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

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September 22, 2009

Chairman Hinojosa, friends and guests, on behalf of my colleagues, Carlos Castillo-Chavez, Regents and Joaquin Bustoz Jr. Professor of Mathematical Biology, Arizona State University and Sylvia T. Bozeman, Professor of Mathematics, Spelman College and for myself, I want to thank you for giving us this opportunity to share our concerns about undergraduate Mathematics and to share promising recruitment and retention strategies that encourage diversity in the pipeline toward degrees in the STEM disciplines, those within Science, Technology, Engineering, and Mathematics.

Without question, the United States can boast of the best system of higher education in the world. But that does not mean that this system is perfect. It has failed to meet our nation's requirements for graduates trained in the STEM disciplines, a fact that is witnessed by our need to import large numbers of scientists and engineers. Much of this failure can be tied to the serious underrepresentation of minority populations within the STEM disciplines.

These disciplines all share a core reliance on the Mathematical Sciences. Mathematics lies at the heart of scientific modeling. Success in Mathematics opens the doors to all of the STEM fields. Lack of success often closes these doors. Last spring, when I talked with many of the legislative assistants here today, my mention of struggles with Calculus brought a smile of recognition to the faces of many of the staffers. Even for those privileged with superior K-12 education, the transition to college mathematics is difficult.

Furthermore, Mathematics is a bellwether for trends in all of the STEM disciplines. As my first graph shows, fluctuations in Engineering and Mathematics enrollments are highly synchronized. The 1990's saw significant decreases in both the number of Engineering majors and the number of Mathematics majors. Both numbers have since recovered, but to only just above the level of 1990. Disturbingly, the recent recoveries in both disciplines are powered almost entirely by white males and non-US residents. Women as well as African, Hispanic, and Native Americans are decreasing as a share of these majors. If we want to build a talented American workforce for the future, we cannot afford to ignore these students.

The most dramatic and discouraging story has been among non-Hispanic African Americans. African Americans have steadily improved their fraction of all bachelor's degrees awarded in the US, now approaching their percentage of the population. For many years, African Americans were represented among Mathematics majors in proportion to their numbers, but that has changed significantly since 1998. The number of African-Americans earning bachelor's

degrees in Mathematics was higher in 1992 than in 2007, the latest year for which we have this data.

This decrease in Mathematics majors is mirrored in what has happened to African American Engineering majors. While the percentage of African Americans among Mathematics majors was rising, it was also rising among Engineering majors. With the start of this century and the leveling off and then decline in African American Mathematics majors, there has been a comparable leveling off and decline among African American Engineering majors. Starting from a lower base, the decline in Engineering majors has not been as pronounced, but it is very real.

The story is similar for Hispanic Americans where Mathematics and Engineering follow each other extremely closely. It is similar for Native Americans, though in the last case the numbers are so small that there is a great deal of year-to-year variability.

I am also concerned about the trends for women in the Mathematical Sciences. Though the shifts have been subtler, the downward trends since 2000 are particularly significant because the numbers are so large. The percentage of bachelor's degrees earned by women is now holding at just under 58%. From the mid-1980's through the 1990's, the percentage of bachelor's degrees in Mathematics that were earned by women has held very steady at between 46% and 48%. In this century, we have witnessed a slow but unmistakable steady decrease, dropping to 44% in 2007. In Engineering, after a valiant climb from 15% in 1990 to 21% in 2002, this fraction has dropped back to 18%.

There has been real success in getting students from underrepresented groups into and successfully through college, but this has not been matched by broad scale successful efforts to support these students within Mathematics in particular nor the STEM fields in general.

My colleagues will now address three critical questions:

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

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

3. What is the federal role in these programs?

Conclusion:

The Federal government has a role to play in increasing the participation of Underrepresented Minorities (URMs). In particular, federal programs must

1. Continue support for scholarship programs for URMs and combine them with active recruitment, mentoring, and community building.

Scholarship programs are essential, but they are not enough. We must actively recruit students to the STEM fields from the moment they are accepted to college, if not before. Especially for those who are in the first generation of their family to attend college, support through mentoring and community building is known to make a critical difference in rates of success.

2. Create research opportunities for URMs by encouraging partnerships between Minority Serving Institutions and research centers.

From the programs of NIH to the National Institutes in the Mathematical Sciences, largely supported though NSF, the federal government is an important sponsor of scientific research. We know that students are energized and empowered by the challenge to participate in real, ongoing scientific research. More can and must be done to connect URMs with this research.

3. Promote integrated programs, both vertically and across disciplines.

Vertically integrated programs such as NSF's *Enhancing the Mathematical Sciences Workforce in the 21st Century* (EMSW21) help students understand where they can go and what they can accomplish while articulating across the transition points from high school to college, introductory to advanced work, college to graduate school, and graduate school to a career as a scientific researcher. Interdisciplinary programs such as NSF's *Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences* (UBM) introduce students to the rich and exciting questions that today mostly live at the interstices of disciplines.