MAKING STRIDES

Research News On Minority Graduate Education (MGE)
Volume 1 Number 2

July 1999

Inside this issue:

Managing Editor: Yolanda S. George
Editor:

From the Editors:

Each issue of *Making Strides* will feature a profile on a MGE institution. Dr. Shirley Malcom, Head of the Directorate for Education and Human Resources Programs at AAAS, was the commencement speaker for the Rackham Graduate School and honorary doctorate recipient at the spring 1999 University of Michigan commencement. Naturally, we thought it appropriate to ask Dr. Malcom to write a short profile on this MGE institution.

Peter Syverson, Vice President for Research at the Council of Graduate Schools, wrote an article on the contribution of Doctorate, Master's and Other Specialized institutions to SME graduate education. Drs. Michael Nettles and Catherine Millet at the University of Michigan share findings from their ongoing study of doctoral student retention. And, Dr. Carlos Castillo-Chavez, a Biomathematics professor at Cornell University, is profiled in this issue.

There's been a great deal of press, of late, on the financial debt burden of students. An April 16, 1999 National Science Foundation Issue Brief by Alan Rapoport noted that underrepresented minority SME Ph.D. recipients reported higher levels of debt than their white and Asian counterparts. This same brief noted a slightly higher debt burden of women, but, Rapoport noted that field-level data indicate that the aggregate findings mask substantial differences in the debt situation between male and female SME Ph.D. recipients. See page 2 of the newsletter for tables highlighting this data.

A Brief Overview of MGE

In late October of 1998, the NSF Minority Graduate Education program awarded eight universities nearly $2.5 million each to significantly increase the number of African American, Hispanic and Native American students receiving SME doctoral degrees. Also, as part of this initiative, AAAS and CPST received a three-year research award of $450,000 to identify and disseminate factors that affect these

Editor:
Virginia Van Horne
Art Director:
Ann Williams
Online Editor:
Maria Sosa

Making Strides is a quarterly (April, July, October, and January) research newsletter published by the American Association for the Advancement of Science, Directorate for Education and Human Resources Program. Its purpose is to share information about minority graduate education (MGE) in the fields of science, mathematics, and engineering. It is available in print and electronic format. Inquiries, information related to MGE, and all correspondence should be sent to the editor.

students' underrepresentation in SME as well as the successful strategies that lead to their increased representation in science, mathematics and engineering doctoral programs and careers, in particular, the professoriate. The eight universities that received awards are Georgia Institute of Technology, Howard University, University of Alabama at Birmingham, University of Florida, University of Michigan, University of Missouri-Columbia, University of Puerto Rico and Rice University.

As noted on the NSF/MGE webpage, "the Congress has consistently stressed the need for the National Science Foundation to expand its efforts to provide opportunities for underrepresented groups to participate in the Nation's science and engineering enterprise." In the House of Representative Reports 105-610 and 105-769 (reports that accompanied the Foundation's FY 1999 appropriations) the NSF was directed to increase its support for minority graduate education. NSF solicited additional proposals for the MGE program in early February, 1999. Official announcements will be made on new awardees before early fall 1999.

Lastly, we would like to take a moment to say thank you for the warm response we have received toward our newsletter. Please continue to send us your comments, feedback and inquiries. We also ask that you make a point to take a few moments to answer the hot topic question. Your answers assist us with our research.

Visit (http://www.ehr.nsf.gov/ehr/hrd/mge.asp) for additional information on the NSF Minority Graduate Education program.

Click here to view the April 1999 issue of *Making Strides*.

Research News On Minority Graduate Education (MGE)
Volume 1 Number 2

July 1999

Inside this issue:

Managing Editor:
Yolanda S. George

Forty Percent of the System: The Contribution of DMOS[1] Institutions to Diversity in Science and Engineering Graduate Education

Peter D. Syverson, Vice President for Research and Information Services, Council of Graduate Schools

Introduction

In the world of U.S. higher education, considerable attention is paid to the major research universities classified in the Carnegie[2] system as Research I and Research II. These 125 research-intensive institutions enroll more than one-half million graduate students, grant 79 percent of all doctoral degrees and 83 percent of doctoral degrees in science and engineering. Faculty at research-intensive institutions are at the top of the "academic food chain," and a tenure-track position at a Carnegie research institution is the ultimate goal of many Ph.D. students.

Studies of these institutions form the basis for much of what we know about graduate education. For instance, the AAAS study *Losing Ground* focussed on 93 major research universities. The Bowen and Rudenstine study *In Pursuit of the Ph.D*. built its findings on the experiences of doctoral students at just 10 research institutions. And the *Ten Years Later*[3] study of the careers of Ph.D. recipients is using 61 research-intensive universities as the basis for its sample.

However, there are many other institutions in the graduate-education system. These institutions also have an important role to play in preparing-and employing-the next generation of scientists and engineers. In fact, there are more than 800 institutions in 7 other Carnegie categories that are involved in the graduate education enterprise. These include the Carnegie Doctorate-Granting and Master's (Comprehensive) institutions and universities with special missions classified as "Other Specialized." In addition, there are a number of colleges classified as Baccalaureate I and II that offer graduate programs.

Making Strides is a quarterly (April, July, October, and January) research newsletter published by the American Association for the Advancement of Science, Directorate for Education and Human Resources Program. Its purpose is to share information about minority graduate education (MGE) in the fields of science, mathematics, and engineering. It is available in print and electronic format. Inquiries, information related to MGE, and all correspondence should be sent to the editor.

graduate programs.

DMOS (Doctorate, Master's, and Other Specialized) institutions enroll 56 percent of all graduate students and annually grant more than 230,000 Master's degrees and 9,000 doctoral degrees. Moreover, they are the employers of many doctorate recipients from all levels of institutions, including those from research-intensive campuses. Estimates are that most doctorate recipients from Research I institutions find faculty positions in non-Research I institutions. According to the American Mathematical Society, more than one-half of all new Ph.D.s in mathematics find faculty jobs in non-research intensive institutions.

DMOS are also a highly diverse group of institutions, ranging from doctoral institutions to small regionals to medical schools. In addition, this group includes most of the Historically Black and Hispanic Serving institutions with graduate programs.

This article will examine the contribution of the DMOS institutions to graduate education in science and engineering, focussing on ethnic groups underrepresented in science and engineering-American Indian, African American, and Hispanic. Data will be drawn primarily from the CGS/GRE Survey of Graduate Enrollment, a survey of the 685 institutions that are either members of the Council of Graduate Schools or one of its regional affiliates. The survey population includes all 125 research-intensive institutions and 560 of the DMOS institutions.

National Context

The nation's universities are in the midst of a sea change in graduate enrollment. The late 1980s and early 1990s were years of steady growth throughout graduate education, with annual growth rates of 2 percent and increasing enrollments across the disciplines. In the mid-1990s graduate enrollment plateaued, with growth in some fields and decline in others. In 1995, an extremely attractive job market for bachelor's-degree recipients spurred the beginning of a decrease in graduate enrollment, which continued through 1997. According to the National Science Foundation, science and engineering graduate enrollment peaked in 1993 and had declined by 6 percent by 1997. Enrollment decreases have been especially pronounced in mathematics, engineering, and the physical sciences.

At the same time, enrollment of women and minority-group members[4] remained steady or increased. In science and engineering, the number of women, African Americans, Hispanics, and Native Americans enrolled in graduate science and engineering programs increased through 1997. Asian enrollment in science peaked in 1994 and has declined slightly since then.

Graduate enrollment at DMOS institutions has followed a different path, reaching a plateau in the last few years but not beginning the decrease seen in the national data. Like the national trends, science and engineering enrollment at DMOS institutions peaked in 1995 and decreased by 5 percent from 1994 to 1997.

Science and Engineering Graduate Students at DMOS Institutions

With these national trends in mind, we turn to the contribution of DMOS institutions to graduate enrollment and diversity in science and engineering. As shown in **Table 1**, Research I and II institutions enroll 44 percent of all graduate students and 59 percent in science and engineering. Doctoral institutions contribute about one-fifth of graduate enrollment, and the Master's-granting institutions account for 31 percent of the total population of graduate students and 17 percent of science and engineering students. Specialized institutions, consisting primarily of freestanding medical, health sciences, and engineering schools, contribute another 7 percent. In total, DMOS institutions enroll 56 percent of graduate students in all fields and 41 percent in science and engineering.

Well beyond enrolling 41 percent of science graduate students, DMOS institutions enroll a disproportionate fraction of women and minority graduate students. According to **Table 2**, DMOS institutions enroll 47 percent of women pursuing graduate degrees in science and engineering. For underrepresented minority groups the percentages are considerably higher. While accounting for 41 percent of science and engineering graduate enrollment, DMOS institutions enroll 47 percent of American Indian and 57 percent of African American and Hispanic graduate students.

One reason for this is the presence of Historically Black and Hispanic Serving institutions and regional systems such as the California State and CUNY systems that serve minority communities. There are 24 Historically Black institutions participating in the CGS/GRE survey and 19 in the DMOS category offer graduate programs in science and engineering. These 19 institutions account for 36 percent of African American science and engineering graduate enrollment at DMOS institutions.

In contrast, 75 percent of international students enroll at Research I or Research II universities. This is not surprising, considering that international students at the graduate level tend to enroll in full-time doctoral programs in science and engineering.

Minority Enrollment Trends at DMOS Institutions

Displayed in **Table 3** are data on changes in science and engineering enrollment at DMOS institutions over the 1986 to 1997 period. During those 11 years, graduate S&E enrollment for minority-group members increased markedly, rising by an average annual percent change of between 6 and 8 percent.[5] These large annual percent changes resulted in a more than doubling of enrollment for African Americans, American Indians, and Hispanics. Asian American enrollment in S&E fields increased a total of 81 percent over the 1986 to 1997 period. In contrast, White graduate enrollment increased by 17 percent over the same period.

While minority enrollment in all fields grew substantially over the 11-year period, several fields stood out as areas of particularly rapid growth. African American enrollment in engineering grew at a 14 percent annual rate, Hispanic enrollment in health science fields increased by 12 percent per year and health and social sciences increased by 11 percent per year for Asian Americans.

Moreover, the rapid increase in enrollment has resulted in increases in the percent share that minority groups are of total DMOS science and engineering graduate enrollment. In 1986, African American students accounted for 4 percent of all DMOS S&E enrollment; by 1997 they were 7 percent of the total. Similar increases were experienced by other minority groups, with the Hispanic share growing from 4 to 7 percent, the Asian share from 6 to 8 percent and the American Indian percentage rising as well.

Recent decreases in graduate enrollment have raised questions about whether enrollment for underrepresented groups will continue on its upward trajectory. The 1996 to 1997 percent change figures in **Table 3** shed some light on that issue. As previously noted, graduate enrollment at DMOS institutions appears to have reached a plateau, but has yet to decline. The Enrollment Survey data indicates a more unsettled situation is underway, with some groups increasing and others decreasing. In the last year, African American enrollment rose by 2 percent and Hispanic by 4 percent. In contrast, Asian and American Indian S&E

enrollment both decreased by 5 percent from 1996 to 1997.

First-Year Enrollment at DMOS Institutions

While trends in total enrollment provide a measure of the direction of the entire pool of enrolled students, first-year enrollment may be used as an early indicator of future trends. There has been much concern about minority student interest in graduate education in the post-Proposition 209/post-Hopwood era. For example, the Losing Ground report found decreases in first-year enrollment in some research-intensive institutions.

However, evidence from a sample of DMOS institutions responding to the CGS/GRE Survey of Graduate Enrollment survey indicates a different situation. While overall first-year enrollment in S&E fields did decrease from 1996 to 1997, first-year enrollment for members of most minority groups rose modestly. Although there was no change in American Indian first-year enrollment, first-year enrollment in S&E fields rose by 2 percent for Asians and African Americans and by 4 percent for the Hispanic group.

Summary and Discussion

In Greek demos means "the people," and is the root for English words such as democracy and demographics. DMOS institutions reflect the populist meaning of the Greek word, for these institutions are clearly "of the people." They are a widely diverse group of universities including many Historically Black and Hispanic Serving institutions. They form the center of graduate education in the United States, serving as the local institution where many Americans go to pursue graduate degrees. Moreover, they make a substantial contribution to graduate education and research, enrolling the majority of graduate students in all fields and more than two-fifths of students in science and engineering.

As well as being institutionally diverse, DMOS institutions enroll a disproportionate share of women and members of U.S. minority groups. While enrolling 41 percent of all students in science and engineering, they enroll 47 percent of the women, 57 percent of the African American and Hispanic graduate students, and 47 percent of the American Indian students.

Data presented here indicate that S&E graduate enrollment of minority-group members at DMOS institutions has increased substantially over the past 11 years. Moreover, the share that minority students are of graduate enrollment has increased as well. There is evidence of a slow-down in that growth trend, however, as the current attractive job market siphons-off potential graduate students. While it is difficult to predict where enrollment is heading, first-year enrollment trends at DMOS institutions indicate a slowdown in growth and a leveling-off in the future.

The contributions of DMOS institutions go well beyond the numbers of graduate students that they enroll. For many students-especially first-generation college graduates-a master's degree program at a DMOS institution is an opportunity to "try out" advanced study and research in science. It is at these regional institutions where students find that they are good at science, that they enjoy the challenge, and want to pursue it further.

This means that the Master's degree in science and engineering at a DMOS institution can serve a quite different role than a master's degree at a major research institution. Rather than being a consolation prize in a doctoral program, the master's degree is a sound step along the road to a career in science or to the doctorate. The diverse graduate student population at DMOS institutions should be considered fertile ground for corporate hiring and for research universities seeking to recruit high-quality students for doctoral programs.

References

Bowen, William G. and Neil L. Rudenstine. 1992. *In Pursuit of the Ph.D*. Princeton, NJ: Princeton University Press.

The Carnegie Foundation for the Advancement of Teaching. 1994. *A Classification of Institutions of Higher Education*. Princeton, NJ: The Carnegie Foundation for the Advancement of Science.

Davis, Paul W., James W. Maxwell, and Kinda M. Remick. 1998. 1997 AMS-IMS-MAA Annual Survey (Second Report). *Notices of the AMS*, 45-9: 1158-1165. October.

Malcom, Shirley M., Virginia V. Van Horne, Catherine D. Gaddy, and Yolanda S. George. 1998. *Losing Ground: Science and Engineering Graduate Education of Black and Hispanic Americans*. Washington, DC: American Association for the Advancement of Science.

Olson, Kristen. 1998. *Total Science and Engineering Graduate Enrollment Falls for Fourth Consecutive Year*. National Science Foundation, Division of Science Resources Studies:
Data Brief, December.

Syverson, Peter D. and Stephen R. Welch. 1997. G*raduate Enrollment and Degrees: 1986 to 1996*. Washington, DC: Council of Graduate Schools.

Footnotes

1. DMOS institutions are Doctoral, Master's, and Other Specialized institutions as classified in the Carnegie Classification system. For purposes of this analysis, the category also includes Baccalaureate institutions that have graduate programs in science and engineering fields.
2. The Carnegie Classification includes all colleges and universities in the U.S. that are degree-granting and accredited by an agency recognized by the U.S. Secretary of Education. For detailed definitions of Carnegie categories, please visit http://www.carnegiefoundation.org/cihe/cihe-dc.htm.
3. *The Ten Years Later* study is an ongoing research study at the University of California, Berkeley. The Co-Principal Investigators of this study are Drs. Maresi Nerad and Joseph Cerny.
4. Data on minorities refer to U.S. citizens and permanent resident minority graduate students only.
5. It is important to note that these percent change figures are based on small starting enrollment figures, so that a 5 percent increase may represent an increase of less than 500 students. Nevertheless, the strength and direction of the upward trend is important to recognize.

Back to top

MAKING STRIDES TOWARD STRUCTURAL REFORM

Research News On Minority Graduate Education (MGE)
Volume 1 Number 2

July 1999

Inside this issue:

Managing Editor:
Yolanda S. George

An Interview with **Dr. Carlos Castillo-Chavez**

By Virginia Van Horne
MGE Senior Research Associate

Each issue of *Making Strides* features a short interview with an underrepresented SME minority professor who has been instrumental in mentoring and encouraging students through all levels of the education pipeline, as well as demonstrating leadership and outstanding accomplishments in the world of SME.

I had the opportunity to chat with Dr. Carlos Castillo-Chavez, a Professor of Biomathematics at Cornell University, and Visitor, Institute for Mathematics and its Applications, University of Minnesota, Twin Cities (February-June 1999). A winner of two Presidential Awards, one in 1992 for faculty fellowship, and the other in 1997 for mentoring, Dr. Castillo-Chavez has published close to 60 research articles. He held a Catedra Patrimonial (Chair Professorship) at the Universidad Nacional Autónoma de Mexico from April 1998 through February 1999 and a Profesor Plenario (Chair Professorship) at the Universidad de Belgrano in Argentina since 1995. He is equally well-known for his research on resource management/ecology and epidemiology/ immunology as well as for his mentoring of students. Using a variety of outside funding, he founded the Mathematical and Theoretical Biology Institute for undergraduate research at Cornell to provide research opportunities for students. Most recently, in May 1998 he was named Distinguished Alumni at his undergraduate alma mater, the University of Wisconsin, Stevens Point.

Editor:
Virginia Van Horne
Art Director:
Ann Williams
Online Editor:
Maria Sosa

Making Strides is a quarterly (April, July, October, and January) research newsletter published by the American Association for the Advancement of Science, Directorate for Education and Human Resources Program. Its purpose is to share information about minority graduate education (MGE) in the fields of science, mathematics, and engineering. It is available in print and electronic format. Inquiries, information related to MGE, and all correspondence should be sent to the editor.

How did you become interested in mathematics?

It is somewhat of a long story. Although I have a Ph.D. in analysis and applied mathematics, it was theatre that was my first interest. My goal was to become an actor! Despite my doing well in math, and receiving encouragement from my father to study math, I had a genuine interest in music and theatre. When I graduated from high school, I began working full-time and took several math classes at the National Polytechnic Institute and some classes at the National Institute for Fine Arts and Theatre, both in Mexico City. When I was 19, I entered an acting contest, but I didn't win. Not being one of the top contestants caused me to change my focus from acting to returning to school.

In 1974, at the age of 22, I moved to the United States and settled in Wisconsin. I began working at a cheese factory and quickly realized that there would be more opportunities for me if I returned to school. I applied to the University of Wisconsin, Stevens Point, and was accepted.

Tell us about your experience as an undergraduate.

In 1976 I graduated. It was a short timeframe because my math credits and Spanish credits were transferred, and because I took an overload of courses, to include 11 credits one summer. I thought about studying theatre, but because of my thick accent and limited English, I opted to major in both Spanish literature and in mathematics. To fulfill my undergraduate foreign language requirement, I was able to take English as my second language. In fact, I was the very first student to be given this opportunity. This eventually turned into a program for other students who did not speak English as their first language and for English-speaking students who had deficient education.

I was one of two Latinos on the entire campus! The campus environment was friendly, but I was looked at with genuine curiosity by other students. For example, I can remember several people actually asking me why Mexicans were lazy. Consequently, I always felt that I had to prove something-to demonstrate that I was fully capable of obtaining my degree, despite my being of Mexican descent.

Did you encounter any road blocks?

I wanted to increase my courseload, enabling me to graduate in a shorter time period. Unfortunately, my Spanish professor, who was my advisor, would not allow me to take on this heavy load. I went over his head and obtained approval to take on more classes. Later, this same professor gave me a B in a Spanish reading course, although I deserved an A. I appealed the grade and won. (It should be noted that the entire appeal process took a period of two years.)

Another semester, I was $450 short on my tuition. I went to the financial aid office to ask for assistance, but was denied. Not being one to simply "give up," I approached Chancellor Lee Dreyfus. By strange coincidence, the Chancellor was available and alone in his office! I explained that I would have to drop out of the university if I did not receive assistance. He authorized financial assistance.

What did you do after graduation?

I got married and we moved Milwaukee. I wanted to pursue my education in mathematics and applied to many graduate schools (one being the University of Wisconsin, Madison), but was not accepted because my math background was weak. However, the Milwaukee campus accepted me. I began work on my master's degree and completed it in the summer 1977 and then began work on my Ph.D. in the fall.

During the summers (1977-1979), I worked at the University of Milwaukee's Spanish-speaking Outreach Institute, teaching math to local Latino students. A few years back, parents from the south side of town had a sit-in at the University and demanded their children be granted an opportunity to attend the university. As a result, the outreach institute was created.

The year 1979 became a turning point for me. My advisor invited me to a dinner event. During the course of the dinner, he questioned the validity of offering special treatment to Hispanics, Blacks and Native Americans. I was so taken aback that I did not immediately react. To this day, I regret not confronting him. Rather, the next morning, I attempted to change advisors. However, he prevented the change, stating that he would approve it only after I took and passed my Ph.D. oral qualifying exams, with him serving as chair of my Ph.D. committee. I did not agree with this and quit school in fall 1979.

Did you intend to return to school?

I had complete confidence in my ability to complete my degree. I worked at a bank at night and as a system's analyst in the day. I applied to a number of schools and was accepted by all of them. In fall 1980 I enrolled at the University of Wisconsin, Madison.

I finished my mathematics Ph.D. in 1984. (Of note, I actually completed my thesis problem in 1983, some time before I had passed my qualifying exams and before I had completed my course work.) At Madison, I was very fortunate to interact with a number of mathematics and biology professors who welcomed me into their academic and social community. It was a welcoming and encouraging environment. During my last semester-spring, 1984-I opted to take on biology courses because my thesis was somewhat related to ecology.

What happened after you completed your Ph.D.?

My wife had completed her Ph.D. in English Literature; we were both looking for academic positions. The University of Tulsa was able to offer us two positions. During this time, Simon Levin, a biomathematics professor at Cornell (now at Princeton), offered me a postdoctoral position in the section of ecology and evolutionary biology. He was also able to get a half-time appointment for my wife in the writing program. Consequently, we took the offer and began our careers at Cornell in 1985.

How did you meet Dr. Levin?

I was familiar with his work. In 1984 I wrote to him about a position, but he had no openings. I contacted him again in 1985. Consequently, he interviewed me. I always had an interest in applications. I wanted to be able to contribute my skills in a direct way; applied mathematics-as opposed to pure mathematics-seemed the way.

Please describe your role at Cornell.

I worked with Dr. Levin for three years as a postdoc. He is an incredible mentor-he taught me a number of things: ecology and evolutionary thinking, how to write, how to be a better person, etc. He encouraged me to attend meetings and interact with visitors. In 1987 I began working on HIV research and began to amass a number of publications. In 1988, I applied to several academic positions around the country and received several offers, including one from the Harvard School of Public Health and two from Cornell. I accepted the offer to join the Cornell biometrics department.

The majority of my early career at Cornell was spent on research. However, in 1990 I joined a university committee on affirmative action, and served as Chairman from 1991-

94, and as co-Chair from 1995-96. We directly created at least four minority faculty positions, and indirectly influenced the creation of several more. This committee is still in existence.

In 1989 I received two grants¾one from NIH and one from NSF. I was the first faculty member in my department to be the recipient of an RO1 grant. In 1991 I was promoted to associate professor with tenure and in1992 I won a Presidential Faculty award (a first for Cornell) and received a half-million dollars to continue my research.

You also received a Presidential Award for Mentoring in Science & Engineering in 1997. How did you become involved with students?

In 1996, I did limited teaching. To be frank, I was challenged by Frank Gomez (then a postdoc at Harvard, now a chemistry professor at Cal State, Los Angeles) to do something for underrepresented students. I was not familiar with the Society for the Advancement of Chicanos and Native Americans (SACNAS). Frank challenged me to start a northeast chapter of SACNAS. One thing lead to another. A chapter was born and I was named its first president (1993-1996)! Afterwards, I served on the SACNAS board of directors from 1995-1996.

As a result of my work with SACNAS, I began a summer program (now known as the Cornell-SACNAS Mathematical Sciences Program) which helped to establish the Cornell Mathematical and Theoretical Institute. The program is designed to encourage undergraduates to pursue advanced degrees in math and sciences and facilitate access to graduate studies for Chicano, Latino, Native American, and other minority students in the sciences through a training program that includes a series of small group research projects. A program based on mathematical training and mentorship is also offered. The role models are nationally recognized Chicano, Latino, and Native American professors as well as successful young faculty, providing the students with a unique mentoring experience.

Additionally, I've been mentoring many women-around the country-for many years as my postdoctoral students or in an informal role.

Thank you Dr. Castillo-Chavez.

For further information on the summer program, please visit http://www.biom.cornell.edu/MTBI/index.html. For further information on SACNAS, please visit http://www.sacnas.org.

MAKING STRIDES TOWARD STRUCTURAL REFORM

Research News On Minority Graduate Education (MGE)
Volume 1 Number 2

July 1999

Inside this issue:

Managing Editor:

A Profile of an MGE Institution: University of Michigan

By Shirley M. Malcom
Head, AAAS Directorate for Education and Human Resources Programs

One can tell a lot about an institution by being present during its ritual time of celebration. At the University of Michigan in spring 1999 the sheer size of the institution was apparent just by the number of different commencements that it held, systematically pulling together the graduates and their families from public health or engineering or the Rackham School of Graduate Studies. With a fall 1998 enrollment of 6,684 in engineering, over 6,400 graduate students and nearly 17,000 Literature, Science and Arts majors, it is not surprising that the main commencement exercises fill half of the giant Michigan Stadium which seats some 110,000 persons.

In 1997-98 the University of Michigan received over $491 million in research expenditures, with 65% provided from federal sources. Major research universities have major research resources. The challenge remains one of making research resources available to as many students as possible. In science and engineering the challenge is one of integrating research and education in ways that make it clear that doing research is integral to doing science, at any level.

Research in undergraduate education was a topic addressed at the Jerome Weisner Symposium that University of Michigan sponsored in March 1999. Studies support the importance of undergraduate research participation as key motivator and predictor of minority graduate participation. As a component of its MGE program , Michigan sponsors a Summer Research Opportunity Program at Ann Arbor to provide an eight-week research experience and provide opportunity for presentation for students from historically Black and Hispanic serving institutions.

Many non-Michigan residents might be surprised (as I was) to learn that the University owes its founding in 1817 in large

Managing Editor:
Yolanda S. George
Editor:
Virginia Van Horne
Art Director:
Ann Williams
Online Editor:
Maria Sosa

Making Strides is a quarterly (April, July, October, and January) research newsletter published by the American Association for the Advancement of Science, Directorate for Education and Human Resources Program. Its purpose is to share information about minority graduate education (MGE) in the fields of science, mathematics, and engineering. It is available in print and electronic format. Inquiries, information related to MGE, and all correspondence should be sent to the editor.

part to a grant of 1,920 acres of land ceded by the Ojibwa, Ottawa, Potawatomi and Shawnee people "for a college at Detroit." The land was later sold and the proceeds became part of the university's permanent endowment when it moved to Ann Arbor in 1837.

The advantages of large size, large resources and large range of program opportunities must be coupled with departments, programs, living and learning communities that "shrink the institution" to a manageable size for the students. I met staff from various programs and colleges with responsibilities for woman and/or minorities in science and/or engineering, staff dedicated to identifying ways for the institution to identify, recruit and retain these students for SME fields. As with a number of similarly sized and resourced public universities, the University of Michigan also faces a lawsuit challenging a number of its practices aimed at diversifying the institution's student population. The university has indicated its intentions to document the value of diversity to meeting its educational mission and its web site (http://www.umich.edu/~newsinfo/Admission/admiss.html) has links to information on admissions lawsuits, including the full text of a study and expert witness testimony by Professor Patricia Gurin, Interim Dean of the College of Literature, Sciences and the Arts.

Watching as each doctorate was hooded, named and marched across the stage to the cheers of family and friends one could not help but be struck by the small number of minority doctorate recipients in science and engineering fields. And yet we are aware statistically that the university is a major contributor to the doctoral pool, ranking in 1996 as number five in Ph.D.s awarded to Blacks, number nine in awards to Latinos, and number 15 as a baccalaureate origin institution for African American doctorates .

"Eyeballing" rather than counting the number made it feel sparse; the trickle of underrepresented minority students was visible as the trickle from a talent pool that 25 to 30 years ago held out the promise for a diverse future faculty. I make these remarks by way of observation rather than criticism since, in fact, Michigan rates high marks for effort as well as for accomplishment, producing over 4% of the total Black SME Ph.D. output in 1996, for U.S. citizens and permanent residents. I even saw a newly minted African American Ph.D. in computer science, among the rarest of doctorates. I then remembered Walter Massey's AAAS Presidential address where he challenged university departments just to double their current Ph.D. output (+ one for those cases with zero current output) and wondered what would happen to this profile nationally if we just heeded his advice.

Note: Shirley Malcom was the commencement speaker for the Rackham Graduate School and honorary doctorate recipient at the Spring 1999 University of Michigan commencement

For information on the University of Michigan's MGE program, please visit: *http://www.rackham.umich.edu/Fellowships/nsf.html*

MAKING STRIDES

Research News On Minority Graduate Education (MGE)
Volume 1 Number 2

July 1999

Inside this issue:

Managing Editor:
Yolanda S. George

The Human Capital Liabilities of Underrepresented Minorities in Pursuit of Science, Mathematics and Engineering Doctoral Degrees

By Michael T. Nettles, Ph.D. and Catherine M. Millett, Ph.D., University of Michigan, Ann Arbor

Introduction   Research Design and Methods   Findings   Conclusion

I. Introduction

Throughout their lifetimes, students accumulate assets in the form of knowledge, cultural and social experiences that when taken altogether becomes their human capital. Their social-class standing and quality of schooling and quality of their non-school related activities during childhood and adolescence contribute to their asset accumulation by providing access to knowledge and opportunities for social and cultural involvement in society. As students progress through successive stages of life and education they build more capital for use in future stages of life and education. The higher one's social-class status and their quality of schooling, the more human capital they develop and accumulate and the greater access they gain to high quality colleges and universities and doctoral programs, and the better prepared they are to succeed in doctoral programs.

Human capital development may be a critical element in the race group differences that we observe in higher education and in the workforce. The extent to which the important components of human capital and the racial differences can be identified, the greater the likelihood that colleges and universities will be able to attack them as barriers to equality in access, performance and achievement.

This paper presents some of the findings from a national study of doctoral students sponsored by the Spencer Foundation , in which many components of human capital and their effect upon student experiences and achievement

Editor:
Virginia Van Horne
Art Director:
Ann Williams
Online Editor:
Maria Sosa

Making Strides is a quarterly (April, July, October, and January) research newsletter published by the American Association for the Advancement of Science, Directorate for Education and Human Resources Program. Its purpose is to share information about minority graduate education (MGE) in the fields of science, mathematics, and engineering. It is available in print and electronic format. Inquiries, information related to MGE, and all correspondence should be sent to the editor.

were examined. The research was aimed toward assessing the backgrounds, finances, experiences, progress and performance of doctoral students, and the relationship of their backgrounds and finances to the quality of their experiences and performance in doctoral programs. The research was also structured to identify race, sex, social class and other demographic distinctions among doctoral students on a broad array of variables and to show how these differences relate to differences in their progress and performance.

The study grew out of the need to fill the void of data and information about human capital assets of doctoral students such as their current and past family and personal characteristics and educational processes and experiences. The needed data and information also include the types of support they have received, their satisfaction, performance and their opinions and behaviors while pursuing their doctoral degrees. Much is known about people who seek to enter graduate programs through the Graduate Record Examinations Board's Background Information Questionnaire (BIQ) which accompanies the Graduate Record Examination (GRE). Even more is known about students when they successfully complete doctoral programs through The National Research Council's (NRC) Survey of Earned Doctorates and later on in their careers through the NRC Survey of Doctoral Recipients. Very little is known, however, about doctoral students while they are in the process of pursuing their doctoral degrees. The GRE/BIQ is limited because no effort is ever devoted to following up the examinees to identify if they apply, where they apply, where they are accepted, whether they go on to graduate school and if so, where they go. The two NRC surveys include only those students who successfully complete their doctoral programs, and even for those not much is asked about their pre-collegiate and collegiate experiences, or their experiences during their doctoral programs.

The low representation of African Americans and Hispanics enrolled in U.S. graduate programs and receiving doctoral degrees is very well documented. African American and Hispanic doctoral students are underrepresented in every field, and they are most severely underrepresented in science, mathematics and engineering, and among the nation's highest quality doctoral degree programs. Increasing their representation, however, is only part of the challenge that the nation's leading graduate schools are facing.

Beyond being underrepresented, the African American and Hispanic students who are enrolled in doctoral programs may also be lagging behind their majority and Asian contemporaries on human capital in such areas as their background characteristics as well as their academic and social preparation. They may also be lagging behind in funding support, quality of experiences in doctoral programs, and their rates of progress and performance in doctoral programs. It is very important for graduate school leaders to identify the areas of African American and Hispanic underrepresentation in doctoral programs and to develop strategies to increase the number and the representation. But, equally important is the need to identify gaps in progress, performance and the quality of training and experiences and to seek ways to eliminate the gaps. One strategy may be to eliminate or compensate for the deficits in human capital that African American and Hispanic students reveal. The first challenge is to identify these gaps. Then educators, policymakers and others will know where to aim their efforts toward improvement.

Introduction Research Design and Methods Findings Conclusion

II. Research Design and Method

This research was conducted to measure a myriad of factors including many that are believed to be related to student progress and performance generally, and critical for the success of underrepresented minorities in both science and non-science oriented doctoral programs. This involved collecting information on the personal, family, social and academic backgrounds, experiences and performance of doctoral students prior to, during and since undergraduate school. Among the most important performance emphases of the research were upon ascertaining the extent to which students are acquiring teaching and research skills, developing skills and experience of scholarly inquiry, publishing both independently and in collaboration with professors, and being socialized to succeed in a chosen profession after graduating.

The research has been conducted in collaboration with the Graduate Deans and researchers at a variety of (twenty-one) of the nation's most prestigious doctoral granting universities. The universities are presented in Table 1. The research involved administering a survey to a diverse and representative sample of 13,160 doctoral students, spread among the 21 universities. To be selected as a participant in the study, students had to have completed at least one year of their doctoral program and be registered for at least six credit hours in the fall of 1996. Students also had to be enrolled in one of the following eleven fields of study: biological sciences, economics, education, engineering, English, history, mathematics, physical sciences , political science psychology and sociology. The sample was designed to select all of the African Americans, Asian Americans, Hispanics and Native Americans, three hundred whites (randomly selected) and one-half of the international students (randomly selected) enrolled in these eleven fields.

Table 1: Participating Institutions in the Study Assessing Underrepresented Minority Student Experiences and Success in Doctoral Programs

City University of New York	Teachers College
Clark Atlanta University	Temple University
Columbia University	University of California, Berkeley
Harvard University	University of California, Los Angeles
Howard University	University of Maryland at College Park
Indiana University	University of Michigan
New York University	University of North Carolina at Chapel Hill
Ohio State University	University of Texas at Austin
Princeton University	University of Wisconsin at Madison
Rutgers University	Vanderbilt University
Stanford University	

Each of the 13,160 students received in the mail the Survey of Doctoral Student Finances, Experiences, and Achievements (SDSFEA), which was developed by Nettles and Millett expressly for this study. The SDSFEA is a twenty eight page survey instrument that asks students to provide a plethora of data and information about their backgrounds, current status and activities, academic progress and performance, attitudes and behavior. The SDSFEA also invites students to provide commentary in various places on the instrument. Many students even provided extensive prose on enclosures to accompany their survey responses. The SDSFEA also requested the students to give the researchers permission to retrieve their GRE files from the Educational Testing Service, which includes their score reports and their responses on the BIQ. The overall response rate was 70%, yielding 9,040 usable surveys for the analyses.

The results and findings reported in this paper are limited to the students in the survey who were identified by their institution and who identified themselves on the SDSFEA as pursuing their doctorates in one of the biological or physical sciences, or in mathematics or engineering. Because the emphasis of this paper is upon underrepresented minorities in science, mathematics and engineering in the United States, the U.S. citizen component of the sample is the focus and international students are not included in the analyses. For the three field grouping (science, math and engineering) of U.S. citizens the sample size is 1,891. The race distribution overall is 114 (6%) African Americans, 382 (20%) Asians, 94 (5%) Hispanics and 1,301 (69%) Whites. The analyses for this paper are descriptive. The data are presented with narrative that describes the data for the four race groups of students showing how they compare with each other on a variety of characteristics, experiences and performance within and across the major fields. Approached in this way of working sequentially to assess and contrast groups on numerous variables, a puzzle emerges, which, when completed, reveals a profile of typical doctoral students from each of the four race groups and their accumulation of human capital and performance. When these profiles are contrasted, the reader should have a visual image of how students of different racial groups are alike and different from one another. The reader might then proceed to the next step of imagining what actions could or should be taken to eliminate or compensate for the deficits in performance and progress that are identified among underrepresented minorities. The principal questions to be addressed in the analyses are the following two:

- 1. What are the similarities and differences in measures of human capital among doctoral students of various racial/ethnic groups?
- 2. What are the similarities and differences in the performance and development among doctoral students of various racial/ethnic groups?

Introduction Research Design and Methods Findings Conclusion

III. Findings

This section presents the findings by describing the personal and academic backgrounds, the academic preparation and undergraduate experiences, the transitions from college to the doctoral programs, and the doctoral program experiences and performance of the science/mathematics and engineering doctoral students. For these analyses biological science, physical science and mathematics doctoral students are combined to comprise one group called science/mathematics and the other group is engineers. In addition to contrasting science/mathematics students against engineers, overall, the analyses center upon racial group comparisons both within and across the two major fields.

Background Characteristics

The background characteristics collected by the SDSFEA include the age, race and sex of the doctoral students and the educational and occupational status of their parents. The focus in this paper is upon the socio-economic background distinctions across the four race groups and two field groups. Parents' educational and occupational status are the indicators of the socio-economic status background at least prior to entering college, but for most it covers their college years, and for some it even represents their graduate school social class. Socio-economic status measured in this way is a very important reflection of the exposure they have had to higher levels of education throughout their lives, and is perhaps a good indication of their own educational expectations and aspirations.

Parental Educational Attainment

Mother's Education: In both science/math and engineering, the mothers of Asians and Whites are more likely to have at least a bachelor's degree than both African Americans and Hispanics. In both fields around 60% of the mothers of Asian and White doctoral students had completed at least a bachelor's degree. In science/mathematics, 46% and 45% of the mothers of African Americans and Hispanics, respectively, had received at least a bachelor's degree. The difference between Asian/Whites and African Americans/Hispanics is smaller in the engineering field because of the higher attainment of the mothers of African American and Hispanic engineering doctoral students compared to their counterparts in science/mathematics. Approximately 56% of the mothers of Hispanic engineering doctoral students had completed a bachelor's degree as had 52% of the mothers of African Americans. It is interesting that about 30% of the mothers of both White and Asian doctoral students in science/mathematics and in engineering had completed either a graduate or professional degree, compared to 26% of the mothers of Hispanics but only 20% of the mothers of African Americans (See Table 1A and Table 1B).

Father's Education: With the exception of African Americans in both major field groupings and Hispanics in engineering, the fathers appear to have higher educational attainment than the mothers, but the patterns remain the same as with mothers. As with doctoral students' mothers, the Hispanic and Black doctoral students are less likely than their Asian and White peers to have a father that has completed at least a Bachelor's degree. The difference is especially striking with respect to the fathers of African Americans compared to Asians and Whites. The fathers of Asian and White doctoral students in the science/math field grouping are more than twice as likely to have a father with at least a bachelor's degree relative to Black doctoral students in science/math. Over 70% of the fathers of Asian and White doctoral students in science/mathematics and over 77% in engineering have completed at least a bachelor's degree. Over 46% of the fathers of Asians and 50% of the fathers of White doctoral students in science/mathematics, and over 49% of each in engineering had completed a graduate or professional degree. About sixty percent of the fathers of Hispanic sciences and mathematics doctoral students and 57% in engineering had completed at least a bachelor's degree. Around 42% of the fathers of Hispanic doctoral students in sciences and mathematics and 31% in engineering have completed a graduate or professional degree. Thirty five percent of the fathers of African American science/mathematics doctoral students and 49% in engineering had completed at least a bachelor's degree. Only 17% of the fathers of African American doctoral students in science/mathematics and 33% in engineering had completed graduate or professional degrees (See Table 2A and Table 2B).

It is reasonably clear from these data that the engineering doctoral students are more likely to have parents with higher degrees than their peers science/mathematics. It is also clear that African Americans are least likely among the four race groups to have parents with the highest degrees.

Parental occupational status

Parents' occupation was measured using seven categories arranged in a hierarchical structure that is associated with both income and status. Examples of types of occupation in the seven categories are 1) homemaker, 2) laborer etc., 3) truck driver etc., 4) electrician etc., 5) small business owner,

6) mid-level business person etc., and 7) business executive etc..

Mother's Occupation: African Americans lead the four race/ethnic groups in mothers' occupation. The mothers of African American science/mathematics and in engineering doctoral students are more likely to be employed in the two highest employment categories-53% of the mothers of science/mathematics students and 50% of the mothers of engineering students. The mothers of Asian doctoral students are most likely to be in the highest category-15% of the mothers of science/mathematics students and 17% of the mothers of engineering doctoral students. Fifty-two percent of the mothers of Asian science/mathematics doctoral students and 43% in engineering fall into the highest two employment categories, compared to 46% of White science/mathematics and 45% of White engineering students and 42% of the mothers of Hispanic science/mathematics students and 39% of Hispanic engineering students.

At the other extreme, with the exception of African Americans, the mothers of engineering doctoral students are more likely than their science/mathematics peers to have mothers who were homemakers. Forty-eight percent of the mothers of Hispanic engineering doctoral students were homemakers followed by 34% of the Asians, 31% of the Whites and only 6% of the African Americans. Among mothers of science/mathematics doctoral students, 24% of the mothers of Hispanic students, 26% of the mothers of White students, 22% of the mothers of Asians and 17% of the mothers of African American students were homemakers (See Table 3A and Table 3B).

Father's Occupation: Among fathers of science/mathematics and engineering doctoral students, the fathers of Asian and White doctoral students are more likely to have the highest occupational categories followed by the fathers of Hispanics and then African Americans. Among science/mathematics doctoral students, 72% of the fathers of Asian students, 68% of the fathers of White students, 60% of the fathers of Hispanic students and only 38% of the fathers of African American students fall within the highest two occupational categories. Similarly, among engineering doctoral students, 73% of the fathers of Asian students, 71% of the fathers of White students, 59% of the fathers of Hispanic students and 46% of the fathers of African American students are employed in the top two occupational categories (See Table 4A and Table 4B).

Undergraduate performance and experiences

Undergraduate education is considered to be the place where students build the foundation and the academic and even social preparation for their doctoral program experiences. This study includes a variety of measures of students' undergraduate educational experiences that try to capture the quality of their experience, the match between their undergraduate preparation and their doctoral program, their academic performance, and their financial condition resulting from their undergraduate experience. At this juncture the focus is upon the selectivity of undergraduate institution and grade point average. Together these two measures provide a general indication of the quality of undergraduate preparation for doctoral students. The major field of study will be analyzed later in the paper.

Undergraduate Selectivity: Undergraduate selectivity of undergraduate institution is measured by the average SAT/ACT, the high school GPA and class rank of the entering class of first-time full-time freshmen as calculated by the Baron's Guide. Across the four race groups, engineering students attended more selective undergraduate colleges and universities than science/mathematics students. In general, Asian and White doctoral students attended more selective undergraduate colleges than Hispanics and, especially, African Americans. A higher percentage of Asian engineering doctoral students (64%) attended the most competitive colleges and universities (SAT range* from 625 to 800), followed by Asian science/mathematics students (57%), White engineering students (55%), White science/mathematics students (52%). A larger share of Hispanic students attended the most selective colleges and universities than African Americans. Over 47% of Hispanic engineering students, 40% of Hispanic science/mathematics students, 33% of African American engineering students and 17% of African American science/mathematics students received their baccalaureate degrees from the nation's most selective colleges and universities. In addition, African American doctoral students are much more likely to have graduated from the least selective colleges and universities than the other three racial groups. Over 25% of African American science and math doctoral students and 24% of the engineering doctoral students attended the least selective undergraduate colleges and universities. Across both fields, no more than six percent of any other race attended a Non and Less Competitive undergraduate institution (See Table 5A and Table 5B).

Undergraduate Grade Point Average: Undergraduate cumulative grade point averages (GPA) are reported on the typical four-point scale for all courses taken in college combined. Somewhat similar to selectivity, engineering doctoral students overall report having a higher cumulative GPA than science/mathematics doctoral students. The exception is among African Americans where science/mathematics students report a slightly higher GPA (3.4) than the engineering students (3.3). Among engineering doctoral students the average undergraduate GPA for Hispanics was 3.76 followed by Whites at 3.72, Asians at 3.69 and African Americans at 3.30. Among science/mathematics doctoral students the White and Asian doctoral students have the highest undergraduate GPA at 3.64 and 3.63, respectively, followed by the Hispanics at 3.54 and the African Americans at 3.40. As with other background and undergraduate measures, African Americans have the lowest scores, but there seems not to be much difference between Hispanics and the Asians and Whites on undergraduate GPA in either field (See Table 6).

Preparation and Transition to Doctoral Programs

Three important measures of doctoral students' preparation and transition into graduate school are their GRE scores, the amount of time between their baccalaureate and entering a doctoral program, and the extent to which their undergraduate and graduate major fields match.

GRE Scores: Students in the sample reported their GRE Analytical, Verbal and Quantitative scores on the SDSEPA. The analyses in this paper focus upon the race group average scores for the combined GRE Verbal and Quantitative components. The engineering students reported higher scores than their science/mathematics peers for each of the four race groups. In both fields, Whites report the highest scores (1382 in engineering and 1367 in science/mathematics), followed by Asians (1358 in engineering and 1331 in science/mathematics), Hispanics (1265 in engineering and 1278 in science/mathematics), and African Americans (1252 in engineering and 1131 in science/mathematics). Looking at the Quantitative section of the GRE in isolation, a slightly different pattern emerges. In both fields, Asians have the highest average test scores (740 in Science and Math and 753 in Engineering) instead of Whites (724 and 749, respectively). Hispanics (687 and 716, respectively) and African Americans (598 and 675, respectively) follow these two groups (See Table 7A and Table 7B).

Time Off: Students in the science/mathematics disciplines appear to be more likely to enter their doctoral programs closer to the time that they complete their bachelor's degree than their engineering counterparts. Among the four race/ethnic groups in both science/mathematics and engineering, Hispanics take the shortest time after completing their baccalaureate degree to enter their doctoral programs. A higher percentage of Hispanic and White science/mathematics doctoral students (both 64%) go immediately into their doctoral programs, followed by Asians (60%) and African Americans (55%). Hispanics are most likely to enter a doctoral program within 4 years after obtaining their Bachelor's degree (96%), followed closely by Whites (90%) and Asians (89%). African Americans are least likely to enter within 4 years (80%). The average amount of time off for Hispanic science/mathematics doctoral students is 1.5 years, 1.7 years for Whites, 1.88 years for Asians and 3.92 years for African Americans (See Table 8A, Table 8B and Table 8D).

Experience as an employee in the workforce before entering a doctoral program may be valued more in the field of engineering than in science/mathematics among doctoral students. The percentage of students who enter immediately following undergraduate programs is lower among engineers. A higher percentage of Hispanic engineering doctoral students (46%) go immediately into their doctoral programs after completing their bachelor's degrees, followed by Whites (36%), African Americans (36%) and Asians (25%). Around 96% of Hispanic engineering doctoral students enter their doctoral programs within four years of completing their bachelor's degrees, compared to 78% of Asians, 77% of Whites and 71% of African Americans. The average time off for Hispanic engineering doctoral students was 1.5 years, 2.82 years for Asians, 2.85 years for African Americans and 2.89 years for Whites (See Table 8A, Table 8C and Table 8D).

Undergraduate and Graduate Major Field: By contrasting the undergraduate major with the graduate major fields one gains a sense of the degree to which students' undergraduate experiences prepared them for their graduate programs. The vast majority of the students in both science/mathematics and engineering indicated having the same major fields at both levels and there appears little difference among the four race groups. Ninety three percent of the Asian and Hispanic science doctoral students, 90% of the Whites and 86% of the African Americans have the same fields at both the undergraduate and doctoral levels. Similarly, 96% of Hispanics, 92% of Asians, and 85% of African Americans and White engineering doctoral students have the same majors in their undergraduate and doctoral programs (See Table 9).

Doctoral Program Outcomes

While there are many measures included in the SDSFEA that may be used to assess the performance of doctoral students, the focus in this paper is on two general ones: 1) doctoral grade point average, and 2) research activities undertaken as a doctoral student. The former is important since grade point average is a common measure of how well a student has learned discipline-specific course information. Presumably, this information will be drawn upon as the student completes the dissertation as well as later in the career. The latter measures whether a student has completed three specific research activities that are intended to closely match the type of work that the student will perform in their future career.

Doctoral Grade Point Average: The differences in doctoral GPA are relatively small across fields and race groups. Doctoral grade point averages, however, are uniformly higher in engineering vis-à-vis science and math, across all racial groups. Further, in both fields, African Americans report the lowest grade point average, though differences in absolute GPA seem relatively small. In science/mathematics, Hispanics have the highest GPA at 3.65, followed by Asians (3.48), Whites (3.45) and African Americans (3.41). In engineering, a similar pattern obtains as Hispanics have the highest GPA at 3.78; Asians (3.76), Whites (3.75) and African Americans (3.61) follow (See Table 10).

Doctoral Student Research Activities: With respect to research related activities undertaken as a doctoral student, large racial differences exist with respect to African Americans, but these racial differences, while quite large in the science and math field, are much smaller in engineering. One potentially important activity for doctoral students to partake in is presenting a research paper at a professional conference. In science/mathematics, a smaller percentage of African American and Hispanic doctoral students (21 percent and 16 percent, respectively) report having presented a research paper at a professional conference than Asian and White students (33 percent and 29 percent, respectively). In engineering, the differences are much smaller. Around 48 percent of Hispanics and 52 percent of African Americans compared to 53 percent of Asians and 59 percent of Whites have presented a research paper at a professional conference. While the White and Asian percentages remain higher than the Hispanic and African American percentages, the differences are much smaller than those in science and math, as reported above (See Table 11A and Table 11B).

Another important research activity is the publishing of academic papers. The first stage in publishing papers is submission to relevant journals. In the science and math field, there are substantial racial differences in who has submitted at least one research article for publication in a professional journal. Hispanics (49%), Asians (57%) and Whites (54%) are all more than twice as likely as African Americans (24%) to have submitted an article. This suggests that African Americans are not receiving the opportunity to actually publish articles in professional journals, relative to the other races. The differences in engineering are much smaller and nearly non-existent. Whites lead the way with 73 percent reporting that they have submitted an article for publication, they are followed closely by African Americans (71%) and Asians (68%). Hispanic engineers are the least likely to have submitted an article at 60.9 percent. With respect to actually publishing academic papers, the large racial differences in submission seen in science and math persist. As with science/mathematics Hispanics (42%), Whites (46%) and Asians (48%) are all more than twice as likely to have published a research article in a professional journal than African Americans (18%). Engineering shows a much different picture with Hispanics at 52%, African Americans and Whites at 47%, and Asians at 45%. (See Table 11A and Table 11B).

Introduction Research Design and Methods Findings Conclusion

IV. Conclusion

The analyses presented in this paper are an important first step toward identifying the gaps in both human capital and performance between under-represented science/mathematics and engineering doctoral students and among four race groups of doctoral students. What emerges thus far is a rather strong impression that there are clearly human capital differences between the major fields and among the race groups. Engineering doctoral students have more human capital than their science/mathematics counterparts. As a group, engineering doctoral students have parents with a higher level of education and occupation, have attended the most selective colleges or universities, have a higher college grade point average, have higher GRE scores, and are more likely to have worked at a job between the time that they graduated from college and entered their doctoral programs than science/mathematics students. Engineering doctoral students in each of the four race/ethnic groups have amassed a greater amount of human capital and research productivity than their science/mathematics counterparts.

Among the four race/ethnic groups, a human capital status hierarchy emerges in which White and Asian doctoral students possess the greatest amount of human capital and research productivity followed by Hispanics, and then African Americans. With the exception of mothers' occupational status, African American doctoral students present the lowest human capital and research productivity among the four race groups in each of the two major field groups. Doctoral grade point averages appear to be of little use for discriminating by major field or by race. The doctoral grade point average data presented in this paper suggest that both science/mathematics and engineering doctoral students are performing at a high level in their courses-work. Research productivity may be a more important performance indicator for doctoral students than grades because they reflect the extent to which students are acquiring the research skills they need to progress in their careers. In contrast to doctoral grade point average, research productivity yields greater discrimination and African Americans in science/mathematics are half as likely to publish research during their doctoral programs as their peers of other race groups and are half as likely to submit papers for publication. It is important to note that nearly three-quarters of African American doctoral students in engineering are submitting papers for publication and a higher percent are succeeding in publishing.

The actions that colleges and universities and African American science/mathematics doctoral students may take to address the lower success of African American students may be in part identified by examining more closely the African American engineering students and the factors that are of benefit to them. Another approach would be to address their deficits in human capital. Regression analyses in which numbers of papers published is the dependent variable, fathers' occupation emerges as the most important contributor to publishing. The higher fathers' occupation the higher the publication rate. Colleges and universities may target students whose fathers have lower occupations for encouragement and support for publishing. Both sex and race also emerge to be significant predictors of publishing with women and African Americans being significantly less likely. Even after controlling for human capital assets, African Americans and women need greater encouragement and support toward publishing in order to achieve equality of performance with their male and White, Asian and Hispanic contemporaries. Thus, while Human capital is very important for doctoral student performance, focusing upon the components of human capital alone is not sufficient. Colleges and universities will likely yield greater benefit from focusing upon improving the performance of women and African Americans.

*Range refers to the average of the median verbal reasoning and median mathematics reasoning non-recentered test scores on the SAT I.

Back to top