A Model for Outreach to Groups Underrepresented in Science and Mathematics

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Since the late 1980s, I have been involved in many outreach efforts designed to increase the participation of Native Americans and other minorities in mathematics-based disciplines. This essay will focus on one portion of those activities, pre-college mathematics intervention projects, so called because they are designed to intervene at the points that pre-college students from underrepresented groups are being lost from the educational pipeline that could take them into mathematics-based college majors. Three components will be discussed: the importance of such projects; benefits to participating communities, individuals, and academic institutions; and recommended steps for starting such projects.

My involvement in these issues came about because of my own Native American heritage. When I received my doctorate in mathematics in 1984, I believed few Native Americans held doctorates in the discipline because I had never met any. However, I was unaware of the severity of the shortage until I discovered that in the mid-1970s, the American Association for the Advancement of Science's Project on Native Americans in Science could not find five Native Americans with doctoral degrees in mathematics in a population of more than one million Native Americans (Green 1978). Though the AAAS study may have overlooked some, and a few more have been produced since the study was conducted, a more recent search by the Mathematical Association of America's Project for Strengthening Underrepresented Minority Mathematics Achievement (SUMMA) identified fewer than ten. (Some counts, such as that kept by the American Mathematical Society, show forty or so Native Americans with doctorates in mathematics; some scholars dispute these counts, citing irregularities in the way people identified themselves as members of particular ethnic groups.)

As is well known, this underrepresentation of minorities in mathematics, indeed in almost every academic discipline, is not restricted to Native Americans. Though the 1990 U.S. Census shows that African Americans, Hispanic Americans, and Native Americans

comprise about 22% of the U.S. population, the three groups together accounted for only about 2.7% of the mathematics doctorates given to U.S. citizens between July 1973 and June 1996 (Alexander and Hawkins 1997). Nor has there been any dramatic recent upward trend in these numbers. Of the 423 U.S. citizens and permanent residents who received mathematical doctorates during the 1997-98 academic year, only sixteen, or 3.8%, were from the three minority groups mentioned above (AMS 1999a). It is also not the case that the lack of underpresented minority doctorates is offset by larger-than-expected numbers of doctoral degrees obtained by members of these groups in other mathematics-based disciplines; only 4.8 percent of the doctorates given in U.S. citizens and permanent residents in all such fields during the 1995-96 academic year went to persons from these minority groups (NCES 1999, Table 271). The conclusion is inescapable: Because of the ongoing underrepresentation problem of these groups, nearly one-fifth of the best mathematical talent in the U.S. does not achieve the terminal degree.

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The image of the leaky pipeline to depict the educational progress of underrepresented minorities from pre-kindergarten to advanced degrees in mathematics is quite apt. For every 1,000 white, non-Hispanic, and Asian American U.S. citizens and permanent residents receiving bachelor's degrees in the mathematical sciences during the 1995-96 academic year, 244 members of the same groups received master's degrees and 59 received doctorates in these fields. In contrast, for each 1,000 U.S. citizens and permanent residents from underrepresented minority groups obtaining bachelor's degrees in the mathematical sciences the same year, the corresponding number of master's and doctoral degrees were 165 and 12, respectively (NCES 1999, Tables 265, 268, 271). A number of factors, not the least of which is financial, affect the retention of minority students in the postgraduate pipeline. It would seem that college educators could do a better job of mentoring and encouraging such students to seek advanced degrees when their talents and interests could take them in that direction.

However, as college educators, we cannot solve the problem of too few mathematics degrees given to students from underrepresented minority groups by concentrating only on the portion of the pipeline that is under our direct control. Too few students from these groups who are prepared to do well in college mathematics enter our portion of the pipeline. Data kept by the National Center for Education Statistics shows although

performance gaps have narrowed since 1973, in 1996 the average mathematics proficiency levels of 17-year-old African American and Hispanic American students, as measured on standardized tests, were substantially below the average for white students in the same age group; data for Asian Americans and Native Americans was not given (NCES 1999, table 120). Because of this, it is not surprising that students from underrepresented minority groups received only 13% of the science, mathematics, and engineering bachelor's degrees in 1995, although they comprised about 28% of the college-age population that year (NSF 1997). It is difficult to get students successfully through mathematically intensive baccalaureate programs if they lack the preparation to begin them.

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There is much that college educators can do to help with the pre-college mathematics preparation of underrepresented minority students by reaching out to these students and their communities before the students show up on college campuses. In 1992, I began helping to design and conduct mathematics-intervention projects for pre-college students on the campus of Turtle Mountain Community College (TMCC) on the Turtle Mountain Chippewa Reservation in North Dakota. In the ensuring years, my colleagues at TMCC and I have conducted several projects almost every summer, most involving 20 to 30 middle-school or high-school students who are chosen more for their willingness to apply themselves than for demonstrated success in mathematics. Selection by this criterion is in keeping with a strong cultural emphasis in this community on helping everyone who can benefit from a program rather than concentrating on those who have demonstrated excellence. Our programs typically consisted of summer workshops in some interesting area of mathematics that the students would not normally see during their pre-college years. An academic-year follow-up program keeps the students engaged.

Such pre-college intervention projects can be effective in keeping students in the mathematics pipeline. One of the oldest and most successful has been the Texas Prefreshman Engineering Program (TexPREP), an eight-week summer program that was started in 1979 by Manuel Berriozbal, a mathematician at the University of Texas at San Antonio, and has since spread across the state. As of 1995, 11,300 participants had completed at least one summer of TexPREP; 80% were minority, 52% female, and 50% from low-income families. Long-term tracking of the participants has showed that of those who completed at least one year of the program, 92% eventually entered college, 80% graduated from college, and 58% of

the degrees obtained by those college graduates were in science, mathematics, or engineering (TexPREP 1995).

While our intervention projects at Turtle Mountain have operated only since 1992, a few students who participated have earned college degrees in mathematics-based disciplines each year, where such degrees were previously rare for students from this culture. Green and Brown observed "(t)he felt and stated need among Indian scientists and educators is for applied science, for trained personnel who can assist Indian communities in solving real problems" (1976, p. 3); to date, the degrees earned have generally been in engineering. We hope a significant number of these students will choose to return to their reservation, and accept jobs helping with the development of tribal resources and infrastructure. There they can serve as role models for the next generation of students.

In addition to the societal value of enhancing the pre-college mathematical preparation of students from underrepresented minority groups, there are tangible benefits to the institutions whose faculty members become involved in such efforts. For example, during a time in which the number of undergraduate mathematics majors is growing at the rate of only about 1% per year (AMS 1999b) and competition for mathematics majors is great, mathematics-based intervention projects can be an effective way to interest pre-college students in mathematics and recruit them as majors. Even the students in such a project who do not decide on mathematics as a major are still more likely to enroll in an academic institution that has faculty members who have already established mentoring relationships with them in pre-college programs.

It is difficult for a faculty member to sustain such activities without support and encouragement from the college or university. My own institution, the University of Michigan, recognizes outreach to underrepresented minority communities as a fundamental part of its mission. The Michigan Mandate, introduced by former UM President James Duderstadt in 1987, is our university's basic blueprint for achieving diversity. Under its Strategic Objective Number 4, "Improving the Environment for Diversity," one major goal is to "(r)each out to the wider community to provide support and expertise, to identify new learning opportunities for our students, and to enhance the university's sense of connection and interdependence with the world beyond our campus" (University of Michigan 1995, p. 5). To accomplish this, the university directly supports activities that reach out to underrepresented communities through a wide variety of programs and small grant opportunities, particularly through its Office of Academic and Multicultural Initiatives. Several prestigious awards are given each year for outreach activities of this type and, more generally, for public service, including the Harold R. Johnson Diversity Service Award and the Regents' Award for Distinguished Public Service. All of this

sends a strong message to faculty that public service and outreach, particularly to underrepresented minority communities, are activities that are valued and rewarded by our institution.

One disadvantage to faculty of becoming involved in pre-college intervention projects is that such activities can easily consume one's summer, often reserved for research, reflection, and writing. However, models exist for effective, academic-year intervention projects — such as Project Prime (Professions and Recreations: Intermediate Mathematics Enrichments), conducted for rising elementary school students by the University of Minnesota's School of Mathematics, that consists of workshops, math fairs, lab visits, and career presentations; and Oregon State University's weekly after-school Science and Math Investigative Learning Experiences (SMILE) programs for pre-college students.

College and university faculty interested in these types of outreach activities should be aware of an important principle previously emphasized in the pages of this journal: " ... the collaboration (between the institution and the community must be) one of equals, both of whom draw value from the relationship" (Reid and Williamson 1999, p. 8). Native American communities in which I have worked have expressed great anger about university/ community collaborations that were primarily university research projects by faculty and provided minimal direct benefit to the community. Some projects were perceived as mechanisms for a majority institution to enhance the "fundability" of a grant proposal by seeking a tribal college partner; after funding was secured, the tribal college was relegated to a junior role. Faculty who propose partnerships that benefit both parties will gain the trust of the community.

It is also important for faculty to learn something of the culture, values, and history of any minority community in which they are involved. This is essential when working with issues that affect Native American education. Self-determination, for example, the principle that Native Americans will determine the form and content of the education their children receive, has been a precept guiding Native American education over the last few decades, and has gained legal status through several pieces of federal legislation, notably Title XI of the Education Amendments Act of 1978 (P.L. 95-561).

Faculty who wish to become involved in pre-college intervention projects should be diligent about documenting long-term successes. If external funding is obtained for such a project, the granting institution will no doubt require evidence and indicators of success. However, the typical short duration of the funding cycle usually dictates that indicators be short-term measures, such as attitudinal surveys or post-tests on the final day of the program. However, the real measure of the success of such projects is their effectiveness in keeping students in the pipeline leading to college degrees. Though it is not easy to track the progress of students after they participate in an intervention

project, the commitment to follow-up documentation of impressive achievements will ensure the continued interest of funding agencies in supporting programs that prove their effectiveness. ▨

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Author's Notes

See (MAA 1997) for a directory and description of 133 different precollege mathematics intervention projects that use various summer and academic-year models.

Good sources for learning about the history of Native American education and the reasons for the modern emphasis on self-determination are Szasz 1977 and BIA 1988.

About the Author

Robert E. Megginson (Ph.D., University of Illinois at Urbana-Champaign) received his bachelor of science degree in physics from the University of Illinois in 1969, after which he worked for eight years in industry, rising to the position of lead computer systems software specialist for Roper Corporation in Kankakee, Ill. He received his master of arts degree in statistics at the University of Illinois in 1983 and his doctorate in mathematics the following year. He was a member of the mathematics faculty of Eastern Illinois University from 1983; in 1992 he joined the mathematics faculty of the University of Michigan, where he is currently an associate professor of mathematics and director of the Michigan Mathematics Laboratory.

Megginson's current research interests are in mathematical functional analysis, specifically the geometry of Banach spaces, as well as issues related to the underrepresentation of minorities in mathematics. His book,

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Megginson currently serves as chairman of the Coordinating Council on Human Resources of the Mathematical Association of America (MAA), and is co-chairman of the MAA Committee on Minority Participation in Mathematics that advises the MAA Project for Strengthening Underrepresented Minority Mathematics Achievement. He has recently finished a term on the Board of Trustees of the Mathematical Sciences Research Institute at Berkeley, and as chairman of the Institute's Human Resources Advisory Committee. He has been involved in many outreach programs of the MAA as well as those of the American Indian Science and Engineering Society (AISES), and is an AISES Sequoyah Fellow. For his work with students from groups underrepresented in mathematics, Megginson was one of ten individual recipients of the 1997 U.S. Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. He also received the 1999 University of Michigan Regents' Award for Distinguished Public Service.