

Recommendations for Increasing the Participation and Success of Blacks in Graduate Mathematics Study

Duane A. Cooper

To address national needs in recent years, various agencies and institutions have undertaken efforts to increase the number of Ph.D.'s earned by African Americans and others underrepresented in the communities of mathematicians, scientists, and engineers. Based on an examination of experiences at the University of Maryland, where there is a large population of Black students pursuing Ph.D.'s in the Department of Mathematics, I offer recommendations to various stakeholders in the effort to enlarge the pool of Black mathematics Ph.D.'s. In particular, recommendations are directed to undergraduate professors at *all* institutions, to administrators at predominantly White universities, to advisors of undergraduate students considering graduate school in mathematics, and to departments and individuals who are trying to make a difference.

For several years now much work has been done through informational conferences, mentoring forums, research opportunities, recruitment and retention efforts, and fellowship support to enlarge the pool of Black mathematics Ph.D.'s. The impetus for such efforts has been the relatively small number of Black mathematicians practicing and being produced in the United States. During the 1990s (1990–99), National Science Foundation statistics [5] show that only 71 of the 10,952 mathematics Ph.D.'s awarded in the United States went to Black U.S. citizens, little over one half of one percent and an average of just 7 per year.

Duane A. Cooper is assistant professor of mathematics at Morehouse College. His email address is dcooper@morehouse.edu.

Additionally, 15 Black Ph.D. recipients that decade were U.S. permanent residents. From 1986 through 1995 there were an additional 69 Black Ph.D. recipients who studied here on temporary visas. Similar data is unavailable for the entire 1990s, but even allowing for an increase of this number in the late 1990s, the overall percentage of Black mathematics Ph.D.'s during the 1990s improves at most to the 1-1/2% to 2% range.

This small percentage is a consequence of low enrollments and high attrition among young Black scholars. During the 1990s “between 100 and 200” seemed to describe the number of Black students pursuing Ph.D.'s in mathematics programs across the country. This figure was based on data gathered in a 1995 survey [4] by the Mathematical Association of America (MAA) and the National Association of Mathematicians (NAM) and on analysis by me [2]. However, the small number of Black Ph.D.'s produced annually during those years suggests that a majority of Black students nationwide who enrolled in mathematics Ph.D. programs were not attaining their expressed goal, though it is true that Black students are not the only ones to experience high attrition in mathematics doctoral programs.

I am pleased, though, to report progress. Even as the total number of U.S. earned mathematics doctorates declined from 1998 to 2002, the annual number of new Black math Ph.D.'s, even for U.S. citizens, reached and has maintained double digits. The last six Annual Surveys of the Mathematical Sciences published in the *Notices* reveal a yearly average of 17 Black U.S. citizens or permanent

residents, and 24 Blacks overall, earning the mathematics Ph.D. These numbers, which more than double the typical doctoral production from the decade preceding 1998, are testament to the individuals and institutions who worked towards this improvement. While this improvement should be taken as a sign that we are headed in the right direction, it is nowhere near evidence of a problem solved. The most recent annual survey [3] shows that our nation's 1,017 new mathematics Ph.D.'s last year included 16 U.S. citizens, 5 permanent residents, and 9 others who are Black, still a meager 1.6% (Black citizens) to 2.9% (all Black) of the total.

During this period one of the institutions working to increase Black doctoral production has been the University of Maryland. There, the Department of Mathematics has produced nine Black mathematics Ph.D.'s—five men and four women—over the last nine years: one in 1996, one in 1998, three in 2000, one each in 2001, 2002, and 2003, and one who has successfully defended his dissertation and is finishing this May, 2004. More wait in the pipeline, where a quarter of the roughly twenty Black mathematics graduate students have advanced to candidacy. This population may be the largest concentration of Black mathematics graduate students in the country, rivaled by the population at nearby Howard University, a historically Black university. Maryland's goal for the current large group is to produce from them a substantial number of doctorates, not losing too many to attrition, hoping to produce new Ph.D.'s in numbers more commensurate with the sizable Black graduate student population.

With over 70 graduate faculty and 240 graduate students, the Department of Mathematics at the University of Maryland is one of the largest in the nation. It enjoys an excellent reputation for scholarship and productivity, as acknowledged by the National Research Council's last comprehensive review of doctoral programs, which ranked the department 18th of 139 nationwide and 7th among public universities. The department offers Ph.D. programs in mathematics, applied mathematics and scientific computation, and statistics, currently ranking in *U. S. News & World Report's* top twenty graduate programs in mathematics and applied math. Written qualifying examinations are the primary impediment to the degree for those who do not succeed in the department.

Of the Black mathematics graduate students, almost all are pursuing the Ph.D. A large majority of the group are U.S. citizens, though a few in the group are permanent residents or hold temporary visas. More than half of these graduate students did their undergraduate study at traditionally Black U.S. institutions. This large fraction of students having roots at historically Black colleges and universities (HBCUs) is consistent with findings

showing that, compared to figures for undergraduate institutions overall, traditionally Black institutions produce disproportionate numbers of students who persist towards doctorates in sciences and engineering [6], even though most African American students attend predominantly White institutions. Black colleges launch more of their students to graduate work, and, furthermore, their graduates' performance is comparable to that of their peers from other institutions. Hardly a new phenomenon, a study of Anderson and Hrabowski [1] concluded that Black graduate students from predominantly Black colleges had success equal to that of the Black students who graduated from predominantly White institutions. Likewise, at Maryland there seems to be no significant difference in the success rates among the graduate students who attended predominantly Black versus predominantly White undergraduate institutions.

For an examination of the graduate students' experiences, a questionnaire was distributed among the Black mathematics graduate student population. Fourteen students replied. The responses were insightful into just what is significant about the unique concentration of Black graduate students in the mathematics department, and they form much of the basis for the recommendations that follow.

Recommendations for Undergraduate Professors at All Institutions

Be aware of the significance of your guidance on your students.

Undergraduate professors are especially influential in their students' graduate and career pursuits in mathematics. The MAA-NAM survey [4] of minority graduate students in the mathematical sciences categorized the students' responses about the people who have helped guide them and the ways in which they have done so. Many people and ways were cited as influential, but heading the list of "persons instrumental in pursuit of your goals" were professors from the undergraduate institution, followed by professors from the graduate institution. Giving encouragement and bolstering confidence emerged as the most frequently mentioned ways in which individuals were helpful to students.

The Maryland students' accounts supported this claim. When asked about any particular persons or courses or experiences that influenced the decision to pursue a doctorate in mathematics, more than half of the graduate students credited professors from their undergraduate days as the influence or as an influence on their matriculation at the graduate level. Some undergraduate professors continue to be mentors for their former students who are now at Maryland.

Know that we need more Black mathematics Ph.D.'s.

Many have argued that because of job market conditions of the past dozen years, we do not need as many mathematics Ph.D.'s. Well, let it resound loudly and clearly: *We need more Black ones.*

As mentioned, a disproportionately large number of students who pursue mathematics, science, and engineering Ph.D.'s have roots at HBCUs. Black mathematicians are needed to deliver quality instruction and provide invaluable guidance to students at traditionally Black institutions to address a crying need for more Black mathematics faculty with doctorates. Furthermore, because the population of Black mathematicians is so small, there is a need for greater Black representation on predominantly White campuses and all across the spectrum of opportunities for persons holding doctorates in mathematics.

Identify the potential, *polished or raw*, in Black students you encounter.

Aware of their influence and of the need for more Black mathematicians, undergraduate faculty can serve as “headhunters” for the profession, enlightening Black students to opportunities in mathematics that, chances are, they have never considered. It may be a long-time A student, or it might be someone in need of shoring up his or her background but who shows evidence of thinking clearly and independently and attacking problems cleverly. The professor can encourage the student to consider the possibility of earning a Ph.D. in mathematics, share a variety of reasons the student might do so, express his or her confidence in the student's potential to attain the doctorate, and suggest courses and actions that might facilitate the student's pursuit of this goal, if desired. The professor should keep in mind the adage “You can't win 'em all” and not get discouraged if not all students react as hoped to the guidance.

Recommendations for Administrators at Predominantly White Universities

Work for faculty diversity if you are committed to attracting students and serving them well.

It is clear at Maryland that a Black presence on a department's faculty, staff, and student community can attract students to matriculate. Several of the students cited the Black presence in the department and its supportive environment as a reason they elected to study there. Recruited students have remarked about the extensive Black presence beyond just the student population, noticing and feeling comforted in the racial diversity of the staff, particularly as compared to their campus visits to other institutions.

While there were only two African Americans among the fairly large mathematics faculty at Maryland until recently, students and prospective

students realize that this department had two more than most universities, and both professors were instrumental in attracting Black students to graduate study there. Several years ago the department had two Black postdoctoral fellows who proved to be valuable resources for the graduate students, since they had just experienced and succeeded in the endeavor the graduate students were encountering.

Know that much of the important guidance Black students receive as undergraduates and as graduate students comes from other Blacks.

Non-Black faculty can and often do serve Black students well. However, Maryland's graduate students' reports about mentors and influential individuals suggested that it happens infrequently and that valuable guidance and support often comes from other Blacks or not at all.

Again, more than half of the Black graduate students reported that undergraduate professors were the influence or an influence on their decision to pursue a mathematics Ph.D. Particularly striking is that in all but one instance, the influential faculty or staff member was either Black or from a Black college. More precisely, of the fourteen students who responded to the questionnaire administered in connection with this work, eight came from traditionally Black institutions, and six of those eight credited former professors. However, only two of the six who went to college at predominantly White institutions claimed influence by persons there, and one of those two credited only a Black administrator on his campus.

Beyond mathematics, mentoring has been cited as a significant predictor of Black graduate student success. As graduate students, not all of the group at Maryland feel that they have benefited significantly from mentoring by senior individuals, but several do and speak quite passionately about it. For instance, one student explained:

I don't think I could've survived without having mentors because they are there to let me know that they had to go through some of the same things and sometimes worse. It makes one feel good to know that there are people out there that believe in you, that have your best interests at heart, and who will go to bat for you.

The assistance provided by mentors is broad in scope, but it can generally be described as giving advice or encouragement. Aside from occasional continued mentorship from undergraduate professors, the Black graduate students reported having received guidance and support from Black faculty and postdoctoral fellows, non-Black faculty, campus personnel, and mathematicians at other universities or in industry. Some students

credit Whites with mentoring them, though not all have benefitted from guidance across racial lines, like the student who commented:

Professors have tuned me in to opportunities I didn't know about. The Office of Minority Affairs has done the same. Upper-level grad students have been very helpful in assisting with coursework. Note: In *all* cases, these people were Black.

Recommendations for Advisors of Undergraduate Students Considering Graduate School in Mathematics

Although college and university faculty and staff can accomplish a great deal, students bear extensive responsibility for their preparation for graduate study. Advisors of undergraduates considering graduate work in mathematics should forward this advice:

Study hard.

The stronger the record of an applicant, the more likely the chance of admission and award of a good graduate fellowship which, in turn, can facilitate the course of graduate study.

Prior educational preparation, along with mentoring, have been identified as significant predictors of success of Black graduate students, not specific to mathematics. Study hard. It will serve as good practice for what is to come, as the Black mathematics graduate students are nearly unanimous in agreement, some emphatically, with the notion that the Ph.D. program is difficult and requires hard work in order to succeed. Some had a good sense of the effort required, of the pace and workload of the courses and the pressure of the qualifying examinations, when they entered the program at Maryland. About half though say that the program is harder than they expected, including one who remarked:

I think I was prepared intellectually; however, I was not prepared to put in the long hours and to make the many sacrifices necessary to succeed in graduate school. In fact, it's truly taken every one of [my years here] to (1) know what areas I want to study, (2) gain a better understanding [of] how to study this material, and (3) learn to make the sacrifices (e.g., late hours, working on weekends).

Such industriousness is not unique to Maryland's mathematics programs. Collective wisdom of various mathematicians and math graduate students from groups underrepresented in the profession suggest that peer support and hard work are essential ingredients for surviving a mathematics Ph.D. program.

Enroll in courses that will give you the strongest possible mathematical foundation.

Some undergraduate courses are more important than others as a foundation for graduate coursework and research in mathematics. The experiences of the Black students at Maryland speak to the need for a solid foundation. An advanced student who was firmly satisfied with his own preparedness for the Ph.D. worried that some of the newer students have been arriving without some of the theoretical foundation on which they should be building:

Students need to be better prepared for the more difficult/theoretical classes. I'm sure students are told they should take the most challenging classes they can find as undergraduates, but it still doesn't seem to be happening. It may be too much after the fact to address this once a student is already here.

An example of one such student might be the one who said:

I was more geared towards application at [my undergraduate institution]. Here, even the [applied mathematics] courses are heavy in theory.

Undergraduates should make extra efforts to excel in core upper-level courses in analysis and algebra for their graduate school readiness. Within analysis, real analysis (advanced calculus) is especially important, though complex analysis and, increasingly, numerical analysis are valuable. Algebra should include abstract algebra and linear algebra.

Recommendations for Departments and Individuals Who Are Trying to Make a Difference

Be aware that the Black students, though of common heritage, are individuals.

There is no "one size fits all" way to recruit and retain Black graduate students. They are individuals who will often have different needs, different wants, different study preferences, different social inclinations, and different ways to achieve success. As an example, a straight-A mathematics student from a major university will not benefit from academic support the way a B student from a small college will. A lunch or dinner might be the most appropriate kind of social outlet to arrange, since all students eat, but not everybody drinks or bowls or prays.

At Maryland many differences in the study preferences of students were realized. Scholarly collaboration among peers is generally encouraged, and research studies suggest that collaboration holds promise for countering intellectual and social isolation among graduate students, though the studies present no compelling evidence that

collaboration is necessary. A few years ago an internal Department of Mathematics report at Maryland spoke well of collaboration in its recommendations, noting in its assessment of the overall graduate program that “several graduate students told the Review Committee that collective work in preparation for the written exams greatly increased the chances of success, and that students who were isolated frequently had difficulty on the exams.”

Though all of the Black mathematics graduate students surveyed had participated in study groups, sometimes all Black and sometimes multiracial, several expressed a preference for studying alone. One said:

I prefer to study on my own. It takes me a lot longer to learn the material but I do learn it much better.

Another student, reflecting on having passed a qualifying examination along with two peers, proclaimed:

I don't think we would have passed if we had not worked together.

Another describes how she struck a balance that afforded her the benefits of both individual and group study:

It takes a combination of both to be most effective for me. I must first study on my own to know exactly what it is that I am not strong on. The group helps me to strengthen my weak areas...My study groups have mainly consisted of other African American students even though [a mentor] advised against it.

Involved faculty will find it prudent to talk to and get to know the students in order to best determine what sort of support to provide.

Strive to create a framework in which your Black students can find support and determine how best to maneuver the graduate program.

The two primary sources of unrest among mathematics graduate students of all races at Maryland are the qualifying examinations and the climate. The qualifiers have been a source of debate among students and faculty alike, with questions being raised about the reasonableness of the examinations offered in certain fields. And while some have been fairly pleased with life in the department (“They are doing a pretty good job here at Maryland”), quite a few negative feelings were aired about the atmosphere of the department. That environment includes students with “competitive attitudes,” professors who can be “unfriendly” and “condescending,” program directors who seem “out of touch,” and a general climate that is “cold” in which it is “easy to

get lost.” This environmental matter is a general issue affecting the graduate student population at large. However, Black students, if isolated, could find it especially difficult to flourish in such a setting.

To counter the impersonal natures of some large mathematics departments, committed professors can take the initiative, bring the Black graduate students together, and show they care, providing facts and opinions as to how to successfully negotiate the department's Ph.D. program. At Maryland, Raymond L. Johnson, former chairman and for most of his years the department's only Black professor, did just that during his term as chair. Reflecting on his efforts while chair, Johnson explained:

I have been meeting with our Black graduate students about once a month to provide reliable information and to validate the information/misinformation they have received. You don't have to be Black to do this; [more importantly,] it is critical that you be able to look at the students and say/believe that they belong in your school.

Several students suggested that these sessions were extremely valuable, particularly in helping them adjust during the transitional first years of the program. One advanced student reflected on the importance of a solid beginning:

I strongly believe that the first year is crucial. If a student makes it through the first year with a positive “yes, I can” attitude, then there's a good chance [the student] will make it through the program.

Departments and individuals may decide on different courses of action, depending on their students' needs and wants and on their program's characteristics. However, the framework should attend to common difficulties like isolation and inadequate advising, and it should promote academic collaboration and mentorship.

Recommendation for Further Reading

I hope that these recommendations will prove valuable to individuals and institutions nationwide who wish to address the underrepresentation of Blacks, as well as Latinos and Native Americans, in the ranks of Ph.D. mathematicians. While I speak to the specific situation of developing Black mathematicians at Maryland and in the United States, I do expect that many readers will conclude that some of these recommendations (e.g., “strive to create a framework in which...students can find support”) are fitting to any group of students who may be at risk of isolation and that some recommendations (e.g., “study hard”) are sound advice for all.

I refer interested readers to a more extensive exposition on this subject [2], including more elaborate quotes from and examination of the graduate students' responses. This more detailed account highlights lessons from the examination of Maryland's graduate students' experiences. We learn: one individual can make a tremendous difference, though departmental commitment is recommended; a Black presence in a department's faculty, staff, and in the student community can attract students to matriculate; academic and social peer support are vital for many students to survive the hard work of a mathematics Ph.D. program, especially the transitional first year; mentorship before and during graduate school is important to influence and academically prepare students to pursue the Ph.D. and to facilitate progress towards the degree; and some maintenance of support mechanisms is needed.

References

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