Underrepresented Minority Achievement and Course Taking - The Kindergarten-Graduate Continuum

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1. Introduction

Perplexing problem, daunting challenge, formidable task -- how many times, and in how many different ways have we attempted to describe underrepresentation? For at least three decades this nation has attempted to increase the participation of underrepresented minorities in science, mathematics, engineering, and technology (SMET) with little success. Countless research projects have been conducted with numerous programs implemented with so little improvement that one wonders if the same increase would have occurred if none of these efforts had ever been expended (see Table 1). Even at the bachelor's level, from 1975 to 1995, science and engineering degrees earned by underrepresented minorities rose from 6 to only 8 percent of all such degrees earned (NSB, 1998). Given the huge growth in minority population, especially Hispanic, during this same time period, we actually may have declined proportionally rather than increased.

Table 1 - Percent of the doctoral degrees in science, math, engineering, and technology earned by people of various races/ethnicities, 1977-1998.

	1977	1979	1981	1983	1985	1987	1989	1991	1993	1995	1996	1997	1998
Total	9,003	8,999	8,825	8,852	8,859	9,034	9,682	10,500	10,874	13,076	12,609	12,300	12,051
White	85.5%	82.6%	84.7%	86.7%	86.0%	84.9%	84.8%	83.1%	81.4%	69.2%	71.7%	73.2%	75.5%
Asian	7.0%	8.2%	7.8%	7.5%	7.6%	8.4%	8.6%	9.5%	12.6%	24.7%	21.4%	17.6%	15.0%
Black	1.2%	1.3%	1.3%	1.3%	1.6%	1.5%	1.5%	1.8%	1.8%	2.0%	2.2%	2.5%	2.5%
Hispanic	1.2%	1.3%	1.3%	1.4%	1.7%	2.1%	2.3%	2.6%	2.9%	2.5%	2.8%	3.1%	3.5%
Native Amer	0.2%	0.1%	0.1%	0.2%	0.2%	0.3%	0.4%	0.3%	0.2%	0.3%	0.4%	0.3%	0.4%
Other	4.9%	6.5%	4.8%	2.9%	2.8%	2.8%	2.4%	2.7%	1.1%	1.3%	1.4%	0.0%	0.0%

NOTE: U.S. citizens and permanent residents only.
SOURCE: ***Science and Engineering Indicators, 1996; Women, Minorities, and Persons with Disabilities in Science and Engineering, 1996 and 1998.***

In this paper we will resist lamenting the failures of the past, but will rather call for a major reexamination of the system. It is time to ask - will new programs grafted onto an ailing system solve

the problem? Thirty years of failure should tell us that for underrepresented minorities, the system is irreparably broken, and no fine-tuning of existing structures is going to fix it.

Rather than present a research paper, we will set forth experiences gained from a combined 35+ years of working in both K-12 and higher education with underrepresented minority students. Consequently, most issues that we raise we propose as recommendations for further research.

2. Why not just give it up as a lost cause?

In spite of the failures of the past, the consequences are too large to merely give up. Increasing the participation of underrepresented minorities is critical to the health of this country. No first-world nation can maintain the health of its economy or society when such a large part of its population remains outside all scientific and technological endeavors. This becomes more and more true as minority population escalates and as the knowledge age advances. As the White House's National Science and Technology Council (2000) put it, "It is a fundamental responsibility of a modern nation to develop the talent of all its citizens." We are, however, coming closer and closer to developing a permanent underclass who will never benefit from the strong economics and leadership potential of science and technology.

A 1999 Computer Technology Industry Association (CompTIA) study revealed that a shortage of information technology (IT) staffers is costing U.S. companies billions per year. Estimates of the shortage range from 300,000 at the present time to a million workers by 2001.

Underrepresentation has never been a threat to science or mathematics, because when we need more scientists or mathematicians, we import them, and science and mathematics lives on. That's the way that we, as a nation, have dealt for decades with SMET shortages. We imported scientists during World War II; math faculty in the 60's from England (and questionably left England in a bad situation); graduate students since the 70's; and faculty today. Yet now our quick-fix importation strategy fails us. We can't possibly import fast enough to solve our IT shortages. Experts say that if the U.S. imported all the IT workers it needed, this would leave Europe in dire straits. And frankly, what would contribute

more to the general economic health of the nation, import more, or prepare domestic workers to fill these jobs?

When you talk about underrepresented minorities, you talk about the nation's cities. In many of the country's major cities, minorities comprise the majority. Consider Houston, for example. The fourth largest city in the U.S., the greater Houston area contains 4 million inhabitants and is unique in its uniform distribution of diversity -- roughly 30% white, 30% brown, 30% black, and 10% Asian and other. The Census Bureau (1999) estimated that in Houston in 1995 roughly half a million people lived in poverty. The Houston Independent School District is the largest school system in Texas and the seventh largest in the U.S. It has much in common with its sister urban districts. Notice the ethnicity of some of the country's largest urban school districts.

Table 2. Ethnicity of Selected Urban School Districts

Ethnicity	Chicago	Houston	New York	Los Angeles
Latino	34.2%	52.5%	37.7%	69.1%
African-American	52.5%	34.1%	35.7%	13.6%
Asian/Pacific Islander	3.2%	2.8%,	10.8%	6.5%
Native American	0.2%	0.1%.	0.3%	0.3%
White	10.0%	10.6%,	15.5%	10.5%

Source: Respective websites- http://www.cps.k12.il.us/AboutCPS/Statistical_Information/statistical_information.html; http://www.lausd.k12.ca.us/lausd/demographics/; http://www.houstonisd.org/Pubs/AboutHISD/Enrollment.htm

Every school district above is 85 -90% underrepresented minorities. If we bail out on underrepresentation, we bail out on our nation's big-city school districts. Urban schools are entrenched in urban culture. One reason underrepresentation is such a hard problem is because it is intertwined with so many other cultural and social problems associated with the nation's cities.

Have you noticed that as long as teen violence remained confined to cities, it was not seen as an *American* problem, just a big-city one? We expect urban minority kids to be violent. Not until teen

violence emerged in rural and small-town white America did the country see it in crisis proportions. What do we as a nation believe about cities (and we really mean inner-cities), and how much of the cities' failures do we merely accept as a consequence of minority culture? None of us see cities as just very big small towns. Cities and city schools are driven by parallel minority cultures. Do we just expect them to be bad?

We have to learn more about these cultures and our expectations if we are ever going to invent an educational system that is a good fit for urban America. How can we invent a new educational model for our cities until we expect better for them?

3. What we mean by Underrepresented Minority

One of the most misunderstood issues is one of the most basic -- who are "underrepresented minorities"? In a perfect world, percentages of ethnic and racial groups in science would roughly mirror that of the population in general. In 1995, over 32 percent of the entire college-aged population had completed a bachelor's degree in some field, and over 5 percent of them had earned that degree in a SMET field. Yet in that same year, only about 15 percent of the college-aged African Americans and Hispanics had earned a college degree, and only about 2 percent of them had earned their degree in a SMET field. In contrast, almost 40 percent of the college-aged Asian Americans had obtained a bachelor's degree, and over 12 percent had earned that degree in SMET. Notice in Table 1 above that in 1998 although representing only 4 percent of the U.S. population, Asian Americans received 15% of SMET doctoral degrees. Hence, as a group, Asian Americans are not underrepresented, but African Americans, Native Americans, Pacific Islanders, and Hispanics *as a group* are. Sometimes representation data is practically meaningless because it is reported aggregated as "minorities". Notice in Table 1 above, if you included Asian, African American, Hispanic, and Native American, over 21% of the PhD's were earned by minorities -- not too shabby.

3.1 Diversity Within Diversity

Another serious problem that is seldom understood is the "Hispanic" classification. Hispanic is a broad category that represents both varied ethnic heritages, life experiences, and levels of underrepresentation. Too often Hispanics are treated as a homogeneous group when in actuality they may share little affinity other than common surnames and the common language of their ancestors. Cuban Americans are the most represented in science whereas Mexican Americans and Mainland Puerto Ricans are the least. Mexican Americans tend to immigrate for economic reasons, Cuban Americans for political. To treat them as one homogeneous group and to collect data as such does great disservice to underrepresentation efforts. Consider a hypothetical situation where a private foundation awards funding for scientific research. Since the foundation values and promotes representation, they consider a special list of potential "Hispanic" awardees. One candidate on the list is a Spaniard; one is Cuban American; and one is El Salvadorean. All were educated elsewhere and immigrated to the U.S. as adults. Can any of these scientists represent the two thirds of the Hispanic population which is Mexican American? Have we addressed the Mexican American population's underrepresentation with this kind of choice?

Notice the U.S. Hispanic population in Table 3 below. Even this disaggregation is not as thorough as it could be. Mainland and Island Puerto Ricans are worlds apart in life experiences. As a Rice University Puerto Rican student said recently, "Please understand, I went to high school in Puerto Rico -- I wasn't considered a minority student."

Table 3 - Hispanic Population of the United States, by Type of Origin, 1996

Mexican	**63.4%**
Central or South American	**14.3%**
Puerto Rican	**11.0%**
Other Hispanic	**7.3%**
Cuban	**4.0%**

SOURCE: *The Hispanic Population—Population Profile of the United States, (1997) U.S. Bureau of the Census, Current Population Survey.* United States Census Bureau.

This raises a related issue that we have to deal with all the time. At Rice we administer an NSF-funded Alliance for Graduate Education and the Professoriate (AGEP) with the goal to increase minority science and engineering graduate education. Over the last ten years, the Computational and Applied Mathematics Department (CAAM), within the Brown School of Engineering, has been a national leader in recruiting and retaining minority students to graduate degree completion with a balance between both minority men and minority women and between African American and Hispanic American students.

Consider the following scenario. Let's say we have 2 applicants for graduate school at Rice, both Hispanic. One is a U.S. citizen from Houston (or Dallas, or San Antonio). The other is a permanent resident from Argentina (or Spain, Peru, or Venezuela). The NSF considers both equally when they evaluate whether we are meeting our goals, because we can check the Hispanic box for both. Yet which really addresses the nation's underrepresentation problem? The same argument can be made for an African American from Chicago or Detroit or a permanent resident from Nigeria. If urban America is the problem, who will be the solution? Is it possible that these types of issues represent some part of why the nation has made so little progress?

Is underrepresentation even worse than we think? Professor William Velez of the University of Arizona makes a strong case that misunderstanding diversity may mean that underrepresentation is even worse than the current data would indicate. The following appeared in the Letters to the Editor section of Science magazine, Volume 285, 27 August 1999 in response to an article that appeared in Volume 1, Number 1 of Making Strides, “Wanted: A Better Way to Boost Numbers of Minority Ph.D's” Minority Data.

> I was surprised to read in the article by Jeffrey Mervis (News Focus, 28 August 1998, p. 1268) that my own mathematics department was ranked second in the nation for producing 12 minority Ph.D.s in mathematics during the time period 1 July 1992 to 30 June

1996. I did not recall that my department had produced more than a handful of minority Ph.D.s. I was positive that no African-American or Native American had received a doctorate from this department. Mervis's data were obtained from the National Opinion Research Center (NORC), a contractor to the National Science Foundation. According to those data, 74 Ph.D.s in mathematics were produced at the University of Arizona during this time period. The breakdown was as follows: one Black, three Mexican-Americans, eight other Hispanics, 43 Whites, and 19 Asians. Apparently, citizenship is not considered when this data is collected.

I obtained a listing of the students who received doctorates in mathematics, applied mathematics, and statistics from our university. I counted 65 doctorates for that time period. There were no African-Americans, Native Americans, or Chicanos in that list. There was one person whose mother was born in Latin America who could be considered a U.S.-born minority. Seven Mexican nationals were on the list. The discrepancy in data might come from several sources. Apparently, computer theory and practice was considered mathematics for reporting purposes. Twenty-six doctorates in computer science were produced in that time period, and there was one Chicano on the list. Also, several students received doctorates in May 1992 and August 1996 who could be counted.

Mervis's article paints a depressing picture of the education of the minority population, but it is apparently even worse than it appears.

4. Judging Texas Schools -- TAAS

Today's front-page headline read "HISD sophomores post gains on TAAS". TAAS, the Texas Assessment of Academic Skills, measures mastery of the statewide curriculum in reading and mathematics at grades 3 through 8 and the exit level; in writing in grades 4, 8, and the exit level; and in science and social studies at grade 8. Passing of the exit level test, given first in 10th grade, is a pre-requisite for graduation. It's one of the bases for the claims that the Texas educational system is improving.

Austin High School this year has the highest passing rate of all regular (non-magnet) HISD schools -- 87% passed all three exams -- reading, writing, and math. Bellaire High School had the second highest passing rate of 85%. At first glance this sounds like a phenomenal success. Austin is a large high school in the barrios, 96% Hispanic. Do the tests really show that Austin High School has the highest percentage of students who have mastered the curriculum, even beating out Bellaire that sometimes leads the nation in National Merit Finalists?

The scores come out in the paper like sports stats. Davis and Milby tied at 67. Sharpstown 61 Lee 59. TAAS is a high-stakes game that drives Texas education, and Austin has really learned to play the game. That's what these scores tell us. In fact, the paper quoted Olivia Castillo, an Austin student complaining, 'In every single class we have, we have to do TAAS'.

Almost all items on the TAAS exit math are 8th grade level. So in addition to 10th grade geometry, (or instead of) teachers must teach TAAS, and there's not a Texas teacher who doesn't know what that means. Cram enough arithmetic into them long enough for them to pass TAAS. We propose an exercise: give those same sophomores the test again as seniors. See how well they do then. TAAS weakens the high school curriculum because the standard of excellence is an 8th grade level test. It tests to see how many students can jump over a bar about one inch above the ground.

There are some good things about TAAS. Before TAAS, at-risk students were easily ignored. Nobody cared whether they learned *anything.* The best and most experienced teachers taught the

advanced classes and the beginning and marginal teachers taught the lower levels with no support. Now there is intense effort for all students to be at least at TAAS level. TAAS has made it so that these students are now very important, and that is a good thing. We need to make sure all our students can get over that low bar.

But putting this much class-time and manpower on teaching the basics has meant neglecting other important things. Algebra 2, 11th-grade teachers, say principals insist they teach TAAS even if they only have 2 or 3 students who have not passed it. As a consequence, all college preparatory and AP teachers are seeing less-prepared students. AP scores don't come out in the paper, and principals won't lose their jobs if students don't do well in advanced mathematics classes. There aren't any AP pep rallies.

A great stock is put in Texas' diminishing minority/majority TAAS achievement gap. That's fine as far as it goes, at the low end, but what about the high end? What's the minority/majority gap on honors and AP? Where is the legislature, the Texas Education Agency, the governor on that one? If we invested equal resources and energies into developing our minority students' talent across the spectrum rather than just at the low end, then we might have a quality system. We are in dire need of another bar at the medium and high end with the same bite as TAAS that will address college preparation.

As it is, nothing matters in Texas schools if kids don't pass TAAS. The public accepts without question the hype that Texas schools are improving because TAAS scores are going up. We have a flawed evaluation and accountability system that may move a Texan into the White House next year.

We wondered how teachers would react to the statements we have made about TAAS so we circulated them to a network of teachers and asked for their comments. Below are a few of their responses:

> I whole-heartedly agree with you! All teachers are expected to teach TAAS. Which means Social Studies, Science, and electives are all dropped for TAAS. What ever happened to having a well-rounded student? We are not teaching students to solve problems or think logically. Even the supposed Gifted

and Talent students must "cram". I hate to think what will happen to our society if we are "cramming" instead of thinking. This is just my opinion. Unfortunately, teachers can't speak out because of fear of being a troublemaker. It looks bad for the Administration and the school district where they teach.

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When my daughter was in tenth grade, her school's homecoming game was scheduled the night before PSAT. I was furious. My daughter was up all night, home late, and without a decent night's rest for that very important test. In all the ruckus, she left her calculator in her ride's car. Could this have happened the night before TAAS? Absolutely not! The PSAT, which is far more important TO THE STUDENT! was an afterthought. The TAAS, which reflects only upon the school's reputation, is given exhaulted importance.

My daughter is a successful junior at U. Texas. This should be old news yet I still am livid that it happened. Let parents look at tests like the Stanford that show how much a student has grown in a year. TAAS, only a minimal skills test, shows too little. Even children who are below grade level can show parents and schools how much growth has been gained with a test like the Stanford. Our expectations are too low. Parents' values have been shaped by the media and legislatures who have put far too much importance on a test that tells too little. Parents need to be educated to know there are far better indicators of what their children do know and should know.

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I think you are right on target with your comments. It you are speaking out of turn you can add my name to the list. I do have a few things to add. I also read that the high TAAS scores meant that students were learning the important curriculum that was necessary to be successful in school. We both know that isn't true and that TAAS does not address the TEKS at all. (I think the TEKS are on target.) The interesting thing is that TEA - FINALLY- agrees with us. The new Exit level exams that our present 7th graders will have to take are going to be very different than the TAAS. It will be an exam that

requires students to know Algebra I and Geometry. There also will be Probability and Statistics on it. It will be a test that will require technology of some kind. The level of calculator that will be required I do not think has been decided yet. This reminds me of the end of course exam that HISD used to have and the one that TEA now has. Students are being asked to demonstrate real knowledge in mathematics. That is the reason so much emphasis is placed on SAT II and AP exams. They are measuring how well a student really knows something in content area. What is important is to have an external valid exam and finally TEA is going to give one. The real problem is that the pass rate is going to be dismal. Maybe Texas will go to the NY system like Regents. Give a Regents diploma and then the other kind.

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I am in total agreement with you in that the passing of the TAAS test is not a measure of their knowledge or understanding of mathematics. I have had juniors and seniors in geometry for the second time and they have passed the math TAAS. Teaching the test takes up too much of my class time that I really need to spend in group activities that teach thinking skills. No one wants to "hear" what I think so I keep my mouth shut. The other scary part is that the math teachers in our school had to teach the teachers of other subject areas (social studies, art, foreign language, etc.) math so they could teach it in their subject areas. I do not like the results of non-math people trying to teach math concepts, no matter how simple they appear to be.

5. SAT: Minimizing its Effects

A couple of years ago, I was invited to Houston Independent School District's (HISD) Honors Ceremony for the district's valedictorians and National Merit Finalists. Each honoree was allowed to invite a teacher that they felt had most affected their success, and ours honored me with an invitation. As I watched the valedictorians cross the stage, I was struck by the beautiful diversity of

the group -- Latinos, African Americans, Asian Americans, Caucasians -- all closely reflective of the diversity of their schools and of our city. When the National Merit Finalists were introduced and crossed the stage, I was again struck, but this time by the awful realization that the diversity of before was lost. Of the 40 or so honored, I don't remember there being any Latinos or African Americans. The disparity in how well minority students measured up to the two different types of achievement metrics hit me like a brick. Are our urban minority schools preparing students so poorly that even their very best-prepared can't compete? Is the SAT, upon which the Merit program is based, a flawed measuring tool? Are districts like HISD with a huge underrepresented minority population doing a disservice to their students to even administer the SAT if it doesn't reflect their strengths? Wouldn't universities have to find a more valid standard of assessing achievement or potential if districts like Los Angeles, New York, and Chicago just stopped giving it? Or is the problem in the way that the SAT is used?-- Cynthia Lanius

Admissions committees rely heavily on SAT scores at many higher educational institutions. They seem to believe that all students can be well-ordered according to some admissions criteria. For some not well-understood reason university admissions committees demonstrate an addiction to the use of one dimensional qualifiers like SAT scores in the admission process (perhaps because it's easy and cheap). Court cases in both California and Texas ruled that "better" students had been discriminated against because less "better" students were given preference (as if admission is a reward for being "better" on some set of criteria). In both cases the criteria leaned heavily on standardized testing.

In mathematics we know that it is not possible to well-order quantities that display many components of value. In the admissions process we value many student attributes, yet we fall back on the one-dimensional standardized test. Given the ineffectiveness of SAT scores as a predictor of success, minimizing or replacing it is essential. Bowen and Bok (1998) in the *Shape of the River* make the case

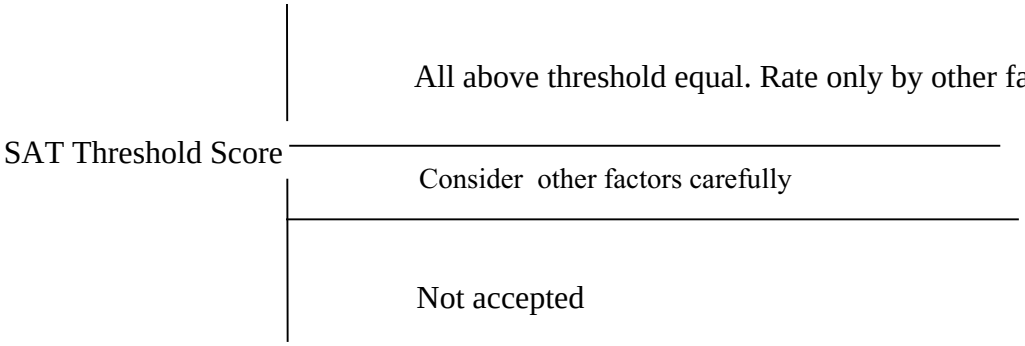
that heavy reliance on SAT scores diminishes the weight given to other criteria that are valuable indicators of both student potential and future achievement.

Many institutions of higher education don't use SAT (Community Colleges, for example). But selective schools are notorious for prizing perfect SAT scores above all else. Many colleges and universities are broadening admissions criteria however, and consequently de-emphasizing SAT. Rice University (1999) has rewritten its admissions guidelines to address the multi-dimensionality of students:

> First, we seek students, both undergraduates and graduates, of keen intellect who will benefit from the Rice experience. Our admissions process employs many different means to identify these qualities in applicants. History shows that no single gauge can adequately predict a student's preparedness for a successful career at Rice. For example, we are cautious in the use of standardized test scores to assess student preparedness and potential. In making a decision to admit or award financial aid, we are careful not to ascribe too much value to any single metric, such as rank in class, grade-point average, the Standard Achievement Test or Graduate Record Exam.
>
> Rice University seeks to create on its campus a rich learning environment in which all students will meet individuals whose life-experiences and world-views differ significantly from their own. We believe that an educated person is one who is at home in many different environments, at ease among people from many different cultures, and willing to test his or her views against those of others. Moreover, we recognize that in this or any university, learning about the world we live in is not by any means limited to the structured interaction between faculty and students in the classroom but also occurs through informal dialogue between students outside the classroom.
>
> Rice places a premium on recruitment of students who have distinguished themselves through initiatives that build bridges between different cultural, racial, and ethnic groups. In so doing, we endeavor to craft a residential community that fosters creative, inter-cultural interactions between students; a place where prejudices of all sorts are confronted squarely and dispelled.
>
> Our admissions process precludes any quick formula for admitting a given applicant or for giving preference to one particular set of qualifications without reference to the class as a whole. An inevitable consequence of this approach is that some otherwise deserving and well-qualified students will not be admitted to Rice. By selecting a wide range of matriculants of all types, the admissions process seeks to enrich the learning environment at Rice, and thus increase the value of a Rice education for all students.

In addition to de-emphasising SAT through broadening of criteria, we (Tapia, 1998) propose what we call a "threshold approach" to its use. In this approach, universities will establish a certain

minimum score deemed critical for success in that university. Then all scores above the minimum score are equal and will not be used to argue that one student is better than another. In essence, this criterion becomes a yes, no, or maybe question. Did the applicant achieve the minimum score? If yes, then they go into the SAT-acceptable pile and differentiations among the acceptable pile will be based on class rank, grade-point average, personal essays, leadership experience, letters of recommendation, contributions to the community, etc. If no, but close and otherwise exemplary in other criteria, deliberations will be made. If clearly no, the student will generally not be considered further without explanations of extenuating circumstances.



We maintain that we can not make meaningful distinctions in terms of real success between members of the group consisting of individuals who have scored, say 1050, and above. Moreover significantly many individuals with SAT scores between 1050 and 1300 will be equally or more successful than individuals with scores above 1300. So, 1050 is our threshold value. This means that all with scores above 1050 are deemed acceptable and other factors should be used to differentiate among the members of the acceptable group. Experience has taught us that at Rice it is unlikely that individuals with scores below say 850, will succeed. Now what can we say about the group of individuals with scores between 850 and 1050? Well, we need to look very closely at them and decide if they should be put in the reject class, the acceptable class, or some other class that would require additional information and study.

Rice University has been quite successful at implementing diversity in its undergraduate population and the threshold system deserves much credit for this success. The Rice Guidelines for Admission and Financial Aid included above strongly allude to a threshold approach to the use of SAT scores in the undergraduate admission process. On average, Rice's underrepresented minority students have substantially lower SAT scores then does the university at large which averages around 1300. However, they are on par with their non-minority counterparts in terms of retention rates and Rice grade point average. They bring in more than their share of awards and admissions to prestigious graduate and professional schools.

We realize that the parameters used in our presentation of the threshold approach to the SAT score are somewhat arbitrary. In a real situation they would have to be fuzzy numbers. However, it is really the concept that we want to discuss.

Sadly, we see a disincentive to universities to revise their SAT policies that have nothing to do with evaluation of students. National magazines and others who rank schools use students' average SAT scores as a way of evaluating the quality of schools. The College Board should take a much stronger stand than they have against this practice.

Look at 1999 scores disaggregated by both gender and ethnic group in Table 4. Notice that the only category where females outscore males is African American women verbal scores. In fact, the College Board describes the low numbers and poor academic preparation of African American and Mexican American ***men*** in particular as a grave concern. According to the College Board, men in these two ethnic groups have the lowest levels of academic preparation for college of any subgroup and are greatly outnumbered by women in these groups. "If such trends continue," former College Board President Donald Stewart said, "the nation will lack a cadre of well-educated black and Mexican American men well into the next century."

Table 4 SAT I 1999 Mean Scores for Males, Females, and Total by Ethnic Group

			SAT I Verbal
			Mean Scores
Ethnicity As Self Reported:	**Male**	**Female**	**Total**
American Indian or Alaskan Native	486	481	484
Asian, Asian American or Pacific Islander	502	495	498
African American or Black	432	435	434
Hispanic or Latino Background:			
Mexican or Mexican American	459	448	453
Puerto Rican	462	450	455
Other Hispanic or Latino	471	457	463
White	531	524	527
Other	515	508	511
No Response	493	490	492

			SAT I Math
			Mean Scores
Ethnicity As Self Reported:	**Male**	**Female**	**Total**
American Indian or Alaskan Native	499	467	481
Asian, Asian American or Pacific Islander	579	541	560
African American or Black	434	415	422
Hispanic or Latino Background:			
Mexican or Mexican American	476	441	456
Puerto Rican	470	433	448

Other Hispanic or Latino	488	446	464
White	548	512	528
Other	537	494	513
No Response	519	488	505

Source: 1999 College-Bound Seniors, National Report, SAT Program Information - 1999 College-Bound Seniors National Profile Report, http://www.collegeboard.org/sat/cbsenior/yr1999/NAT/natbk299.html

6. Mathematics Achievement -- Other criteria

We find it difficult to endorse some of the statements that are being made about how K-12 mathematical achievement is showing gains. We doubt if that resonates with either K-12 or university faculty. According to NSF Science and Engineering Indicators the "National Assessment for Educational Progress tests in 1990, 1992, and 1996 differed markedly from earlier assessments in that they were designed to reflect the relatively new content and teaching standards published by the National Council of Teachers of Mathematics (NCTM 1989 and 1991)". Serious disagreement exists among mathematicians and scientists about the sound-ness of the content changes suggested by the Standards. Many feel the content has been watered down. Has the assessment as well?

7. Course Taking Trends

During the 90's, most states increased mathematics course requirements for graduation. Texas, for example, went from 2 yearlong credits to 3. At the same time, they eliminated foundational mathematics courses and require those three credits to consist of algebra and higher. Consequently, more U.S. students are taking higher-level high school mathematics courses than ever before. Even though underrepresented minority students are also increasing their mathematics coursework, there remain substantial disparities among ethnic and minority groups. (NSB, 1998). This gap is apparent in geometry and algebra 2 as well as in the most advanced courses in the college preparatory sequence. About one-

quarter of Asian Americans/Pacific Islanders completed high school calculus compared with about 10 percent of whites, 6 percent of Hispanics, and 4 percent each of blacks and Native Americans.

However, despite the unequal enrollments, progress *has* been made in the proportion of students in all racial and ethnic groups taking advanced mathematics. Half or more of white, Hispanic, and Asian American/Pacific Islander students in the class of 1994 completed algebra 2 and geometry, the so-called gatekeeper courses for advanced study in mathematics and science. Large gains were made in groups underrepresented in mathematics between 1982 and 1994. The proportion of black students taking geometry increased from 29 to 58 percent between 1982 and 1994. The proportion of Hispanics went from 26 to 69 percent, and the fraction of Native Americans taking geometry rose from 34 to 60 percent over the period. These groups also experienced 20 to 30 percentage point gains in algebra 2. As noted before, these gains can be accounted for in good measure by the increased graduation requirements.

When you talk about course-taking, you must address quality and rigor of courses. How does an Algebra II class taught in a highly selective honors program compare to an Algebra II class taught in a low performing school? One might be hard-pressed to even recognize the two as the same entity.

8. Is AP the High Achievement Leveler?

Advanced Placement (AP) was developed in 1955 by The College Board in collaboration with the Educational Testing Service to give well-prepared students the opportunity to demonstrate mastery of college-level materials learned in high school. In mathematics, AP courses are offered in one-semester Calculus (AB), two-semester Calculus (BC), and Statistics. Exams are administered once annually in the spring. Exams are graded on a 1-5 scale, with anything above a 3 considered passing. Some colleges and universities give credit for a grade of 4 or 5 and less frequently 3. The high school AP Calculus course was designed for students who had demonstrated mastery of algebra, geometry, coordinate geometry, and trigonometry and is expected to be comparable to a college or university calculus course.

What frequently happens in inner-city schools is that students arrive at high school behind, less prepared than they should be. The ninth grade course becomes a glorified 8th grade course. Algebra becomes pre-algebra. Algebra II is a glorified Algebra I, etc. Being behind becomes the norm.

This presents a quandary for teachers in these schools. They have to meet students where they are. They can't say, sorry, you're not where you need to be so I'm not teaching you. Teachers know they're not teaching these courses at the rigor that they need to, that students coming out of these courses are not receiving the depth of understanding that they need. So what do they do?

Pockets of success have taught us that given sufficient time and effort, inner-city minority kids can excel, even to the AP level. AP holds promise for minority students. It's an external standard that judges students equally and rewards hard work. The AP program has been seen by many teachers and schools as a target for which to shoot. If students in the barrios can excel on the AP Calculus exam, then those students have received an objective, external assessment of quality, and teachers can be assured that their students are prepared to compete on a level playing field in college with students coming from majority schools.

Accessibility to AP programs varies widely. Obviously, lower performing schools may not be able to offer AP programs; students aren't working to that level of rigor. Secretary Riley has called for all U.S. high schools to offer at least one AP course within the next two years and ten within the next ten years. Merely saying now we're going to teach AP Calculus won't make a quality program. Pre-AP courses must be implemented all the way into middle school, and merely changing the name of a course from honors algebra to Pre-AP Algebra won't make any difference either. More time and more challenging material must be required, and teachers must have intensive and extensive professional development.

This push to AP Calculus is causing concern in some circles (Sanchez, 2000), and deserves a word of caution. AP Calculus is considered the pinnacle course in high schools, so students begin to think that calculus is the *really important* course - that everything else is just a prelude to prepare them

for calculus. This de-emphasis on other courses to rush to calculus has extreme negative consequences. On TIMSS, our Calculus students did very poorly, not on the Calculus sections, but on pre-calculus sections. Are students being rushed through the requisite courses -- Geometry, Algebra, and Trigonometry -- to get to the really important course -- calculus?

9. Overcoming the Preparation Hurdle

Programs have been developed that attempt to both identify and prepare minority students in a more effective way. One such program, the National Action Council for Minorities in Engineering (NACME, 2000) Vanguard Program identifies and recruits students from under-served communities, primarily urban areas, and provides them with intense academic preparation. NACME selects high schools with high minority enrollment, currently in metropolitan New York/northern New Jersey, Houston, Philadelphia, and Rochester, and works with school counselors and teachers to identify a pool of students interested in engineering. Their selection process is quite novel.

Contrast the traditional SAT with this: students gather in a classroom for a half-day, are divided into teams, and given a set of challenging problems to solve. Evaluators walk around observing the students and their problem solving strategies. Do they quickly get discouraged and give up, or persevere? Are they risk-averse, or bold and daring? Do they ask for help when they don't know what to do, or are they afraid to let it show? What kinds of questions do they ask? What understandings do they exhibit by their statements? Do they work well in a group? Using this assessment process, proven to be effective in evaluating students from a wide range of educational backgrounds, the program identifies seniors who are likely to be overlooked by student recruitment practices at engineering schools, but who possess the skills, motivation and interest to be successful in top tier engineering education environments.

Once identified, students participate in intense academic preparation programs that integrate math and science knowledge and immerse students in the culture of engineering delivered by a carefully

chosen cadre of university faculty members. Selected Vanguard scholars are offered scholarships to participating universities which include: Clarkson University, Drexel University, Lehigh University, New Jersey Institute of Technology, Rensselaer Polytechnic Institute, Rice University, Rochester Institute of Technology, Temple University, Texas A&M University, and Polytechnic University.

Could this ever scale to the nation's standard model (or perhaps standard option) of assessing and preparing SMET underrepresented minorities? It would be an extremely expensive and monumental task for national-scale numbers of students. But we recommend schools look further at this promising program.

10. Moment of Truth - Hitting the Minority to Majority Transition Wall

The national retention rate of engineering underrepresented minority students is 36.5% based on an analysis of the entering freshman classes from 1991 to 1993 and graduating classes from 1996 to 1998. The corresponding rate of engineering non-minority students is 68.3% according to a NACME study. NACME (Georges, 1999) characterized it this way: imagine the first-day-of-class-look-to-your-left-and-right scenario. For non-minorities, 1 of the 3 won't graduate as engineers. But for underrepresented minorities, 2 of the 3 won't. It's not that the students don't graduate, but not as engineers. Given the precious few entering, this loss is debilitating.

11. Profile of the challenge - Schools like Rice

Rice University, located in Houston, Texas, is a small, private university, with approximately 2700 undergraduate enrollment and 1400 graduate students. More than half of the graduate students are enrolled in SMET disciplines. Notable features of Rice include:

- Consistently ranked among the top 15 or so research universities, as reported in annual rankings in national magazines;
- Rated among the top three BEST BUYs for higher education each year since 1992;
- Twenty-eight seniors, the highest proportion of any university in the nation, won highly coveted

National Science Foundation Fellowships for graduate study in science and engineering in 1998;

- Twenty Rice faculty are members of the National Academy of Sciences and/or the National Academy of Engineering; and
- Rice's two Nobel Prize winners in Chemistry have spent their entire academic careers here.

Consider the following data (Rice University, 2000) as they relate to Rice's selectivity:

Table 5 Freshmen Entering Fall 1999

Number of applications	5,740
Students admitted	1,595
Admit rate	28%
Students enrolled	675
Yield rate	42%

Table 6 Freshmen SAT Scores

Verbal	
Top 25% of class scored above	760
Top 75% of class scored above	650
Math	
Top 25% of class scored above	760
Top 75% of class scored above	660

Table 7 Freshmen HS Class Rank

Percentage who were ranked #1	24%
Percentage who were ranked #2	17%

High school class rank in top 5%	75%
High school class rank in top 10%	86%

Table 8 Freshmen Other Entering-Class Distinctions

	Number
National Merit Finalists	170
High school varsity athletes	306
Organization presidents	169
Editors-in-chief (newspapers, yearbooks)	59
Community service activists	318
Members of student government	96
Student Council presidents	27
Senior-class presidents	14
Boys State or Girls State participants	56
Speak more than one language	107
Organization Founders	24
Published Writers	15

...and two members of the national champion Physics bowl team, two members of the world championship pipe and drum band, a two-time Grand Prize of the International Science and Engineering Fair, a member of a national computer science championship team, a member of a national championship dance team and many, many, more.

Table 9 Undergraduate Ethnic Enrollment (Fall 1999)

African American	192	7%

Asian	427	15%
Hispanic	297	11%
International	72	2%
Native American	19	1%
White/Not Reported	1,778	64%
Total	2,785	

Rice University charges the lowest tuition of any highly selective private college or university in the United States.

Table 10 Tuition, Fees, Room and Board

Undergraduate tuition	$15,350
Fees	$446
Room and board	$6,600
Total	$22,396

Approximately 3/4 of Rice undergraduates receive some form of financial aid. Merit-based scholarships at Rice are awarded to exceptional students whose effort and contributions have made a positive and lasting impact on their communities. Part of the assessment includes the following essay question:

> What perspective do you feel that you will be able to share with others as a result of your own life experiences and background? Cite a personal experience to illustrate this. Most applicants are able to respond successfully in two to three pages.

Rice is within the purview of the Fifth United States Circuit Court of Appeals, and therefore all activities must fall within the constraints of "Hopwood". Although the limits imposed by this ruling could be viewed as impeding the development of programs directed at minority students, we have

chosen to use the Court's decision and its accompanying restrictions (perhaps soon to be faced nationally) as a challenge to develop programs that facilitate entry and degree completion for minorities, yet remain within the confines of the law.

Despite minority recruiting efforts, Rice undergraduate minority admissions dropped in ’97-’98, the first year after this court decision. After implementation of the Rice University Guidelines for Admissions and Financial Aid mentioned earlier, enrollment has been more favorable with approximately 20% of the incoming freshman class comprised of minorities.

12. How do Underrepresented Minority Students Fare at Rice?

Spring 2000, Graduate Student Erin Cesteros conducted a survey of Rice's minority students to analyze some of the challenges to minority students at a highly selective school like Rice. Although some students had regrets, the number of students who are satisfied with their overall Rice experience points to a positive Rice experience for most underrepresented minority students. Several students spoke to the difficulties they face from inadequate preparation and some with their discomfort with majority institutional culture. We've decided to include several of their statements here to demonstrate the nature of students' concerns.

- Rice is very demanding and it is hard to get the respect you deserve.
- Sometimes I think that I would be happier with myself and my achievements if I had attended a school that was less academically intensive and didn't stress me out most of the time.
- In such an environment of high academic excellence, I've noticed that sometimes people can come across moments when they feel very stupid in comparison to everyone else. I don't think Rice has done a good job of offering us encouragement or any comments regarding this. Only one professor has mentioned this feeling and tried to combat it. Freshmen year it's hard to deal with

this feeling when you're still trying to make the transitions and are faced with so many different things than you have been before college.

- My GPA would be higher at any other school.
- At times, it feels that my chances of standing out and succeeding are lowered by intimidating competition from students who have come from more advanced high schools. Sometimes I wonder why I am working so hard when I could be receiving the same degree and a better GPA back home.
- Rice has not been an environment where I have felt comfortable. I did not make friends easily. I felt very different from the other students. I felt dumb. I have not been able to regain the confidence I once had. I did not succeed here.
- Too academically challenging. No time for myself. Too strenuous.

Sometimes a principal or parent will call our office after a minority student has been denied admission to Rice. Without fail, we agree with the admissions decision. A school like Rice is not for all students - minority or majority. The transition may just be too large. Tapia says that if he'd attended Rice that he wouldn't have a Ph.D. today. The academic rigor is just too intense for many. Yet, we must reiterate that many of Rice's minority students survive the challenges and thrive. Bowen and Bok showed that many of those who do succeed at schools like Rice go on to positions of leadership.

13. What if Rice or Harvard won't accept me?

Am I a failure if I have to go to a non-research school, a mid-sized state school? Is community college a dead end street? Much of the success that we have had at Rice in minority graduate education has been with students from this profile of school. We frequently advise students who may not have the preparation to come to Rice, to go to a good school and be an A student, and any graduate school in the country will accept them. As to community college, both authors attended community college. It can be

a good bridge with good teaching, but students face one extra transition point if they attend community college.

What about minority serving institutions? ("Strengths and Weakness," 1998). The strengths of minority institutions tend to be the weaknesses of majority institutions and vice versa. Minority institutions nurture students - they build self confidence. At majority institutions, minorities often feel isolated and unwanted. Yet minority institutions often lack the resources needed to provide the academic opportunities that students can have at schools like Rice. At Rice we have had both examples of success and failure with students from minority undergraduate institutions. Some students are well prepared at minority institutions and are ready to hit the ground running in graduate school. But for some, the minority to majority transition is a real moment of truth, both academically and socially, that can result in failure if strong intervention is not performed.

14. Succeeding in a post-affirmative action environment

In March 1996, the Court opinion in the case of Hopwood vs. Texas held that affirmative action programs in matters of higher education admission are a violation of Federal law. In Texas, that ruling was subsequently extended in an opinion by State Attorney General Dan Morales to also encompass financial aid programs based on race. Under anti-affirmative action rulings (like Hopwood) race or ethnicity cannot be considered as a factor in either admissions or scholarship awards. Proposition 209 places the same constraints on California. It is naive to assume that programs across the country that regard race will not likewise be challenged. The country *must* be ready to implement programs that will promote minority participation, but do not consider race as a factor. One goal of Rice's AGEP program is to refine and institutionalize at Rice the most effective methods of accomplishing this. Some techniques that we have used effectively in our SaS program and CAAM Department include:

- Recruiting at schools with high minority enrollment,
- Recruiting minority students at majority schools,
- Considering factors that correlate directly to ethnicity such as economic factors, first-generation

college background, and

- Personal contact with a network of faculty/students through conferences and mailings.

It is arguable that affirmative action was presumably a good idea that was a failure. It allowed schools and systems to get by with under-preparing its minority students. We like the notion of "affirmative development" where equity demands that you provide sufficient support for all groups to achieve at high levels. We're concerned with the 10% solution (accepting the top 10% of all schools) (Carnevale, 1999). Students are beginning to choose less rigorous schools so that they'll fall into the top 10%, thus being less prepared for the college work once they get there.

15. Promoting Graduate study - The Big Three

We see a trend developing here: we have a small percentage of underrepresented minorities entering college SMET degree programs. Then their retention rate as undergraduates is half that of majority students. Does it surprise anyone that a lower percentage of minority students go on to complete a PhD (see Table 13)? We'd like to discuss three main factors identified as barriers to graduate SMET education.

Table 13 - Science, math, engineering, and technology degree attainment by race.

Race/ethnicity	1987 B.S.	1990 Masters	1995 Ph.D.	% of Bachelor's earning Masters in 3 years	% of Masters earning Ph.D. in 5 years	% of Bachelor's earning Ph.D. in 8 years
Total	203,600	36,709	13,076	19.9%	35.6%	7.1%
White	171,376	28,601	9,048	18.5%	31.6%	5.8%
Asian	13,527	3,492	3234	27.5%	92.6%	25.4%
African American	10,108	914	255	10.3%	27.9%	2.9%
Hispanic	7,878	877	330	12.2%	37.6%	4.6%
Native American	711	79	38	12.5%	48.1%	6.0%
Unknown	0	2,746	171			

NOTE: Table includes U.S. citizens and permanent residents only and excludes social and behavioral sciences.
SOURCE: *Science and Engineering Indicators, 1996. Women, Minorities, and Persons with Disabilities in Science and Engineering, 1996 and 1998.*

15.1 Recruitment

Attempting to increase the numbers of underrepresented minorities in their SMET graduate programs, well-intentioned universities increase student funding to recruit the nation's better minority

students. The reasoning goes like this: University X gives $18,000 fellowships. So let's give $20,000, then we'll get the minority students. This strategy may increase diversity on specific campuses, but does *nothing* to increase the minority SMET pool nationally. These specific outstanding students would have succeeded anywhere. The country will never resolve the underrepresentation crisis, regardless of dollars invested, if universities merely compete for the precious few minorities that are identified through traditional assessment measures. Under traditional models, recruitment is defined as enticing the "best" minority students to come to *that particular* university over competing universities. We must redefine recruitment to mean identifying, motivating, and preparing students for graduate education that would not be identified under traditional models. This approach results in an increase in the overall number of students. In fact, the Rice Computational and Applied Mathematics Department (CAAM) has built its success on this type of student. Few, if any of the current minority CAAM graduate students would have been recruited or accepted in a research university with strict adherence to traditional assessment models.

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15.2 Admissions

Change the SAT into GRE in the above discussion, intensify it by letting research faculty make the decisions on students at the department level, and you have the problems associated with graduate admissions. Using our current formal and often arbitrary criteria, especially GRE score, many minority students do not meet the "standards" within a discipline and are rejected for graduate study, often despite the potential to achieve and contribute in their selected field.

In general, graduate departments seek students with a demonstrated potential for carrying out research, and, for the most part, use a traditional set of criteria that they believe is predictive: research experience, letters of recommendation and test scores. While there is general agreement that students with low scores will not succeed, with several students in the Rice program, this has not been the case. Consider a student who graduated from a large state university with 3.2 GPA and a GRE verbal

percentile of single digits who now has a Ph.D. in the engineering school and a tenure-track faculty position. In every case, these students have been dedicated, creative, and persistent, qualities that are difficult to capture in application materials. A major goal of the Rice MGE program is to gain a further understanding of a fuller range of predictors for success in graduate school and to ensure that each predictor is given appropriate weight in decision-making.

15.3 Retention

Not only is the goal to significantly increase enrollment by minority students in graduate programs but to ensure completion of the graduate degree by those who enroll. This aim can be realized only by addressing fundamental and important issues in the culture of the institution and creating a community that recognizes and values diversity and provides a supportive structure for students.

Over the last several years, Tapia's program has earned national recognition for its success in recruiting, admitting, and retaining minority graduates in the Computational and Applied Mathematics department. This program operates year-round in providing a supportive and interactive environment for participating students. To aid in its dissemination and replication at other universities and to uncover the essential elements contributing to its success the Learning Through Evaluation, Adaptation, and Dissemination (LEAD) Center, University of Wisconsin, Madison (Alexander, Foertsch, & Daffinrud, 1998) conducted an evaluation with the following conclusions.

Participants in the program at Rice by 1997 had included 33 Hispanic American and 27 African American undergraduate and graduate students. The LEAD Center's evaluation revealed that 95% of those who had participated in the program were either enrolled in graduate or professional school or were employed in a computational sciences-related area. Further, of the graduate student participants, only 3% had left the program without a degree (17% had obtained an M.A. degree and were still enrolled for the Ph.D., 40% were still enrolled, 13% left with M.A. degree, and 27% had left with a Ph.D. degree). The program had significant impact on whether the student desired to attend or remain in

graduate school, with almost 90% reporting that their participation had "increased somewhat" (30%) or "increased greatly" (59%) their desire to pursue graduate study.

The LEAD Center identified the following elements as key components of the program. In the study, the factors deemed most important in increasing the participants' desire to attend/remain in graduate school were (1) being in the company of other minority students, (2) interactions with the Program Director, (3) interactions with other students, (4) interactions with mentor, (5) discussions about professional development, (6) discussions about race, and (7) doing research in a university setting. Critical elements of the program identified by the evaluation include:

A Program Director who:

- Supports and encourages students through individual mentoring relationships and builds their confidence to pursue and persist to graduate degrees;
- Serves as a guide to the academic world by providing professional development information and opportunities to participants;
- Maintains a position of power within the university, actively supporting and advocating for the students' academic and financial interests;

Even though students rated that the Program Director be a minority is important, we are proceeding under the assumption that we can determine in this experiment whether a Cluster Leader who possesses all of the other attributes but is not him/herself a minority will be able to serve effectively. What we believe will be required is sensitivity to the issues that face minority students and utilization of current minority graduate students who can provide perspective and frank feedback when necessary. The final results will indicate whether this assumption is valid and will influence how this model is disseminated elsewhere.

A Nurturing Community that:

- Surrounds participants with students from similar backgrounds who understand their experiences firsthand;

- Provides a tier of mentoring relationships between students at different levels so that each student can both be a mentor and be mentored;
- Allows support to come from many individuals rather than having students rely on a single mentoring relationship;
- Surrounds students with successful graduate student role models;
- Has continuity and is sustained through having students participate for multiple years;
- Is fully integrated into the life of the department and receives legitimacy through connections to a respected research center;
- Provides an open forum for discussions about race and ethnicity;
- Provides instruction, practice, and encouragement in professional development; and
- Provides a home base of support for ethnic minority graduate students on the Rice University campus.

To create this community, participants meet weekly during the academic year and twice weekly during the summer with their cohorts and Faculty Leader for discussions on current education, professional development, race/ethnicity, or other issues that pertain to members of the group. More senior graduate students mentor those more junior, who in turn also mentor the undergraduates. The Faculty Leader will advocate with the university as needed for the students' financial and academic needs. As a part of the cluster's functioning, participants will do outreach to the community, especially in K-12. Participants will be expected to attend and present at conferences and will assist each other in and critique presentations that they make. Participants become ambassadors for recruitment as they talk to prospective students.

A Research Project that:

- Allows students to experience and learn about the research process through working on an open-ended research problem;

- Provides students with an introduction to the world of academic research and graduate

16. What can We Learn from Women's Movement?

Over roughly the same time period that the nation has attempted to increase participation by minorities, we have attempted to increase participation of women. It is clear that in most areas, the women's movement has been more successful than the minority movement (Mortenson, 1999). We hasten to add that this work is not complete; we are not suggesting that the women's movement has been totally successful, but women have made great strides in many fields.

Are there any lessons learned that can be exported to minority movement? Are the issues parallel?

What has happened to minority males? After examining 1997 SAT data, Donald Stewart, former head of the College Board identified African American and Mexican American males as the lowest performing sub-groups (College Board 1997). Walk into historically black universities and colleges and you will see a majority female population. Consequently, gender equity programs directed towards females in cities with majority minority populations make little sense. What kinds of programs are needed to engage minority males in science?

17. Conclusion

There clearly are no simple solutions to the underrepresentation problem. The nation's almost 17 million underrepresented minority students still lag in their preparation all up and down the K-Graduate continuum. They are not receiving an education that prepares them or motivates them for a career in science or technology. Public policy must address these systematic inequalities, not with a crutch, but with a major overhaul of the system.

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