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Background

Despite the country's general shortage of science, mathematics and engineering (SME) professionals (Holden, 1994), undergraduate education in these fields continues to be more of a "weeding-out" than a cultivation process (Miller, 1993). It may therefore come as little surprise that these fields are predicted to remain dominated by one gender (males) and one race (White) (Grandy, 1997). While the likelihood of students of color entering science, mathematics or engineering fields is slim, for the small number of undergraduate minority students who manage to major in SME the likelihood of remaining in the field and enrolling in subsequent graduate level education is even more improbable. Yet despite our knowledge that a shortage of people of color exists in SME fields, we know little of why talented minority students tend to shun SME and why those who do enter these fields at the undergraduate level "derail" from the track prior to the graduate level and entrance to related careers.

Data from the National Assessment of Educational Progress (NAEP) sheds some light on the phenomenon. While African American and Hispanic students in the 4th through the 12th grades report the same levels of enjoyment of mathematics as their White counterparts (National Center for Educational Statistics, 1991); on average their mathematics scores are lower (NAEP, 1996). Lower mathematics test scores combined with sparse numbers of minority students completing a course in calculus have been identified as one of the explanations for the shortage of SME students among underrepresented groups (Alexander, Burda, & Illar, 1997).

Although we fail to truly understand the "whys", the evidence of the shortage emerges with crystal clarity. The National Science Board reported that between 1977 and 1993 only 6% of the bachelor's degrees and 2% of Ph.D.'s in science and engineering were awarded to African Americans (Foundation, 1996). In 1988 less than 2% of the enrollment in undergraduate science and engineering courses were Hispanic (Levy, 1992). In 1994, only 52 African Americans earned the Ph.D. degree in the physical sciences (Simmons & Thurgood, 1995). Further evidence of the shortage of degreed minorities in SME is provided by membership in the professional societies. The American Chemical Society reported that less than 2% of their membership was African American and the Institute for Electrical and Electronic Engineers reported their African American membership at only 1% (Institute of Electrical and Electronic Engineers; Smith, 1991).

The aforementioned underrepresentation of people of color is problematic. SME careers typically provide relatively high levels of prestige and salary and should be an available option for all (regardless of color, race, or gender). Further, whenever there are barriers for a set of individuals in any important field, the country is robbed of important future contributions and discoveries of talented individuals that may assist us to maintain a competitive technological edge. Finally, underrepresentation begets continued underrepresentation. The low number of Ph.D.'s among minority individuals in the SME fields produces minute representation among the professoriate thus creating a serious lack of role models and mentors. The cycle of very low numbers of minority people in SME fields therefore serves as a guarantee that careers in SME will continue to appear foreign and inappropriate to students of color.

Problem Statement

As demonstrated, the word "underrepresented" is apt when describing the extent of participation of people of color in SME fields. This problem and the need to nurture students into SME fields has not gone unrecognized. There are numerous secondary level programs supported by state, local, or federal governments, industries, or foundations that assist high school students to enter college and subsequently enroll in SME disciplines. A recent project by the Center for Higher Education Policy Analysis at the University of Southern California recently identified 62 campus based, 5 federally or state based, and 11 independent or foundation based college preparation programs operating in the state of California. At least seven of the programs are fully dedicated to SME categories.

Although they exist, programs that assist students AFTER they successfully enter college (i.e., graduate preparation programs) are very sparse. It appears that most efforts assume that once a student has successfully navigated high school and has declared an undergraduate SME major, the job is complete. Sadly, although college preparation programs have been successful in encouraging students to enroll in college, the slim number of people of color among SME disciplines clearly demonstrates that the need to carry support further.

An example of a prominent and highly successful program that recognizes the need to bring minority students into SME fields is MESA (Mathematics, Engineering, Science Achievement). MESA is an 27-year-old program that operates throughout California serving and supporting educationally disadvantaged students of color through elementary, junior, and senior high schools. Note that the MESA program stops short of assisting students through graduate education and into their chosen careers. However, MESA's sister program, MEP (MESA Engineering Program) does support students in colleges and universities. The high numbers of MEP students who have earned a bachelor's degree in engineering clearly demonstrate the success of the program. However, even this program stops short of assisting students through graduate level work and subsequent career success.

Although there are a limited number of programs supported by government agencies, colleges, foundations, and/or industries that continue nurturing students through graduate level SME programs, to date there is no resource guide and directory for graduate preparation programs similar to the one prepared at USC for undergraduate programs. Our knowledge of these programs, therefore, is piecemeal and fragmented and basically includes only the knowledge that some programs support students in the form of financial aid while others may provide tutoring or other programmatic assistance. Despite the purpose and direction that these programs are taking we know almost nothing of their successes or levels of effectiveness. There is a lack of a series of systematic inquiries and studies that will help to identify the factors that contribute to talented minority students remaining "on the SME track" through graduate school and into appropriate careers. For example, what patterns of graduate school course taking and faculty support leads to successful completion of independent research and dissertation completion?

What is the role and importance of family influences, undergraduate experiences, personal levels of skills and abilities, aspirations, level of determination, commitment to the discipline, and career expectations? Perhaps of even more immediate concern is do support programs at the graduate level work? Or should efforts continue to be concentrated on younger students?

There is a desperate need to find out what works, what should be continued, what should be discontinued, and what should be established. Specifically, I believe the following must be accomplished:

1. Catalogue and critique currently existing graduate level programs that specifically target the SME disciplines
2. Successfully define and identify effective programs
3. Determine the characteristics and/or factors that contribute to a successful program.

4. Inform graduate preparation programs and undergraduate institutions of the results of our analyses so that they may institute appropriate policies to increase the number of SME graduates among people of color.

This essay is a call to researchers to dig a bit deeper to study WHY the programs to nurture SME students through graduate school are not apparently working. How should existing programs be modified so as to change the future of SME professions? And finally, what programs need to be instituted? Certainly these students deserve to be studied!

References

Aldrich, J. H., & F. D. Nelson (1986). *Linear probability, logit, and probit models*. (3 ed.). Beverly Hills, CA: Sage Publications.

Alexander, B. B., A. C. Burda, & S. B. Illar (1997). A community approach to learning calculus: Fostering success for underrepresented ethnic minorities in an emerging scholars program. *Journal of Women and Minorities in Science and Engineering*, 3(3), 145-159.

Anderson, J. C., & D. W. Gerbing (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, 103(1-15).

Byrne, B. M. (1994). *Structural equation modeling with EQS and EQS/Windows*. Thousand Oaks, CA: Sage Publications.

Foundation, N. S. (1996). *Science & engineering indicators (NSB 96-21)*. Washington, D.C.: U.S. Government Printing Office.

Grandy, J. (1997). Gender and ethnic differences in the experiences, achievements, and expectations of science and engineering majors. *Journal of Women and Minorities in Science and Engineering*, 3(3), 119-144.

Hanusheck, E. K., & J. E. Jackson (1977). *Statistical methods for social scientists*. New York: Academic Press.

Holden, C. (1994). Wanted 675,000 future scientists and engineers. *Science*, 244(4912), 89.

Institute of Electrical and Electronic Engineers (1991). *IEEE U.S. Membership Salary & Fringe Benefit Survey*. New York: IEEE.

Levy, D. (1992). Puerto Rico exports Hispanic Scientists. *Science*, 258(13), 1191.

Miller, A. (1993). Introduction. *Initiatives*, 55(3), 1-2.

NAEP. (1996). *NAEP 1996 Mathematics Report Card for the Nation and the States*. NAEP. Available: <http://nces.ed.gov/naep/96report/97488.shtml> [1998, July 6, 1998].

National Center for Educational Statistics. (1991). *The state of mathematics achievement: NAEP's 1990 assessment of the nation and the trial assessment of the states*. Washington D.C.: U.S. Government Printing Office

Simmons, R. O., & Thurgood, D. H. (1995). Summary report 1994: Doctorate recipients from United States universities. Washington D.C.: National Academy Press.

Smith, E. (1991). African-American chemists in the American Chemical Society (Workforce Report: Professionals in Chemistry). Washington, D.C.: American Chemical Society.