

Promoting Participation in Science and Engineering

A How-To Manual Describing the Essential Elements of the Rice University Alliance for Graduate Education and the Professoriate (AGEP)

Richard Tapia

University Professor and Maxfield-Oshman Professor in Engineering

With thanks to

Naomi Reed, University of Texas

For work on this document

April 2012

Introduction: For over two decades, Rice University has been recognized as a national leader in promoting participation of underrepresented minorities in graduate science and engineering. In 1998, Rice was awarded one of the National Science Foundation's (NSF) inaugural Alliances for Graduate Education and the Professoriate (AGEP) programs based on prior work we had done in the Computational and Applied Mathematics Department (CAAM). In 1986, the NSF informed us that over the two previous years, eight underrepresented minority Ph.D.s in mathematics were produced in the country, and Rice had produced four — or half the total. That statistic was bittersweet; sweet because CAAM was number one in the country, but bitter because the national production was so incredibly small. With strong support and leadership from university administration and faculty, the new AGEP scaled the successful CAAM recruiting and retention model across all of Rice's science and engineering departments. In 2010, the American Mathematical Society honored the department with a *Mathematics Programs That Make a Difference Award*, citing CAAM as one of the most successful departments in the nation in mentoring and graduating doctoral students from underrepresented minority groups.

Over the five years of our first AGEP grant, with additional funding from the Alfred P. Sloan Foundation, underrepresented minority (URM) enrollment in Rice science and engineering increased from 34 to 62 students, and Rice produced 26 URM Ph.D.s in science and engineering. Based upon this success, in 2004 NSF funded a follow-up AGEP grant that expanded the AGEP program to the University of Houston (UH), a large urban public research institution. With this Rice-Houston AGEP grant, Rice graduated 65 URM Ph.D. students in 2005-2011 and UH graduated 38 URM Ph.D. students. Many of these Ph.D. recipients have gone on to positions of leadership both within the academy and in industry.

The Rice AGEP is a tested program that can serve as a model for universities across the country. University faculty members and administrators realize that minorities (in particular, Hispanics, African American, and Native Americans/Pacific Islanders) are underrepresented in science and engineering, recognize this underrepresentation as a problem, and express a genuine desire to address the problem. Despite their good intentions, however, many feel at a loss to know what to do or how to do it. For instance, as we were producing our original AGEP proposal in 1998, I'd asked Terry Millar, Associate Dean for the Physical Sciences of the Graduate School at the University of Wisconsin-Madison (UW-M) for a letter of support for the proposal. Terry

responded that they'd like to partner on the proposal. Terry's statement was, "We aren't after funding; what we need are new ideas." After implementing the Rice AGEP model, the UW-M engineering school went from producing zero minority Ph.D.s to 45 over a ten year period and became the model adopted by all of the major colleges/schools at UW-M. The University of Texas, Austin has also incorporated the model into their Computer Science Department as a retention program for undergraduates. This work was through the Broadening Participation in Computing Alliances program of the National Science Foundation. These examples provide strong evidence that the Rice AGEP model can be adapted and implemented successfully at other universities. In this paper, we describe the essential elements of the program so that universities can implement it elsewhere.

How the Program Works: The Rice AGEP functions through the oversight of a faculty "cluster" committee. Committee members and their clusters include:

Chair; Richard Tapia

Chemical and Physical Sciences and Engineering Departments; Leader: Enrique Barrera

Biology and Earth Sciences Departments; Leader: Bonnie Bartel

Computer and Mathematical Sciences Departments; Leader: Illya Hicks

Bartel, Barrera, and I have been members of the committee since AGEP's inception in 1998. Hicks is a former Rice AGEP Ph.D. student who became Cluster Leader when he returned to Rice (as an Associate Professor with tenure) from Texas A&M.

The Cluster Committee oversees all aspects of the program. Other key features of the program include:

- The faculty cluster committee gives guidance to departments on admissions and makes fellowship funding decisions using a holistic approach to admissions criteria.
- An integrated student, faculty, and staff community is the primary retention tool.
- Faculty members play critical roles in the program.
- University administrators, especially science, engineering and graduate deans, actively endorse and support the program to provide buy-in for the faculty members.
- Effective staff members provide the many administrative needs of the community and a secondary level of support for students.

Details of each of the essential elements are described below.

The faculty cluster committee gives guidance to departments on admissions and makes fellowship funding decisions using a holistic approach to admissions criteria.

All students interested in pursuing a Ph.D. at Rice apply for admission to their respective departments. Admissions decisions are made by departments, although departments frequently ask the AGEP Cluster Committee for recommendations on the strength of an applicant. Once the department accepts an underrepresented minority student that they would like to recommend for an AGEP fellowship, they send the application to the AGEP Cluster Committee. The Cluster

committee then judges all applications received to determine if they should receive an AGEP fellowship.

Applications for admission and fellowship support are judged holistically. Criteria include GRE scores, undergraduate grades measured against the rigor of the undergraduate program, essays about student experiences, research experience, and faculty recommendations. Our primary consideration is to admit students who will succeed. Accepting poorly prepared minority students with a limited demonstration of talent hurts the student, hurts the department, and hurts the AGEP program.

GRE scores are considered using a threshold approach. Rice experience has been that there is no predictive value at the high end of the test score. For example, there is essentially no value in favoring a student with a GRE score in the 95th percentile versus one whose GRE score is only in the 85th percentile. Applications with scores above the threshold are deemed passing the GRE threshold and judged by other criteria. Students with scores significantly below the threshold value are not accepted, and those students with scores near the threshold value are looked at with extra care. The precise threshold value is a judgment call and varies from department to department. For more on the Threshold Approach read “Assessing and Evaluating the Assessment Tool” <<http://www.caam.rice.edu/~rat/cv/publications/diversity/nise.html>.

Undergraduate grades are also examined carefully. A couple of low undergraduate grades from a minority student who attended a weak high school is not robustly predictive of how well that student will do in graduate school. Did the student start out weak and get stronger as they went along? How strong was the undergraduate program? The Rice experience has been that a student with B’s or even C’s from a rigorous undergraduate program is better prepared than a student with all A’s from a weak undergraduate program.

Rice annually awards approximately twenty full AGEP fellowships with tuition waivers. To optimize the effects of their funding, the committee sometimes will barter with departments so that AGEP will fund half of a fellowship if the department funds half. When a department has two students, one obviously stronger than the other, rather than letting the departments fund the strong student and AGEP the less strong, AGEP will fund half of both students and the department the other half, so as not to marginalize the AGEP program,. This division ensures that the program is not perceived as just for weaker students who cannot get funded other ways. The committee seeks to maintain a balance of both African American and Hispanic students, men and women. Some non-minority students, especially women, are also funded if it is perceived that they will contribute to the community.

At Rice, the AGEP focus is on supporting domestic students rather than international ones. Many international students are admitted to graduate school in the United States because they are highly competitive and their system’s best students. Often the products of early academic tracking, they have had strong educational foundations and intense, specialized study in their fields. They are stronger candidates for admission than all but the very best American undergraduates. Accepting foreign-produced students, even those who are black, brown, or Spanish-speaking, does little to solve the problem of our universities' lack of success with underrepresented minority youth from the United States. For more information about foreign versus domestic production, see the Chronicle of Higher Education’s Op-Ed piece “True Diversity Doesn't Come From Abroad” (Tapia, 2008).

When possible, AGEP brings prospective students to visit Rice to increase matriculation. Current AGEP scholars and leaders visit with applicants to give them a vision of what being a part of the AGEP community is like. Many times students will say they came to Rice because the Rice students seem so happy here.

Several of our biggest successes have been recruiting our own Rice minority undergraduates. If we look across the country at minority faculty leaders, it is not unusual to find that many went to undergraduate and graduate school at the same place. It is a relatively easy transition. Faculty know the student, and even more importantly, the student knows the university. The student has dealt with the environment and feels that he/she belongs. I did this at UCLA. This feeling of belonging is particularly important when there are few underrepresented minority graduate students. One student in particular had attended a very weak urban high school, and even had C's on his/her Rice undergraduate transcript early on, but I had had him/her in my class and knew the student to be a very creative individual. This student applied to other universities, was not admitted, was admitted to Rice, got a Ph.D. with no problems, and is a national leader today.

For various reasons, many Rice minority undergraduates had never thought about going to graduate school nor received encouragement from their department's faculty members. However, they either were encouraged by an AGEP faculty leader or were associated with the AGEP program as undergraduates and motivated and influenced by the graduate students. I made my own decision to go to graduate school when I saw other students that were going. I knew that I was as good as they, and thought if they could make it, so could I.

Our next most successful group of students comes from schools that are similarly situated to Rice, i.e., Research One universities like the University of Texas at Austin, Texas A&M, or the various branches of the University of California. This group of students has played a large role in our success over the years. Many of these students were not A students but were solid B or B+ students. I was a solid B+ student as an undergraduate in mathematics at UCLA. As such, I knew a lot of mathematics and was well prepared for graduate school at UCLA, but I was not viewed as a star and probably would not have been accepted at the more elite math graduate schools.

We have not been as successful with students from minority serving institutions. While there are clearly many excellent students at these schools, the top students usually end up going to the more elite schools like Stanford or Berkeley rather than Rice. The students who come to us from minority serving institutions invariably come with an A average. However, their preparation is often deficient. Some HBCUs have essentially open admissions and the variance of the students is large, making the courses less effective. The AGEP program has academic support strategies in place that are described later in this paper, but if the preparation is too weak, they are not sufficient to overcome the deficiencies.

There is a significant difference between Hispanic serving institutions (HSIs) and Historically Black Colleges and Universities (HBCUs). HSIs are regional, often the only school in an area, whereas attendance at HBCUs usually results from a deliberate choice. We have experienced the full spectrum of students from the HSIs in South Texas. Several of our best students came from the University of Texas El Paso, University of Texas Pan American, and Texas A & M University

Corpus Christi. These students were identified not by grades, since all of our applicants from minority serving institutions have good grades, but by letters of recommendation from faculty that we know and trust.

In summary, graduate admission is more of an art than a science, but we have identified key indicators of success. As stated earlier, admitting students that are not adequately prepared is a disservice to everyone, especially to the student.

An integrated student, faculty, and staff community is the primary retention tool.

A major component that contributes to the success of the Rice AGEP program is community. Graduate school can be a very isolating experience and having a strong support system can often be the difference between a student completing the Ph.D. or leaving early. The AGEP program serves as a strong familial community that supports students through each phase of the Ph.D. process. There are different stressors throughout graduate school, from becoming acclimated, to passing qualifying exams, to presenting at conferences, to conducting research, and ultimately to the very isolating experience of writing the dissertation. The community aspect of the AGEP program is set up to provide support for students at each phase. The overarching idea is that students are made to feel as if they belong to a unit that is bigger than one person. They belong to a unit that gives them support that is very similar to an extended family, as the people around them are individuals who are similarly situated or have been in the past.

It is easy for a minority student to feel isolated when there are few minority students in their department. Hence we try to build critical mass in each department. Since Rice is a small school, we cannot always do this. So we create critical mass by building a community across all 13 science and engineering departments and supportive friendships are built across departments. The common experiences that the students share across departments seem to be more important than the differences that occur because they are in different departments. We try to balance black and brown and male and female. The program seems to run more smoothly with a good balance.

The community component is self-sustaining as students buy into this aspect and contribute greatly to its success. As they work to support this model, students improve their own experiences at Rice while enriching their peers' experiences. Cluster leaders provide an example of leadership that senior students often emulate as they serve as mentors and supporters for their junior colleagues. Many AGEP students who graduate and take academic positions at other universities mentor and support their own students in a manner similar to what they experienced in the AGEP program, a clear indicator of success as the AGEP model stretches beyond Rice and begins to aid in the production of more black and brown Ph.D.s at other institutions.

A summer program that includes all AGEP students from all years and all clusters lays the foundation for the community. We try to have AGEP students spend the summer at Rice prior to the first year of graduate school. They mix and form relationships with other students before the rigor of classes begins. They are assigned to their cluster, work on a research project, and participate in all community building activities. An evaluation shows that 89% of the participants indicated this had a positive or very positive impact on their integration into the graduate community.

In addition to working on their research, all AGEP students meet frequently with the program faculty leaders both for professional development and community building activities. During the summer, all AGEP students and faculty leaders meet together as a group each Friday afternoon (4-5 hours) and also as a cluster with their cluster leaders weekly. The Friday meetings include talks by leading scientists and discussions of society, race, and the challenges and rewards of a career in research.

Undergraduates recruited from Rice and across the country participate in research projects with Rice faculty and are assigned a graduate student mentor who shows them what graduate studies are like. Graduate students and undergraduates also mentor high school students who are on the campus for outreach programs.

An end-of-the summer banquet celebrates the successes of the summer. Students present a poster on their research, and a distinguished visitor gives a talk. Research advisors are invited and a large percentage of them support this activity. A band or DJ provides entertainment and the banquet feels like a warm celebration.

During the academic year, the community-building activities continue, and even though they diminish in frequency to about once per month, they are still vitally important to keep contact with the students. We monitor the new students closely at the start and throughout the first year. We direct them to undergraduate classes if their preparation is deficient in a particular area, and allow them to drop down to a minimal course load as needed. This is done in a manner that does not generate a negative stigma.

Academic Community Events

In addition to the summer weekly meetings, students associate together throughout the year. An intense level of support is very evident at academic conferences, which Rice students attend as a group to support one another when they are giving talks and to actively recruit future Rice graduate students. Students often say that when they met the Rice AGEP program at a conference that the image of this cohesive black and brown STEM family definitely made an impression on them. Some students say that their decision to come to Rice over other universities was in part due to the community solidarity that they witnessed at conferences among our AGEP students.

AGEP students frequently are asked to attend talks at Rice. Meetings are often arranged for AGEP students to meet with the speaker prior to the talk, thus bridging the leadership and community components. Students are able to ask questions and get advice from successful STEM professionals. These meetings also serve as an opportunity for students to come together during the semester. These meetings are usually required, but AGEP students know the academic and social benefits of attending and participate willingly. They are also aware of how attendance at these talks positively impacts their home university and they are typically very invested in making Rice a better institution. When students come together in these types of events, they grow together as future academicians and their bonds as colleagues further solidify.

Social Community Events

The graduate school experience can often keep students within the social walls of their respective departments, but AGEP works to bridge relationships across departments. Sometimes AGEP students are socially very close across departments. Students support each other outside of the academic world as they attend many social events throughout the year in support of each other and the program leadership. I frequently invite them into my home for parties. In fact, students have remarked that it is the first time that they've ever been in the home of a faculty member. Other events are organized by AGEP staff. A bus day trip is planned early in the summer so that students will bond on the bus to and from the event. Holiday parties, car shows, local plays, and live music events are scheduled, and students often self-organize additional parties, sporting activities, and other outings. Program leadership decides whether attendance is optional or required on social events, but I cannot overemphasize the importance of these types of community building experiences outside of academia. They solidify the familial bonds that help students through their graduate school experience, and are too important to be left to the chance that students will build them on their own. The Sloan Foundation support makes many of these social community building events possible.

Faculty members are integrally involved in every aspect of the program.

University science and engineering faculty are especially crucial to the success or failure of representation efforts at the graduate level. Faculty decide graduate admissions and accept students into research programs, support students on research grants, serve as research advisors, and make decisions about when a student's research merits the Ph.D. Consequently, it is absolutely essential that people who understand and can influence faculty culture are in charge of the program. In addition, students need mentors who understand the challenges they are facing. Staff members play a critical role (as described below), but faculty play a major leadership role that staff cannot. This may be the most critical difference between the Rice program and many other AGEP programs.

As explained earlier, the Cluster Committee is the principal faculty AGEP committee. Cluster leaders have a special responsibility for the students in their cluster. They also have the responsibility to arbitrate with departments within their cluster about fellowship and admissions decisions. Within their departments, they advocate for the program and for students, advertise successes, and identify supportive research advisors.

Other faculty members across the campus make important contributions. Research advisors must support the student's time commitment for community-building activities. Even more importantly, research advisors must be willing to provide significant time in mentoring within a reward system and a faculty culture that is not set up to encourage the effort required to foster graduate student diversity.

Respected senior faculty, minority and non-minority, are involved in the community as mentors, advisors, role models, and advocates so that the program is respected by both members of the community and the greater university community alike. Junior faculty, especially minority faculty,

with whom the students tend to identify, are used sparingly prior to tenure so as not to jeopardize their own research and professional growth.

We use a pyramid mentoring scheme. Senior graduate students mentor junior graduate students, who in turn mentor undergraduates, who in turn mentor high school students. At the top of the pyramid are well respected faculty who can deal with how to choose an advisor, what to do if you fail the qualifying exam, how to help get support for the next year, etc. This faculty member advocates for the student as needed. The student culture emphasizes that more junior students are counting on senior students to succeed, and this element of community responsibility brings with it powerful motivation. Sometimes other students are the first to know when a student needs help, and when needed, they turn to faculty program leaders to help resolve a student's problem. This usually involves the faculty member counseling with the student or perhaps advocating on the student's behalf with the administration or the student's research advisor. Program leaders can play this role because of their status as senior faculty members. I have seen schools use only well intentioned staff as student mentors, but this does not work. Staff members cannot effectively advocate at the upper levels of the administration. I claim that a big part of the Rice success is the strong role that is played by distinguished and caring faculty.

Many Rice science and engineering faculty think that they are preparing future Princeton faculty and are not supportive of preparing doctoral students to be faculty at minority serving institutions. Yet we have been very successful at this endeavor. We have around fifteen minority Rice doctorates in science and engineering who are now faculty at minority serving institutions. They are doing great things and impacting their culture at their institutions. Their presidents often ask me if we have more, since the ones that they have are so successful.

University administrators, especially science, engineering and graduate deans, actively endorse and support the program to provide buy-in for faculty members.

At Rice, the AGEP program has gained respect across the campus so that this support is less important than it was at the beginning. Even though universities give lip service to increasing representation, few will implement policy and practices that reward or encourage the kind of commitment from faculty that this kind of program requires. However, university administration, especially science and engineering deans, must actively endorse and support the program to provide buy-in for faculty members across the campus. Deans are responsible for articulating institutional values, and leading change in departments, and they also make final approval decisions on faculty review. Sometimes something as simple as a note from the deans to faculty members endorsing a program workshop or talk and encouraging attendance, along with the dean's attendance, greatly improves faculty attendance at such events.

While research universities value and reward research over all other faculty activities, advising underrepresented minority students is usually one of the least prestigious or rewarded endeavors in which faculty engage. Program leaders worked with the President's office to initiate the Rice University Presidential Award for Mentoring (modeled after the NSF Presidential Mentoring award) that is now given annually to a faculty member who has demonstrated a commitment to mentoring students with an emphasis on those who have promoted diversity.

Effective staff members provide the many administrative needs of the community and a secondary level of support for students.

Staff members have played a key role since the AGEP program's conception, both in performing administrative duties and in providing a secondary support role with students. Rice AGEP staff members have been individuals who are genuinely concerned about students and their academic and personal wellbeing. Theresa Chatman has been the Program Manager and Linda Torres the Program Administrator since AGEP's inception at Rice. Many students describe Theresa as a "confidante," and they explain how she makes life better for them. We all know that life happens even when you are in graduate school, and students describe numerous personal events that may have been detrimental to their careers had Theresa not been there for them to turn to. For example, one student described how she went through a very complicated divorce, another student's parents wanted him to quit school and work on the family farm in south Texas, another student felt overwhelmingly isolated as a black female in her majority department; the list goes on. Theresa takes in each of these students and helps them through these trying personal times, often acting as an unofficial counselor or therapist. It is this kind of dedication to the happiness of students that a successful staff member must have in order to be impactful in a program like this.

Linda Torres works more behind the scenes making administrative details function smoothly, but she is equally critical to the successful running of the program. It is important that the staff member be adept with maneuvering the university administrative system and be able to navigate the landscape for both faculty and students. The time and labor that goes into organizing activities and talks for students and also for program visibility are too demanding for faculty members to take on. Other administrative issues such as stipends, tuition waivers, travel funds, human resources paperwork, etc., are additional areas that a staff person must be proficient in controlling so that faculty can concentrate on the academic side of things.

Conclusion: Research schools must play a role in increasing participation. Many minority serving institutions are now implementing their own Ph.D. programs. I do not believe this is wise. It creates a two-tier system and greatly limits the potential of graduates of the second tier. If we are ever going to have representation on the faculty at the nation's top universities, then these same universities must produce minority graduates of sufficient quality that they would eventually hire them. For more information about the role of research universities, see "Minority Students and Research Universities: How to Overcome the 'Mismatch'" in the Chronicle of Higher Education (Tapia, 2009).

The Rice model is not complicated. What it requires is found on every campus -- caring faculty members and administrators who want to make their campuses welcoming and supportive of *all* students. For faculty members beginning a program, the recommendation is to start small and build success. With this success in hand, it will be easier to seek out supporters and allies across the campus.

Bibliography

Writings on Diversity Authored by Richard Tapia

Richard Tapia, "Minority Students and Research Universities: How to Overcome the 'Mismatch,'" The Chronicle of Higher Education, March 27, 2009

Richard Tapia, "True Diversity Doesn't Come From Abroad", published in the September 28, 2007 issue of the *Chronicle of Higher Education*

http://www.caam.rice.edu/~rat/articles/true_diversity_tapia_chronicle_2007-09-28.html

"Factors that Influence Science and Engineering Graduate Student Diversity: Results of a Rice Faculty Survey" (2003)

<http://ceee.rice.edu/Books/DV/facsurvey/facsurvey.pdf>

"Underrepresented Minority Achievement and Course Taking - The Kindergarten-Graduate Continuum" (2000)

<http://ceee.rice.edu/Books/DV/continuum/continuum.pdf>

"Promoting National Minority Leadership in Science and Engineering" (1999)

<http://ceee.rice.edu/Books/DV/leadership/leadership.pdf>

"NISE: Assessing and Evaluating the Evaluation Tool - The Standardized Test" (1998)

http://www.caam.rice.edu/%7Erat/cv/publications/diversity/Tapia_NISE.pdf

Rice AGEP

<http://graduate.rice.edu/agep/>

University of Houston AGEP

<http://agep.uh.edu/index.htm>

Professional Conferences Named for Richard Tapia

Richard Tapia Celebration of Diversity in Computing

<http://tapiaconference.org/>

David Blackwell and Richard Tapia Conference

<http://icerm.brown.edu/blackwell-tapia-2012>

A Short Biography of Richard Tapia

Dr. Richard Tapia is a mathematician and professor in the Department of Computational and Applied Mathematics at Rice University. He is internationally known for his research in the computational and mathematical sciences and is a national leader in the education of Hispanic and African American students. Because of this, President Obama awarded him the 2011 National Medal on Science, the highest honor bestowed by the United States government on scientists and engineers.

Tapia holds Rice's highest rank, University Professor, one of only six named in the history of the university. He is also named Maxfield-Oshman Professor in Engineering; and is Founding Director of the Center for Excellence and Equity in Education.

Tapia was born in Los Angeles to parents who, separately, emigrated from Mexico as young teenagers in search of educational opportunities for themselves and for future generations. Tapia fulfilled this dream to the utmost. He was the first in his family to attend college. He received B.A., M.A. and Ph.D. degrees in mathematics from the University of California-Los Angeles and then spent two years in a post-doctorate at the University of Wisconsin. Then in 1970 he moved to Rice University where he was promoted to associate professor in 1972 and full professor in 1976. He is currently an adjunct faculty member of Baylor College of Medicine and the University of Houston.

Tapia has authored or co-authored two books and over 80 mathematical research papers. He has delivered numerous invited addresses at national and international mathematical conferences and serves on several national advisory boards. Each year he travels throughout the country making presentations to inspire educational excellence.

Throughout his career at Rice, Tapia has inspired and guided students to pursue a career in mathematics, directing or co-directing 35 Ph.D. doctoral recipients in mathematics, 23 of them Hispanic or African American or women, more than anyone else in the country.

His many honors include among others: In 2011, President Obama named Tapia one of the recipients of the National Medal of Science. The Gary D. Keller Award was awarded to Tapia at Princeton University in November 2005. In April 2005, Tapia was noted as one of 50 Most Important Hispanics in Technology and Business by the Hispanic Engineer and

Information Technology Magazine. He received the Distinguished Scientist Award from the Society for the Advancement of Chicanos and Native Americans in Science; and honorary doctorates from Carnegie Mellon University, Colorado School of Mines, and Claremont Graduate University. In 1996, Tapia was presented the first ever Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring from President Bill Clinton. Two professional conferences are named in his honor: The Richard Tapia Celebration of Diversity in Computing and the Blackwell/Tapia Mathematics Conference.