Mathematical Association of America

Undergraduate Mathematics: Promising Recruitment and Retention Strategies to Ensure Diversity in the STEM Pipeline
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Executive Summary

What are the issues related to ensuring that our nation has a diverse pipeline of students into STEM, specifically undergraduate mathematics?

We must create a more welcoming environment, new pathways into science with additional courses of study, and a nurturing environment with exposure to role models and mentors.

Recruitment programs must identify and highlight the important positive aspects of STEM fields. We must communicate why mathematics is important and relevant in the 21st century. The message must be communicated to a diverse audience and hence, the message and the messenger cannot be the same for all groups, that is, we need appropriate role models.

Our nation's colleges and universities now have large numbers of their students from African-American, Hispanic and Native American populations, but these groups make up only a small fraction of the mathematics faculty, and those overwhelmingly at the lower ranks. It is important for ALL students to see African-American, Hispanic and Native American role models in the front of the classroom just as they need to see these groups in other professional roles and in the media. For the nation's students who are from these populations, mathematics faculty role models serve as confirmation that competence in mathematics is possible for them.

Finally, we cannot ignore the economic realities faced by many minority students. There remains a critical need for student scholarships and maintenance of a high quality educational infrastructure– including the curriculum, personnel and physical facilities.

What are examples of effective programs that recruit and retain minority and female students into mathematics and other STEM disciplines?

There are several significant efforts. Leading mentors of underrepresented minorities (URM) in the mathematical sciences include Richard Tapia and Raymond Johnson who have aimed their efforts towards the mentorship of URM PhDs. Professor William Velez is an example of an extraordinary mentor. A winner of the Presidential Mentorship Award, and a former President of the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS), he has devoted a considerable amount of his time on efforts to increase the number of undergraduate mathematics majors at the University of Arizona. His efforts have resulted, roughly speaking, in a community with more than 565 mathematics majors, a group that includes 120 URM (22%), that is, nearly two percent of the University of Arizona population of undergraduate students has declared an undergraduate mathematics major.

The Spelman College Women in Science and Engineering Scholars Program has won awards and recognition for its outstanding record of success. It was originally named the NASA WISE Scholars Program, because of the support of the National Aeronautics and Space Administration (NASA). In 1987 Spelman College partnered with NASA to increase the number of students earning advanced degrees in STEM areas. The structure designed by Dr. Etta Falconer and NASA officials included scholarships for students, an enhanced academic curriculum, on campus mentoring and research with faculty, careful academic advising and enrichment programs, and a pre-college transition program. In addition, the students entered internships at NASA sites during the summers where they were also mentored by NASA scientists. Today, of the more than 320 women who were WISE Scholars at Spelman, more than half have received graduate degrees, and at least 40 have earned Ph.D. degrees. These WISE Scholars, who earned bachelor's degrees across all STEM disciplines, contribute throughout the academic and scientific enterprises of this nation.

Since 2003, the MAA has sponsored Research Experiences for Minority Undergraduate Students in Mathematics. To date over 300 students have participated. Many have gone onto graduate education in mathematics and other STEM fields. The program has been supported by NSF, NSA, and corporate funding.

What is needed is a vision of a coherent and systematic program that includes the following elements:

- High school-to-college transition programs in STEM
- Active recruitment by faculty
- Strategic 'community building'
- Advising and mentoring
- Undergraduate research
- Scholarships integrated into special programs
- College to graduate school transition program in mathematics
- College curriculum that excites students with the wonder of mathematics and its applications in the real world and in other disciplines, is accessible to a wide student audience, and serves students of diverse backgrounds and interests

What is the federal role in these programs?

The primary source for funding for mathematical research and education is the National Science Foundation.

Prior to the existence of NSF programs like IGERT, LSAMP, AGEP and EMSW21, the number of undergraduate *mathematics* majors thinking of a future as professional mathematicians was *extremely* low. Sustained funding for undergraduate education at levels that will close the gap caused by decreased funding in the years preceding 2009 for NSF and new funding for undergraduate mathematics education at other agencies such as NIH, Department of Energy and Department of Defense is critical.

The establishment of university models on the principles that merge access with excellence is essential. Models capable of sustaining large-scale education-through-research quality efforts are unlikely unless our national political leaders and the federal government offer strong support, guidance and direction on what must be done to develop a diverse and competitive 21st century workforce.

Funding of institutions and organizations that make a difference in meeting the diversity goals in undergraduate STEM disciplines must go beyond direct student support. In addition to scholarships, there must be support for

mentoring and research programs and the entire infrastructure that is required to develop students in STEM disciplines.

In conclusion, there are three areas that need increased federal attention:

1. **Gather and disseminate information about what works.**
   Only the federal government has the resources to conduct the longitudinal studies that identify the most promising routes to success and to support the in-depth analysis that tell us not just what works but why it works, so that others can adopt successful practices. For example, the Division of Research and Learning at NSF's Directorate for Education and Human Resources supports projects that carefully evaluate mechanisms that support student learning.

2. **Fund programs at science-oriented agencies that use research that partners mathematics with other disciplines as a means of attracting students from underrepresented minorities.**
   It is precisely on the boundaries with other disciplines where much of the most exciting and accessible mathematical research is being done today. This is where we have the greatest potential to attract students from underrepresented minorities. An exemplary program is the *Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences* supported jointly by the Directorates for Biological Sciences (BIO), Mathematical and Physical Sciences (MPS), and Education and Human Resources (EHR), at NSF. The program supports long-term interdisciplinary research experiences for teams of undergraduates majoring in the biological and mathematical sciences. With additional funding this model can be replicated for interdisciplinary research combining mathematics with other areas and for collaborative support for such programs between NSF, NIH, and other agencies such as the Department of Energy, NASA, and the Department of Defense.

3. **Invest in programs and research opportunities that are critical to student success.**
   Such programs have been shown to improve retention and success for all students. If we want to see more students from underrepresented minorities succeed in the mathematical sciences and the STEM disciplines that rely on mathematics, it is not enough to offer just scholarship aid. Aid must be combined with innovative and varied curricula and research and mentoring opportunities that give students the inspiration, experience, and confidence needed to achieve their goals. Examples of such programs at NSF include the *Science, Technology, Engineering, and Mathematics Talent Expansion Program* (STEP), supported through the Division of Undergraduate Education (DUE), and *Enhancing the Mathematical Sciences Workforce in the 21st Century* (EMSW21), supported through the Division of Mathematical Sciences as well as the core programs in DUE. Further, faculty development programs such as the MAA Professional Enhancement Program, funded by DUE, serve to disseminate innovative approaches and prepare faculty to adapt and implement effective practices at their institutions. **Expanded support for students to participate in exemplary programs, coupled with funds for faculty development, is critical to broadening student access to, and success in, mathematics and science and is essential for the U.S. to maintain our leadership in science and technology.**