring practices, and have a lower recommended starting salary for women, compared with managers who believed that women still face discrimination in veterinary sciences. It makes sense: When we think something isn't a problem, we don't pay attention to it anymore. Most workplaces want to focus on diversity, which is important for getting people in the door, but we have to stay vigilant on matters of equity and inclusion.



Jim Gates. Image credit: Alex Boersma/PNAS.

Gates: In 1980, I went to a conference in Cambridge, England, where I met Stephen Hawking. I was with a group of postdocs, discussing a problem to which none of us knew the answer. And I made a suggestion that was promptly ignored. A few minutes later, the same suggestion came from a French physicist, and it was suddenly an amazing breakthrough. This is an example of a process that some people call cognitive bias. And I've seen this happen at all kinds of scales throughout my almost 40-year-long career: When an underrepresented scientist in a group of scientists offers a possible way to a solution, it's often ignored. In fact, my PhD adviser at MIT, James Young (7), had warned me about this. Although he said I was mathematically capable of making important contributions to the field, I wouldn't have the permission to do so. I see it happen to young people all the time, and it still happens to me continuously to this day. But I don't believe most scientists consciously wish to maintain an environment where demographic differences either act as gates to allow the influx of great ideas or prevent them. Yet I've seen it happen for 40 years. Awareness is the predicate for progress, namely that in scientific fields, scientists have to take the responsibility of educating themselves about what they do unknowingly (8).

PNAS: Over the past 30 years, it seems like STEM workforce diversity has not been addressed adequately in the United States. The percentage of Black individuals in STEM jobs has risen by only 2 points since 1990; it is now at 9% (9). What are some possible explanations for such trends?

Husbands Fealing: Part of this is the lack of role models that makes it difficult for students to envision themselves in a STEM career. Some youths or individuals early in their career may ask, "Why would I even want to go into STEM? I don't see myself there." And it may not be the actual visual of doing STEM, but rather the climate of STEM. So, they use their talents to pursue something else. A big problem is that individuals from underrepresented groups are often presumed not to have the capacity to succeed in STEM, even after they're hired into the field. There's a constant requirement to prove yourself, over and over again. Nobody wants to always be expected or assumed to "not get it," or "not understand," or "not be good enough." That's not welcoming, but those types of statements are often thought and sometimes conveyed directly or implicitly. So you have to decide: either you say, "I don't care," and keep going, or you find something else. But it's just too tiring to struggle against these assumptions, especially when there are so many other things that you could do in fields other than science, engineering, mathematics, and even medicine. So those are some reasons why you don't see the persistence, and a lot of it really revolves around whether STEM is a welcoming place.

Byars-Winston: I published a study that examined census data from 1970 through 2010 (10). And my colleagues and I asked the questions: "Is growing



Evelynnn Hammonds. Image credit: Alex Boersma/PNAS.

diversity in the general population being proportionately absorbed into the labor market? And if so, where? In what occupations?" As you can imagine, the answer was "no." Although there were more proportionate advances in some of the humanities, STEM fields in particular had been stuck in making progress. Where we found the smallest changes in STEM fields were in computer sciences and engineering. Another finding was that Black male participation had stagnated since 1970. In fact, their overall labor force participation was greater in 1970 than in 2010. I'm not even talking about specific fields; this was in the entire labor force. We have some ideas about why this is, but they pretty much center on assertions that have been laid out before, which state that nobody is paying attention. There is racism, and it's real.

PNAS: Many Black students attend underresourced high schools that do not offer advanced science or math courses (11). How can these high schools recruit qualified teachers for such courses and improve STEM education?

Gates: One of Obama's primary concerns was STEM education. As a lead author on four reports that the White House did on that subject (12), I learned there are more than 13,000 school districts in this country (13). Each one has its own set of rules, and the neighborhood surrounding a school is actually the funding source for that school. If your neighborhood isn't financially well-endowed, then your school system won't be either. And so, the way we fund education in this country is a major problem. That is, those who live in financially well-to-do neighborhoods are guaranteed to have more resources in their schools than those in poorer communities. So, what do you do about it? I don't think anyone's going to find a way to fix that problem anytime soon, not even in my children's lifetime. But in our recommendations to President Obama, we pointed out that you can have more community-based approaches to provide after-school and out-of-school educational opportunities.



Kaye Husbands Fealing. Image credit: Alex Boersma/PNAS.

Nowadays, people are getting used to using things like Zoom and other platforms. Even back then, we looked ahead and figuratively said, “You know, there’s an opportunity to use the internet to fill in this gap if you can get either philanthropic or profit-based entities interested in meeting the national need to provide an equitable education to all of our young people.”

Hammonds: We’ve got a chicken-and-egg problem: We haven’t pushed enough students through the educational system who are interested in science education, so we don’t have a large pool of science teachers. And the United States certainly doesn’t have enough science teachers who are African American or Hispanic. Therefore, we’re not going to increase the number of African American or Hispanic STEM students who need teachers from their communities as role models. The real issue then becomes how much the federal government and states are going to invest in producing a cadre of well-trained STEM teachers—regardless of race or ethnicity—for K–12 education. And the fact that the number of science teachers is so limited means that students who live in the most underresourced communities get the short end of the stick because we don’t have a sufficient pool of

teachers who are prepared to teach in those communities as well. There just aren’t enough good science teachers in this country. I’ve seen it in private schools. I’ve seen it in public schools that are well-resourced and those that are not well-resourced. This is a serious problem because the future success of US science and technology will depend on making excellent science and technical education available to all of our students regardless of race, ethnicity, gender, or economic status.

PNAS: How can the STEM community tackle diversity problems in the age of COVID-19 and beyond?

Byars-Winston: It’s going to come down to bold choices in order to retain funding that can support diversity, equity, inclusion, and antiracism work, despite the fiscal losses of institutions. That’s what I’ve been thinking more about: less about the people that we’re physically losing because of their inability to participate in the workforce, but rather the pressure on academic leaders because of budget constrictions, especially at a place that has a medical school, like the University of Wisconsin. The loss of revenue just from the stoppage of elective surgeries has been traumatic for the campus. And yet, I’ve seen examples, my own university being one of them, where senior leadership is saying, “We’re still going to maintain a budget for addressing issues around diversity, equity, inclusion, and antiracism. And we’re going to stay the course, all the more in the age of COVID and restricted budgets, to retain our investment in addressing these issues.”

Husbands Fealing: It’s absolutely time for a change, and not just in our desire to see change. We need to be active, and I think we know some of the things we can do, even though we don’t know everything. The problem is that when we don’t have all the answers, we’re sometimes reluctant to do anything—but that’s not working anymore. We already know that broadening participation in science is not a one-size-fits-all solution. But, in answering all of these questions, you need leaders who are willing to set the course and won’t take “no” for an answer. That kind of leadership is infectious, and that’s when you begin to see positive change.

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