Measuring Graduate School Recruitment and Retention

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Abstract This paper reports on findings from an evaluation capacity building project with graduate schools that are awardees of the National Science Foundation (NSF) Alliance for Graduate Education and Professoriate (AGEP). An evaluation framework for the AGEP Program was developed based on the objectives of increasing the number of minority students pursuing advanced study, obtaining doctoral degrees, and entering the professoriate in science, technology, engineering and mathematics (STEM) disciplines. Underrepresented minority (UM) students include students who are African American, Hispanic American, and American Indian/Alaskan Native/Pacific Islanders. Data for academic years 1996-1997 through 2002-2003 were received from 63 AGEP graduate institutions participating in 26 different alliances. Data are presented on (a) changes in the percent of UM student who are new enrollees in graduate schools for the pre and post-period and (b) changes in the percent of UM graduate students in the total STEM graduate student population for the pre and post period. Since time to STEM PhD degree is 6.5 to 7 years, we have not yet examined changes in PhD degrees earned and post-PhD employment plans because it is to early to attribute these changes to the AGEP Program.

Introduction, Goal, and Methods

The U.S. continues to suffer from a long-standing underrepresentation of minorities (i.e., African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians or other Pacific Islanders) among science, mathematics and engineering doctorates. This untapped talent has serious consequences for the nation's ability to compete in a world economy driven by technological advances, as well as for a large segment of the nation's citizens who suffer loss of opportunity. This underrepresentation is evident in all sectors: academe, industry, and government. Over the years, both government and private sectors have invested significant resources to increase minority representation in STEM graduate programs and the PhD workforce. While some exemplary programs exist, limited progress has been made overall (NSF, 2004).

The National Science Foundation (NSF) Alliances for Graduate Education and the Professoriate (AGEP) program is intended to increase significantly the number of students receiving doctoral degrees in the sciences, technology, engineering, and mathematics (STEM), with special emphasis on those population groups underrepresented in these fields (i.e., African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians or other Pacific Islanders). In addition, since lack of role models and mentors in the professoriate constitutes a significant barrier to producing minority STEM graduates, NSF is particularly interested in increasing the number of minorities who will enter the professoriate in these disciplines (NSF 2004). Since

1998, AGEP has given twenty-six awards to alliances of doctoral degree granting institutions and their partners.

The primary goal of the project described in this paper was to identify and pilot an evaluation framework to examine the progress of graduate institutions that receive AGEP funds with a particular emphasis on the degree to which they increase the number of underrepresented minority students pursuing advanced study, obtaining doctoral degrees, and entering the professoriate STEM disciplines.

In addition the project is working on ways to both document and assess the impact of comprehensive institutional cultural changes that may lead to sustained increases in the conferral of STEM doctoral degrees, significantly exceeding historic levels of performance" as related to UM graduate students..

To do this, our work builds upon the ongoing research studies of the American Association for the Advancement of Science and Commission for Professionals in Science and Technology in the area of STEM minority graduate education, as well as upon the work of other researchers in this area. Our research design is similar to those used for *Investing in Human Potential: Science and Engineering at the Crossroads* (Matyas and Malcom, 1991) and *Losing Ground: Science and Engineering Graduate Education of Black and Hispanic Americans* (Malcom, Van Horn, Gaddy, and George, 1998).

To develop the AGEP evaluation framework, a community development process was used, including:

- A meeting with evaluators and selected recipients of AGEP awards/cooperative agreements, including faculty and deans; held in November 2002.
- A focus group held at the NSF Human Resources Development Meeting in March 2003 and 2004.
- Site visits to five AGEP campuses from March to June 2003. Teams of site visitors included selected participants from the November 2002 study group meeting, including graduate deans, evaluators and researchers, faculty, and AGEP staff. One-hundred-and-five (105) participants were involved in site visits, including graduate deans, department chairs, the Provost, evaluators and researchers, faculty, AGEP staff, and UM graduate students.
- An Evaluation Capacity Workshop with 101 leaders from the 26 AGEP Programs held in Puerto Rico in January 2004.

The objectives of the meetings, focus groups, and site visits were to gain a better understanding about AGEP implementation and STEM data collection, uses, and evaluation practices at the graduate school and department level.

It was determined that from the perspective of UM graduate student entry into graduate school to PhD degree completion, the objective of the AGEP quantitative evaluation should include examining changes in number and percentage of:

- UM applicants.
- UM admits.
- New or first time UM enrollees.
- Overall UM enrollment.

- UM students continuing in PhD Programs.
- UM students completing PhD degrees
- Post PhD employment, particularly as related to the Professoriate.

Based on this work, a pilot evaluation was conducted to determine quantitative indicators that could be collected and used to examine the progress of AGEP institutions as related to recruitment, retention, PhD degree completion, and post-PhD employment and to collect baseline data. The site visits revealed that many graduate schools had computerized their application and student record keeping process, perhaps making it possible to get data on applicants, admits, new enrollees, general enrollment, graduate students continuing to PhDs, and degree completion.

Findings from the Pilot Study

At the time of data collection, Fall 2003, AGEP institutions were in various stages of implementation ---

- Cohort 1 institutions were in the fourth year of implementation.
- Cohort 2 institutions were in the third year of implementation.
- Cohort 3 institutions were in the second year of implementation.
- Cohort 4 institutions were in the first year of implementation.

For this reason, we only examined data related to progression to graduate school (including data on graduate student *applicants, admits, new enrollees*) and *overall student enrollment*. It is too early in the AGEP implementation phase for changes in PhD degrees earned and Post-PhD employment to be attributed to the AGEP Program; however to assess the feasibility of collecting data on progress to degree, degree attainment and post degree activities, these categories were also included.

Data was requested for academic years 1996-1997 through 2002-2003. To ensure a context for the analysis of the UM student data, data were also collected for foreign students and for White American and Asian American students. UM students include students who are African American, Hispanic American, and Native American. Data were collected over 11 different academic content areas but to more accurately reflect how data from some of the largest AGEP projects were reported, findings are reported by:

- Natural Sciences and Engineering (the sum of Engineering; Computer Engineering; Computer Sciences; Chemistry; Other Physical Science; Earth, Atmospheric, and Ocean Sciences; Mathematics; and Biological and Agricultural Sciences).
- Engineering, including Computer Sciences and Computer Engineering (a subset of Natural Sciences and Engineering).
- Biological & Agricultural Sciences (a subset of Natural Sciences and Engineering).
- Social Sciences and Psychology.

To reduce the impact of annual variability in the data, data were examined in three-year segments and three-year means were computed. The mean of the sum of the data from years 1997-98, 1998-99, and 1999-00 was computed as the "pre" mean and the mean of the sum of the

data from the years 2000-01, 2001-02, and 2002-03 was computed as the "post" mean and comparisons were made.

Data were received from 63 AGEP institutions participating in 26 different alliances. Data limitations are as follows:

- The data submitted by participating AGEP institutions have NOT been independently validated.
- Definition of the fields that comprise the Social Sciences, including Psychology, vary from institution to institution; therefore, data across different institutions may not be comparable.

Of the 63 institutions that submitted data:

- 38% (24) were able to provide six years of data disaggregated by race/ethnicity on STEM graduate student *applicants.*
- 41% (26) were able to provide six years of data disaggregated by race/ethnicity on STEM graduate student *admits.*
- 79% (50) were able to provide six years of disaggregated data on *new enrollees* and on *all graduate enrollees* in STEM graduate programs, although these were not all the same institutions.

Eighty-nine percent of the institutions (56) were able to provide complete data on their past three years (2000/01 to 2002/03) of *new enrollees* and *all enrollees* in STEM graduate programs but these were not all the same institutions.

As indicated in Table 1, for the total of the 2000-01, 2001-02 and 2002-03 academic years, the increase in *newly enrolled* UM graduate students compared to the total of the 1997-98, 1998-99 and 1999-2000 academic years was:

- 261 more UM graduate students in the Natural Sciences and Engineering (an average increase of 87 *per year*).
- 67 more UM graduate students in Engineering, a subset of all Natural Sciences and Engineering, (an average increase of 22 *per year*).
- 90 more UM graduate students in the Biological, Agricultural Sciences, a subset of all Natural Sciences and Engineering, (an average increase of 30 *per year*).
- 19 more UM graduate students in the Social Sciences (an average increase of *6 per year)*.

As indicated in Table 2, for the total of the 2000-01, 2001-02 and 2002-03 academic years, the change in *all enrolled* UM graduate students compared to the total of the 1997-98, 1998-99 and 1999-2000 academic years was:

- 741 more UM graduate students in all Natural Sciences and Engineering (an average increase of 247 *per year*).
- 347 more UM graduate students in Engineering, a subset of all Natural Sciences and Engineering (an average increase of 115 *per year*).
- 208 more UM graduate students in the Biological, Agricultural Sciences, a subset of all Natural Sciences and Engineering (an average increase of 70 *per year*).
- 81 fewer UM graduate students in the Social Sciences (an average decrease of 27 *per year*).

Table 1 -- Change in Numbers of Newly Enrolled Underrepresented Minority Students in Graduate School Programs in Reporting AGEP Institutions Based on 1997/1998/1999 Mean and 2000/2001/2003 Mean

STEM Fields N=number of institutions with six years of data	1997/1998/1999 Mean	2000/2001/2003 Mean	Average Annual Difference Between Means	Percent Change
Natural Sciences & Engineering (N=50)	1,165	1,252	87	7.5%
Engineering (N=44)	557	579	22	3.9%
Biological & Agricultural Sciences (N=40)	303	333	30	9.9%
Social Sciences & Psychology (N=39)	426	432	6	1.4%

Table 2 --- Change in Numbers of All Underrepresented Minority Students Enrolled in Graduate School Programs in Reporting AGEP Institutions Based on 1997/1998/1999 Mean and 2000/2002/2003 Mean

STEM Fields N=number of institutions with six years of data	1997/1998/1999 Mean	2000/2001/2003 Mean	Average Annual Difference Between Means	Percent Change
Natural Science & Engineering (N=50)	4,414	4,661	247	5.6%
Engineering (N=48)	1,999	2,114	115	5.8%
Biological & Agricultural Sciences (N=40)	1,278	1,348	70	5.4%
Social Sciences & Psychology (N=41)	2,294	2,267	(27)	-1.2%

As indicated in Table 3, the percent of *newly enrolled* UM students in STEM graduate school programs in reporting AGEP institutions varied between the Pre period (1997-98, 1998-99 and 1999-2000 academic years) and the Post period (2000-01, 2001-02 and 2002-03 academic years) in the following ways:

- In the Natural Sciences and Engineering, UM graduate students were about the same percentage of all *newly enrolled* graduate students in these areas during both the Pre (1997-2000) and Post periods (2000-2003) (6.6% vs. 6.5%).
- In Engineering, a subset of the Natural Sciences and Engineering, the percent of all *newly enrolled* graduate students, who were UM declined between the Pre period (1997-2000) and the Post period (2000-2003) (6.1% vs. 5.5%).
- In the Biological and Agricultural Sciences, a subset of the Natural Sciences and Engineering, the percent of all *newly enrolled* graduate students, who were UM increased between the Pre period (1997-2000) and the Post period (2000-2003) (8.8% vs. 9.3%).
- In the Social Sciences and Psychology, the percent of all *newly enrolled* graduate students, who were UM declined slightly between the Pre period (1997-2000) and the Post period (2000-2003) (11.3% vs. 11.0%).

Table 3 -- Average Annual Percent of Newly Enrolled Underrepresented Minority Students in Graduate School Programs in Reporting AGEP Institutions Based on 1997/1998/1999 Mean and 2000/2002/2003 Mean

STEM Fields N=number of institutions with six years of data	1997-1999 Mean of UM Students	1997-1999 Mean of All Students	2000-2003 Mean of UM Students	2000-2003 Mean of All Students	1997-1999 Average Annual Percent of Students who are UM	2000-2003 Average Annual Percent of Students who are UM
Natural Sciences & Engineering (N=50)	1,165	17,754	1,252	19,339	6.6%	6.5%
Engineering (N = 44)	557	9,165	579	10,530	6.1%	5.5%
Biological & Agricultural Sciences (N = 40)	303	3,444	333	3,580	8.8%	9.3%
Social Sciences & Psychology (N=39)	426	3,782	432	3,911	11.3%	11.0%

As indicated in Table 4, there were minimal changes in the percentage of UM graduate student in the total STEM graduate student population between the Pre period (1997-98, 1998-99 and 1999-2000 academic years) and the Post period (2000-01, 2001-02 and 2002-03 academic years):

- In the Natural Sciences and Engineering, UM graduate students were about the same percentage of *all enrolled* graduate students in these areas during both the Pre (1997-2000) and Post periods (2000-2003) (6.9% vs. 6.7%).
- In Engineering, a subset of the Natural Sciences and Engineering, the percent of *all enrolled* graduate students, who were UM declined between the Pre period (1997-2000) and the Post period (2000-2003) (6.1% vs. 5.7%).
- In the Biological and Agricultural Sciences, a subset of the Natural Sciences and Engineering, the percent of *all enrolled* graduate students, who were UM increased slightly between the Pre period (1997-2000) and the Post period (2000-2003) (8.1% vs. 8.4%).
- In the Social Sciences and Psychology, the percent of all *newly enrolled* graduate students, who were UM decreased slightly between the Pre period (1997-2000) and the Post period (2000-2003) (12.2% vs. 11.9%).

Table 4 -- Average Annual Percent of All Underrepresented Minority Students Enrolled in Graduate School STEM Programs in Reporting AGEP Institutions Based on 1997/1998/1999 Mean and 2000/2002/2003 Mean

STEM Fields N=number of institutions with six years of data	1997-1999 Mean of UM Students	1997-1999 Mean of All Students	2000-2003 Mean of UM Students	2000-2003 Mean of All Students	1997-1999 Average Annual Percent of Students who are UM	2000-2003 Average Annual Percent of Students who are UM
Natural Sciences & Engineering (N= 50)	4,414	63,702	4,661	69,452	6.9%	6.7%
Engineering (N = 48)	1,999	32,512	2,114	37,406	6.1%	5.7%
Biological & Agricultural Sciences (N = 40)	1,278	15,762	1,348	15,952	8.1%	8.4%
Social Sciences & Psychology (N= 41)	2,294	18,767	2,267	18,996	12.2%	11.9%

For the Post Period, 2000/2002/2003:

- Almost three quarters of the UM *new enrollees* in the Natural Sciences and Engineering were in Engineering (46%) or Biological/Agricultural Sciences (26%) and almost three quarters of the *total UM enrollees* in the Natural Sciences and Engineering (Engineering, 45%; Biological/Agricultural Sciences, 29%).
- Over half of the UM *new enrollees* in all STEM fields, including Social Sciences and Psychology, were in Engineering (34%) or Biological and Agricultural Sciences (20%) as were almost half of the *total UM enrollees* in STEM, including Social Sciences (Engineering, 30%; Biological/Agricultural Sciences, 19%). Nearly 26% of all UM *new enrollees* and 33% of *all UM enrollees* were in the Social Sciences and Psychology.

Conclusions from the Pilot Study of Quantitative Indicators for AGEP Programs

Quantitative indicators, disaggregated by race/ethnicity, that can be collected from 1997-1998 from most AGEP institutions include:

- Number and percent of new enrollees.
- Number and percent of overall graduate student enrollment.

These data can be used to determine:

- Percent of UM new enrollees as compared to the percent of all new enrollees.
- Percent of UM graduate student in the total STEM graduate student population.

Although most AGEP institutions cannot report six years of historical data on applicants and admits to STEM graduate programs, disaggregated by race/ethnicity, these are good indicators to measure recruitment and admissions/selection strategies and should continue to be collected. We recognize that many graduate student applicants might not indicate race/ethnicity; however, AGEP institutions should begin to collect race/ethnicity data on applicants and admits.

Many AGEP institutions could not easily report information on students continuing to PhD programs for several reasons:

- Student enrollment data is not usually kept indicating whether students are enrolled in a Masters Program or in a PhD Program.
- Some departments require a Masters degree before a student can enter a PhD Program.
- Current databases are not configured to do student cohort tracking.

A possible interim indicator to progression to the PhD is number of UM students that have advanced to doctoral candidacy. This information might serve as an indicator for students that are three to four years from earning a STEM PhD. Although graduate schools keep records of students that advance to doctoral candidacy, in many cases this data has not been collected by race/ethnicity.

Other data disaggregated by race/ethnicity that can be collected from most AGEP institution include number earning PhDs and post-PhD employment plans. Given that UM students take about 6.5 to 7 years to earn a PhD, we do not expect to see changes in data on PhD degrees earned at AGEP institutions or post-PhD employment until 2008.

From data collected and analyzed in this pilot study, predictions could be developed for the number of new enrollees needed to increase the percentage of UM in the total graduate school population. In order for UM graduate students in all Natural Sciences and Engineering to comprise, for example, 12% of the total population of all Natural Sciences and Engineering *new enrollees* within 10 years:

- Assuming an annual 9%[1] increase in all *newly enrolled* students, the number of UM *new enrollees* in the Natural Sciences and Engineering would have to increase annually by 420 students or by 16.5%.

- Assuming no annual increase in all *newly enrolled* students, the number of UM *new enrollees* in the Natural Sciences and Engineering would have to increase annually by 118 students or by 7%.

Prediction analysis could be useful in helping both NSF and AGEP institutions to set targets for admits and new enrollees.

Future studies related to the NSF AGEP include examining graduate student changes in advancement to doctoral candidacy, PhD degrees earned, and post PhD employment patterns. In addition, we are developing an evaluation framework for examining changes in graduate school policies, practices, and programs related to graduate student recruitment, admissions, and retention and faculty recruitment, retention, and advancement.

References

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[1] 9% was selected as an example because it was the overall pre/post percent increase of all Natural Sciences and Engineering students for the reporting institutions.