U.S. COMMISSION ON CIVIL RIGHTS

Encouraging Minority Students to Pursue Science, Technology, Engineering and Math Careers

BRIEFING REPORT

OCTOBER 2010

U.S. COMMISSION ON CIVIL RIGHTS

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- Investigate complaints alleging that citizens are being deprived of their right to vote by reason of their race, color, religion, sex, age, disability, or national origin, or by reason of fraudulent practices.
- Study and collect information relating to discrimination or a denial of equal protection of the laws under the Constitution because of race, color, religion, sex, age, disability, or national origin, or in the administration of justice.
- Appraise federal laws and policies with respect to discrimination or denial of equal protection of the laws because of race, color, religion, sex, age, disability, or national origin, or in the administration of justice.
- Serve as a national clearinghouse for information in respect to discrimination or denial of equal protection of the laws because of race, color, religion, sex, age, disability, or national origin.
- Submit reports, findings, and recommendations to the President and Congress.
- Issue public service announcements to discourage discrimination or denial of equal protection of the laws.

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Encouraging Minority Students to Pursue Science, Technology, Engineering and Math Careers

A Briefing Before
The United States Commission on Civil Rights
Held in Washington, DC

Briefing Report

Letter of Transmittal

The President
The President of the Senate
The Speaker of the House

Sirs and Madam:

The United States Commission on Civil Rights ("Commission") is pleased to transmit this report, *Encouraging Minorities to Pursue Science, Technology, Engineering and Math Careers*. A panel of experts briefed the Commission on September 8, 2008, on possible reasons that minority students who begin college intending to major in science, technology, engineering or math ("STEM") leave these disciplines in disproportionate numbers before graduation. They also discussed possible ways to improve the retention of these students in STEM degree programs. Based on that briefing, the Commission developed the findings and recommendations that are included in this report.

The Commission found that regardless of their racial or ethnic backgrounds, college freshmen show equally substantial degrees of interest in STEM careers. Despite similar levels of interest, the Commission found that black and Hispanic students are ultimately less likely to major in or obtain doctoral degrees in STEM disciplines than are whites and Asians. Data presented to the Commission indicated that racial and ethnic discrimination in college is not a substantial factor in these disproportionate STEM attrition rates. It found that academic mismatch—one consequence of some schools' racially and ethnically preferential admissions policies—is an important reason for these disparities, however.

For example, data indicate that success in STEM majors depends both on a student's absolute entering academic credentials and his or her credentials relative to other students in his or her classes. When black and white students have the similar academic credentials black students are actually more likely than their white counterparts to obtain STEM degrees. Thus, the Commission ascribed the higher minority attrition from STEM programs to credentials gaps or "mismatch" stemming in part from racially preferential admissions policies.

The Commission recommended that selective colleges not admit any STEM student with a large deficit in academic credentials relative to its STEM median without fully informing that student of the potential impact of such deficit on that student. Such disclosure should include the school's record of graduating students with similar academic credentials in STEM majors. Similarly, the Commission urged high school guidance counselors to advise students about the impact of large deficits in academic credentials on success in a particular college's STEM program. It further noted that well-designed academic support programs can sometimes help students with modest deficits in credentials to succeed in STEM programs and advised schools to

implement the best practices employed by such programs and make admitted students aware of their availability.

Part A, which consists of the body of this report, was approved on June 11, 2010 by Chairman Reynolds and Commissioners Gaziano, Heriot, Kirsanow and Taylor. Vice Chair Thernstrom abstained, and Commissioner Yaki voted against. Vote tallies for each of the Commission's findings and recommendations, which make up Part B of the report, are noted therein.

For the Commissioners,

Gerald A. Reynolds,
Chairman

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Executive Summary

The Commission held a briefing entitled, "Encouraging Minority Students to Pursue Science, Technology, Engineering and Math Careers." In particular, the Commission examined why minority college students who begin their college studies intending to major in science, technology, engineering or math (STEM) leave these disciplines in disproportionate numbers before graduation.

Experts appearing before the Commission were Professor Richard Sander of the University of California at Los Angeles (UCLA) Law School; Dr. Richard Tapia, Maxfield-Oshman Professor in Engineering at Rice University; Dr. Rogers Elliott, Professor Emeritus of Psychological and Brain Sciences at Dartmouth College; Dr. Thomas Fortmann, Massachusetts Board of Elementary and Secondary Education; and Ms. Robin Willner, Vice President of Global Community Initiatives at IBM Corporation.

Of particular interest to the Commission on this occasion was the "mismatch hypothesis." The mismatch hypothesis holds that students whose academic credentials are significantly different from the average student in the class may learn less than they would have learned in a class in which their academic credentials "matched" those of the average student. Mismatch may be positive or negative. Students who are positively mismatched – that is, their academic credentials significantly exceed those of their peers – may not be sufficiently challenged by the material. As a result, they may become bored or disengaged. Students who are negatively mismatched – that is, their academic credentials are significantly below those of their peers – may feel overwhelmed by the speed at which difficult material is being taught. They may get lost – even though they could have mastered the material had it only been taught at a slower rate.

Under this hypothesis, aggressive affirmative action or any admissions decision for largely nonacademic reasons can lead to negative mismatch for any student, including underrepresented minorities.[1] Well-meaning efforts to benefit these students can, if the mismatch hypothesis is correct, cause these students to drop out of STEM programs in disproportionate numbers. The result is fewer, not more, minority physicians, scientists, and engineers.

In this briefing, the term "mismatch" did not include the admission of students with small academic deficits who, with the kind of support offered by the colleges and universities they attend, would remain interested in STEM and able to successfully complete a program.

There was substantial agreement among the witnesses. None disputed the evidence that blacks and Hispanics are at least as likely to express interest in STEM majors as whites prior

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[1] The terms "minority," "non-Asian minority," and "underrepresented minority" refer to the same group and were used interchangeably by the panelists.

to attending college. None disputed the evidence that blacks and Hispanics abandon their STEM ambitions in greater proportions than do whites and Asians.

Two witnesses, Dr. Sander and Dr. Elliott, each presented an empirical study that supported the mismatch hypothesis at the undergraduate level. None of the other witnesses disputed either study. Indeed, to one extent or another, they all agreed on the peril that results when a minority student, usually unknowingly, accepts an offer of admission at a college or university at which he or she is mismatched. All the witnesses agreed that prospective students should be informed that his or her academic credentials are substantially below the average at a particular school. Students could then make an informed decision about which school to attend.

No one took the position that the elimination of mismatch in admissions would eliminate the disparities in average STEM credentials upon completion of high school between black and Hispanics students on the one hand and white and Asian students on the other. Mismatch is simply a piece of the puzzle at the college level.

Rather than highlight mismatch, Dr. Fortmann emphasized the difficulty of attracting competent STEM teachers to K-12 schools, which he blamed for inadequate college preparation. Dr. Tapia conceded that the data on mismatch presented by Dr. Sander and Dr. Elliott "are entirely credible to me because they reflect what I have seen at Rice." While he stated that he did "not dispute the data," he took issue with what he perceived to be the conclusions they drew from it and advocated instead strong support and mentoring programs at the graduate level. He emphasized the need for "an equitable presence" of minorities at top research university graduate programs in STEM, where minority faculty members can serve as both role models and mentors.

Ms. Willner discussed a report entitled, "Out Before the Game Begins: Hispanic Leaders Talk About What's Needed to Bring More Hispanic Youngsters into Science, Technology and Math Professions," sponsored by IBM.

Based on this testimony, the Commission made the following findings and recommendations: (Please see next page).

Findings and Recommendations

Findings

1.) Science, technology, engineering, and mathematics (STEM) graduates are important to the U.S. economy because they enable the United States to maintain its preeminence in STEM fields. [Approved (7-0): Chairman Reynolds, Vice Chair Thernstrom, Commissioners Gaziano, Heriot, Kirsanow, Taylor, and Yaki voted in favor.]

2.) Black and Hispanic high school seniors exhibit about the same degree of interest in pursuing STEM careers as white students (Asian students are still more interested). But despite these initially high levels of interest, black and Hispanic students are less likely to major in or obtain a doctoral degree in STEM disciplines than are whites and Asians. [Approved 4-2-1: Chairman Reynolds and Commissioners Gaziano, Heriot, and Kirsanow voted in favor; Vice Chair Thernstrom and Commissioner Yaki voted against; Commissioner Taylor abstained.]

3.) Data presented to the Commission showed that success in a STEM major depends both on the student's absolute entering academic credentials and on the student's entering academic credentials relative to other students in the class. When a student is in a class in which his or her entry credentials are significantly different from the median student, the student is "mismatched" for that class. This mismatch causes a loss of learning, either because the positively mismatched student is not challenged by the material or because the negatively mismatched student feels overwhelmed by the speed at which the material is being taught. [Approved 4-1-2: Chairman Reynolds and Commissioners Gaziano, Heriot, and Kirsanow voted in favor; Commissioner Yaki voted against; Vice Chair Thernstrom and Commissioner Taylor abstained.]

4.) Data presented to the Commission indicated that racial or ethnic discrimination in college was not a substantial factor in black and Hispanic college students' disproportionate attrition from STEM majors. The evidence showed that when black and white students have the same academic index scores, black students are more likely than white students to receive a STEM degree. [Approved 4-0-3: Chairman Reynolds and Commissioners Gaziano, Heriot and Kirsanow voted in favor; Vice Chair Thernstrom and Commissioners Taylor and Yaki abstained.]

5.) The practice of racial and ethnic preferences is one way in which black and Hispanic students may be admitted to a college or university at which their entering academic credentials are significantly lower than those of their peers. When top tier colleges and universities use racial and ethnic preferences to recruit and admit minority students with academic credentials that are significantly below their median — but match the median of lower tier colleges — the resulting mismatch at the top tier institutions has a cascading effect through many lower tiers as each tier engages in racial and ethnic preferences to recruit and

admit black and Hispanic students who do not match the mean in its respective tier. Although the consequence of this cascading mismatch is not the principal reason for the current disparities between blacks and Hispanics and whites and Asians in STEM (see Finding 3 regarding absolute credentials), it is a significant reason. There are fewer black and Hispanic physicians, scientists and engineers today than there would have been if colleges and universities had not recruited and admitted black and Hispanic students with significantly lower academic credentials than their average student. [Approved 4-1-2: Chairman Reynolds and Commissioners Gaziano, Heriot, and Kirsanow voted in favor; Commissioner Yaki voted against; Vice Chair Thernstrom and Commissioner Taylor abstained.]

6.) The high STEM-major attrition rate of students with credentials deficits indicates that many students and their parents may be unaware of the significance of mismatch for students' success in STEM fields because of the lack of institutional transparency. [Approved 4-1-2: Chairman Reynolds and Commissioners Gaziano, Heriot and Taylor voted in favor; Commissioner Yaki voted against; Vice Chair Thernstrom and Commissioner Kirsanow abstained.]

7.) One panelist indicated that some graduate schools that have intensive support programs have been successful in ameliorating the effects of a moderate degree of mismatch. [Approved 4-1-2: Chairman Reynolds and Commissioners Gaziano, Heriot and Kirsanow voted in favor; Commissioner Yaki voted against; Vice Chair Thernstrom and Commissioner Taylor abstained.]

Recommendations

1.) A selective college or university should not admit any student with a large deficit in academic credentials relative to its median student without fully informing the student of the impact this deficit could have. Such deficits place students at a high risk of failure. [Approved 5-3: Chairman Reynolds and Commissioners Gaziano, Heriot, Kirsanow and Taylor voted in favor; Vice Chair Thernstrom and Commissioners Melendez and Yaki voted against.]

2.) In addition to providing other appropriate support and advice to students interested in STEM majors and careers, high school guidance counselors should advise these students about the significant impact of large deficits in academic credentials on college performance. [Approved 5-3: Chairman Reynolds and Commissioners Gaziano, Heriot, Kirsanow and Taylor voted in favor; Vice Chair Thernstrom and Commissioners Melendez and Yaki voted against.]

3.) Each individual student's right to decide which school to attend -- based on the best available evidence and with help from parents and advisors -- should be respected. To aid students with the decision-making process, schools with STEM programs should disclose to all admitted students their projected college grade point averages (and the range of error). Schools should also disclose to interested students the school's track record for graduating

students with similar academic indices in STEM majors. [Approved 4-3-1: Chairman Reynolds and Commissioners Gaziano, Heriot and Taylor voted in favor; Vice Chair Thernstrom and Commissioners Melendez and Yaki voted against; Commissioner Kirsanow abstained.]

4.) Well-designed academic support programs can sometimes help students with modest deficits in credentials to succeed in STEM programs. Schools should study and implement the best practices employed by successful academic support programs. Schools should also routinely disclose information about academic support services to all admitted students. [Approved 5-3: Chairman Reynolds and Commissioners Gaziano, Heriot, Kirsanow and Taylor voted in favor; Vice Chair Thernstrom and Commissioners Melendez and Yaki voted against.]

5.) K-12 schools should recruit qualified math and science teachers using, if necessary, pay adjustments and incentives. [Approved 7-0: Chairman Reynolds, Vice Chair Thernstrom, and Commissioners Gaziano, Heriot, Kirsanow, Taylor and Yaki voted in favor; Commissioner Melendez did not participate in the vote.]

Summary of Proceedings

Richard Sander

Professor Richard Sander[2] has both a Ph.D. in economics and a JD, and is a professor at UCLA Law School where he conducts empirical research on social policy. He began by discussing the different underrepresentation rates among major racial groups with respect to earning an undergraduate or doctoral degree in general education and in STEM disciplines.[3] His data analysis[4] indicated that black students were less likely than white students to earn a bachelor's degree of any kind or a doctorate, relative to their proportion of the general population. Professor Sander stated that underrepresentation in science is even more disproportionate: blacks are 36 percent as likely as whites to earn a bachelor's degree in science, 15 percent as likely to earn a doctorate in science, and 8 percent as likely to earn a non-biological science doctorate. He said that underrepresentation among Hispanics was similar to that of African-Americans with respect to undergraduate and graduate degrees, but that Asians were overrepresented in science relative to their population numbers. He added that within a science degree population, however, Hispanics are better represented relative to their concentrations in other disciplines.

Professor Sander set out four hypotheses to explain STEM underrepresentation among non-Asian minority students (slide 3):

- Black and Hispanic students are less interested in science than whites and Asians (Hypothesis 1);
- Black and Hispanic students have lower achievement levels and credentials by the time they finish high school, which affects their subsequent success rate (Hypothesis 2);
- Minority students have worse outcomes because of factors such as discrimination or inadequate support (Hypothesis 3); and
- Many capable minority students go into science but struggle or leave those disciplines because of mismatch. Professor Sander defined "mismatch" as any loss of learning that occurs because of a disparity between the credentials of a student and the median credentials of his classmates in a learning environment (Hypothesis 4).[5] Such disparities can be the result of admissions policies that emphasize affirmative action.

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[2] STEM Briefing Tr. (hereinafter Tr.) at 11-23. Professor Sander stated that he was presenting preliminary research, subject to revision, based on data obtained in July 2008 from the University of California, Office of the President. Dr. Sander stated that he was collaborating with several other scholars in a study of science mismatch in the University of California system that he hoped would be completed in 2009. During his testimony, he referred to projected images (slides 1–20) which can be found at the end of this summary.

[3] Please refer to slide 2; slide 1 is a title page. Subsequent references to slides will appear in the text.

[4] His data interpretation showed relative proportions of general and science degrees earned by college-aged students of different races compared to a white norm set at 100. This data interpretation showed that black students were 56 percent as likely to earn a BA of any kind, and 43 percent as likely to earn a Ph.D.

[5] According to Dr. Sander, "positive mismatch" occurs when a student is not challenged, since the student can learn more and at a faster rate than his classmates; "negative mismatch" occurs when a student falls behind or feels overwhelmed because of the speed or complexity with which material is presented.

Professor Sander found evidence to support both Hypothesis 2 and Hypothesis 4. On the other hand, the evidence he presented contradicted Hypothesis 1 and Hypothesis 3.

Professor Sander presented data from several studies that showed black and Hispanic high school seniors are at least as interested in becoming science majors as whites. Based on this research, Sander argued that Hypothesis 1 (black and Hispanic students are simply less interested in science careers) is unsupported (slides 4, 5).

By contrast, Professor Sander found that his data supported Hypothesis 2 (black and Hispanic high school graduates have lower achievement levels and credentials that affect their STEM success rate) and was probably the major explanation for both their lower graduation rates in general and higher attrition rates in science in particular (slide 6).

Professor Sander explained that a widely-read book on affirmative action, *The Shape of the River,*[6] by William Bowen and Derek Bok, has somewhat obscured the relationship between entering academic credentials and academic success. In that book, Bowen and Bok presented evidence that at elite schools, SAT scores are not a good predictor of the likelihood of graduation and that graduation rates are high from these schools regardless of SAT scores.[7] Sander stated that any conclusion that SAT scores don't matter to academic success or to graduation rates in general is fundamentally wrong and has not held up to further research.

To illustrate the relationship between entering academic credentials and academic success, he offered an analysis of data obtained from the University of Michigan on several thousand undergraduates who matriculated in 1999. This database made use of an "academic index" assigned to each student by the University of Michigan, which took into consideration both standardized test scores and high school record. Grouping students into three cohorts based on whether they had received a large preference, a moderate preference, or no apparent preference, Sander found that black students who received a large preference had a four-year graduation rate of 21 percent, compared to a 73 percent four-year graduation rate for black students who received no preference (slide 10). A broadly similar pattern held for whites. He also offered data from the National Longitudinal Survey of Freshmen, which showed that students, both black and white, with higher academic credentials have higher four-year graduation rates than those with lower academic credentials (slide 11). Both sets of data showed also that blacks with high credentials had a higher four-year graduation rate than whites with similar credentials.

Professor Sander attempted to demonstrate that what is true for graduation rates also holds for concentration in the sciences: high credentials are important. He observed that for the

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[6] William Bowen & Derek Bok, *The Shape of the River*, (Princeton University Press 2000).

[7] Bowen and Bok looked only at elite schools and only at SAT scores, not at other academic credentials like high school grades. At some schools, students with SAT scores above the school's median may tend to have lower high school grades than the average student's and vice versa; indeed this may account for why the student is attending that school and not a more (or less) competitive one. As a consequence, efforts to show how well SAT scores predict academic success that do not control for high school grades will obscure rather than reveal an important relationship.

1999 Michigan entering students, 5 percent of blacks who received substantial preferences ended up majoring in science or engineering, compared with 43 percent of blacks who received no preference (slide 9). His analysis revealed that whites displayed a similar pattern: 4 percent of those who received a large preference ended up majoring in science or engineering, versus 33 percent who received no preference. As with graduation, Dr. Sander stated that blacks with high academic credentials were more likely to major in science or engineering than were whites with the same credentials. He determined that this not only supported Hypothesis 2 (credential levels have a significant impact in producing science graduates), but contradicted Hypothesis 3 (discrimination and inadequate academic support undermine black and Hispanic academic performance). If high-credential blacks are more likely to major in and graduate from science programs than high-credential whites at Michigan, then Dr. Sander did not think it likely that discrimination plays a meaningful role in STEM attrition.[8] He stated that the problem is that blacks (and to a lesser extent, Hispanics) are far more clustered in the lower-index/high-preference ranges at Michigan than are whites and Asians.

To examine Hypothesis 4 (the effect of "mismatch" on minority success in science), Dr. Sander turned to his analysis of a large data set that he obtained from the University of California, Office of the President (UCOP), that covered nearly a half-million UC students from 1992 through 2006 (slide 13). He stated that to test mismatch, one must compare students with similar credentials who are attending institutions with different degrees of admissions selectivity (slide 12). He stated, for example, that a student with solid but not outstanding credentials might be close to the student median at UC Santa Barbara, but be able to attend UC Berkeley only with the benefit of a significant preference, and thus be potentially affected by mismatch (slide 13). He believed that the UCOP data set makes it possible to compare many thousands of similar students in different academic settings.

Dr. Sander said that his preliminary analysis of the UCOP data strongly supports his mismatch hypothesis (slides 14–19). When he compared students at Berkeley and UCLA whose credentials were substantially lower than the median with similar students attending other UC campuses, the students at less selective campuses had much higher probabilities of graduating with a science degree, often double the science graduation rate of such students at Berkeley and UCLA. He said this held true whether or not one limited the analysis to students intending to major in science in college, or if one considered only underrepresented minority students or all students with potential mismatch at Berkeley or UCLA. It also held true at several different time periods.

Dr. Sander also compared students at UCLA and Berkeley whose credentials were equal to or stronger than their median classmates with similar students at other campuses. Since these students would not be mismatched at UCLA or Berkeley, mismatch theory would predict that they would not be at any disadvantage at those schools. Dr. Sander's data (slide 19) found

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[8] Dr. Sander noted that in slide 10's data set, blacks (and to a lesser extent, Hispanics) are far more clustered in the lower-index/high-preference ranges at Michigan than are whites and Asians, meaning that conclusions as to high-preference white rates are based on relatively few data points.

that these students had higher science graduation rates at Berkeley and UCLA than the average rate for the median students at the other six UC campuses.

Professor Sander also reported on data from the Collegiate Learning Assessment study,[9] which attempts to measure student learning at nearly 200 American colleges (slide 20). He examined cross-section data on factors influencing whether a student was a math major, including as independent variables student credentials, "mismatch" (measured by the gap between a student's credentials and the average credentials of his peers at that college), race, and gender. His analysis found that the degree of mismatch between student and school was the strongest (and very negative) predictor of seniors choosing to major in math; credentials were also strongly predictive, while neither sex nor race predicted pursuit of a math degree. He viewed this, too, as supporting hypotheses two and four (the role of credentials and mismatch) and as cutting against hypotheses one and three (student interest and discrimination).

(Note: Professor Sander's slides begin on the following page.)

[9] *See* http://www.ssrc.org/press/cla-study (accessed Apr. 6, 2009).

Slide 1

Does the "Mismatch Effect" Reduce the Ranks of Minority Scientists?

A Presentation to the
US Civil Rights Commission
September 12, 2008
Dr. Richard Sander, UCLA

Slide 2

How Significant Is the Racial Gap in Science?

Freq Rel to Pop	White	Black	Hispanic	Asian
Gen Pop	100	100	100	100
BA	100	56	33	128
Ph.D.	100	43	21	130
BA Science	100	36	41	454
Ph.D. Science	100	15	26	703

Slide 3

Four Possible Hypotheses

- Hypothesis 1: Black and Hispanic students are less interested in science than whites and Asians.
- Hypothesis 2: Lower achievement and credentials for Blacks and Hispanics by the time of high school graduation translates to lower success rates in science during and after college.
- Hypothesis 3: Minority college students studying science have worse outcomes than similar white and Asian students, because of factors like discrimination.
- Hypothesis 4: Many talented minorities interested in science are admitted through preferences into colleges where their credentials are much lower than those of their classmates. This “mismatch” causes them to struggle in science classes and either leave science or leave college.

Slide 4

Hypothesis One: Are minorities less interested in science?

- The evidence is consistent and overwhelming that Black and Hispanic high school seniors are slightly *more* interested in a science career than are whites. (Asians are still more interested, by a substantial margin.)
- When credentials are taken into account, the higher level of Black and Hispanic interest is even more pronounced.

Slide 5

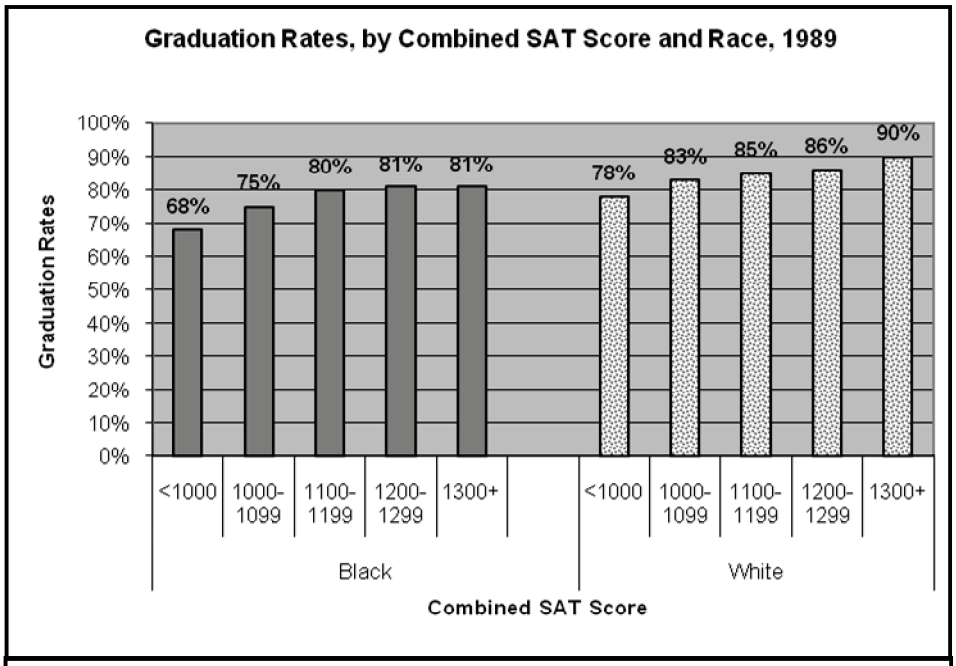
Comparison Group	Proportion of students of each race intending to major in science			
	White	Black	Hispanic	Asian
University of California – Average	34.7%	37.5%		52.6%
University of California-2004-2006	37.3%	40.5%		57.1%
HERI-CIRP data (Astin et al.)	27.3%	34.2%	35.7%	52.6%
Rogers Elliott data (4 elite institutions)	41.4%	44.2%	44.0%	55.0%

Slide 6

Hypothesis Two: Do achievement levels through high school shape later success in science?

- Yes, very much so.
- There's a mythology that's been fostered by many defenders of affirmative action that credentials have little or no impact upon success in college. What matters is not one's preparation going in, but which college one attends. Hence, preferences are crucial.
- This was a core proposition advanced by Bowen & Bok in *The Shape of the River*.

Slide 7



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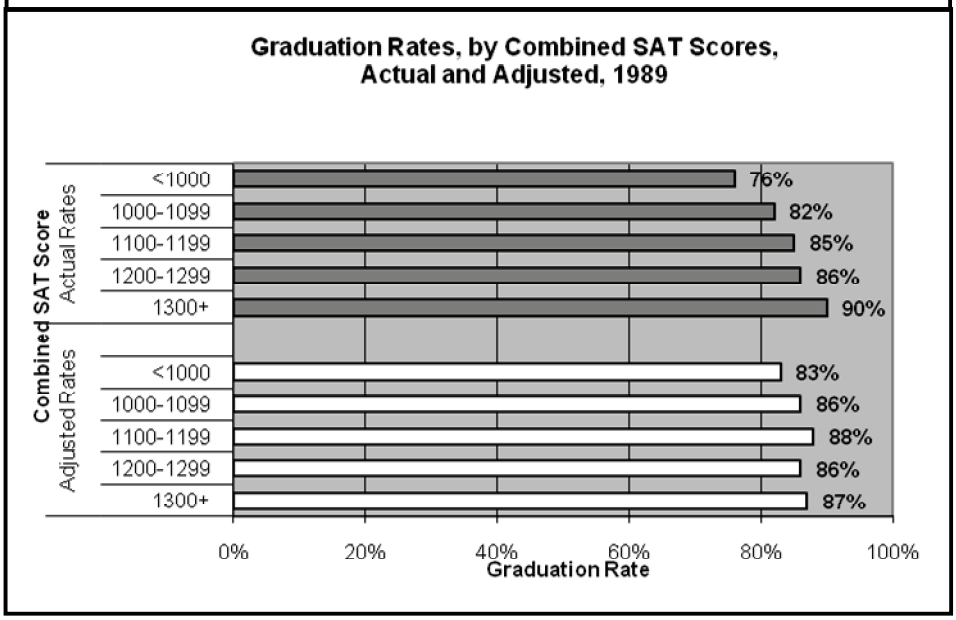

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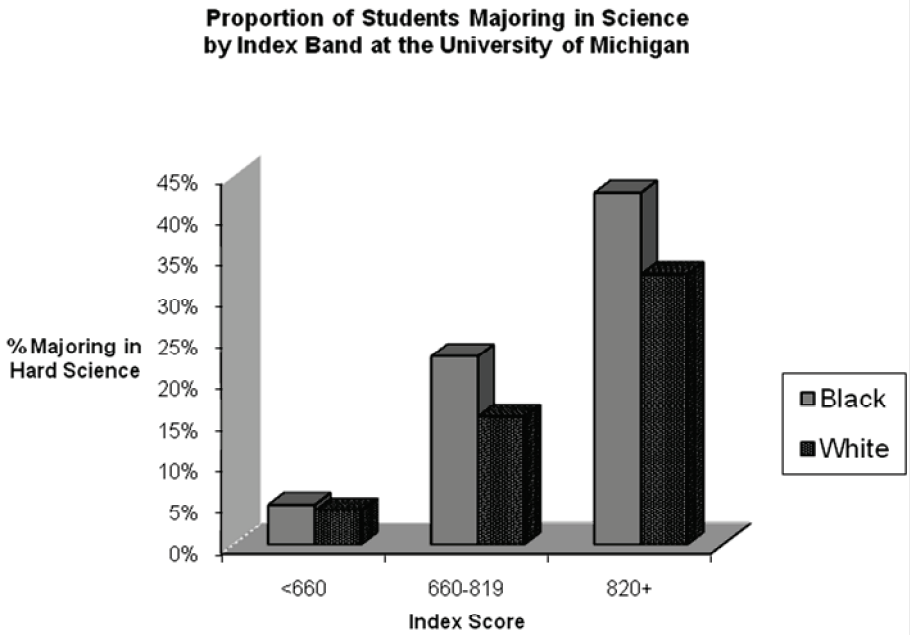


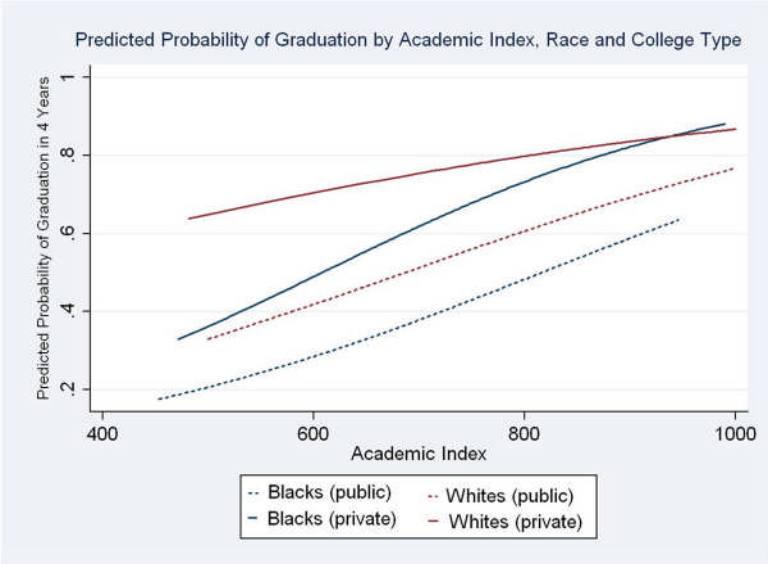
Slide 10

Michigan 4-Year Graduation Rates

1999 Entering Cohort	Large Preference	Moderate Preference	No Preference
Whites	35%	52%	70%
Blacks	21%	50%	73%

Slide 11

National Longitudinal Survey of Freshmen



Slide 12

Hypotheses Three and Four

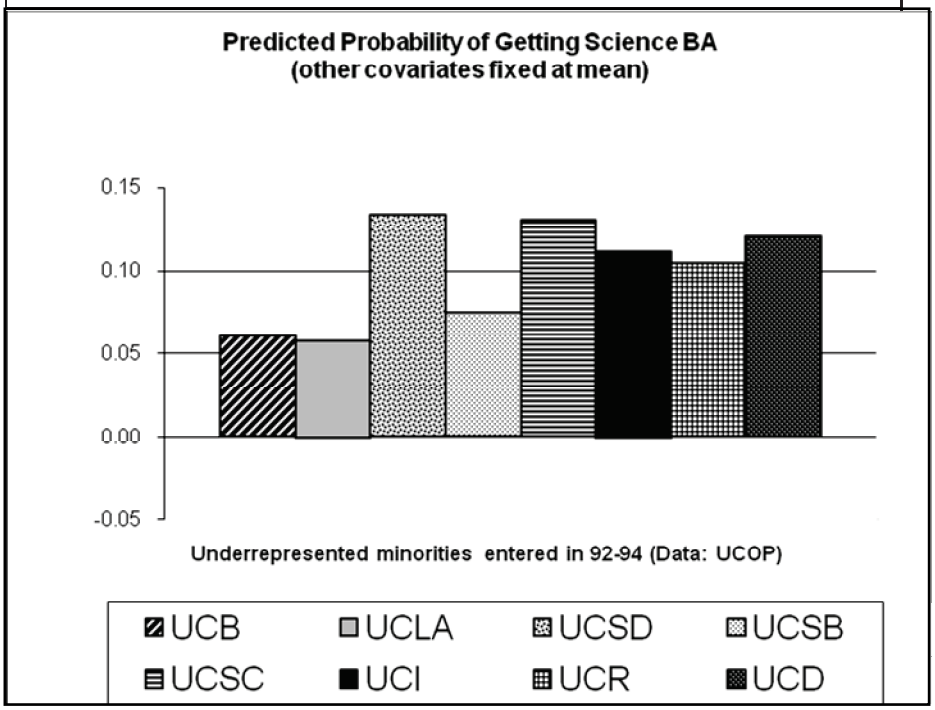
- From my preliminary examinations of the data, it seems likely that “credential gaps” that exist at the end of high school account for 60-75% of the “science achievement” gap between Blacks and Hispanics, on the one hand, and whites on the other.
- To oversimplify, a central question is whether the rest of the gap is due to poor treatment of minorities in college or to the “mismatch” effects resulting from preferences.
- To test this, we want to compare similar students who experience different levels of mismatch, and we want to compare outcomes that control for race, mismatch, and credentials.

Slide 13

The University of California data

- In the past six weeks, Project Seaphe has obtained an enormous volume of data from the UC system, covering the period 1992-2006 across eight UC campuses, ranging from the very elite (Berkeley and UCLA) to very good but non-elite schools (Riverside and UC Santa Cruz). It is possible to examine college outcomes – in particular, the outcome of getting a BA in science – by comparing students who are heavily "mismatched" at Berkeley with similar students who attend other UC campuses. These students will be substantially mismatched at UCLA, but only moderately mismatched at other campuses.

Slide 14



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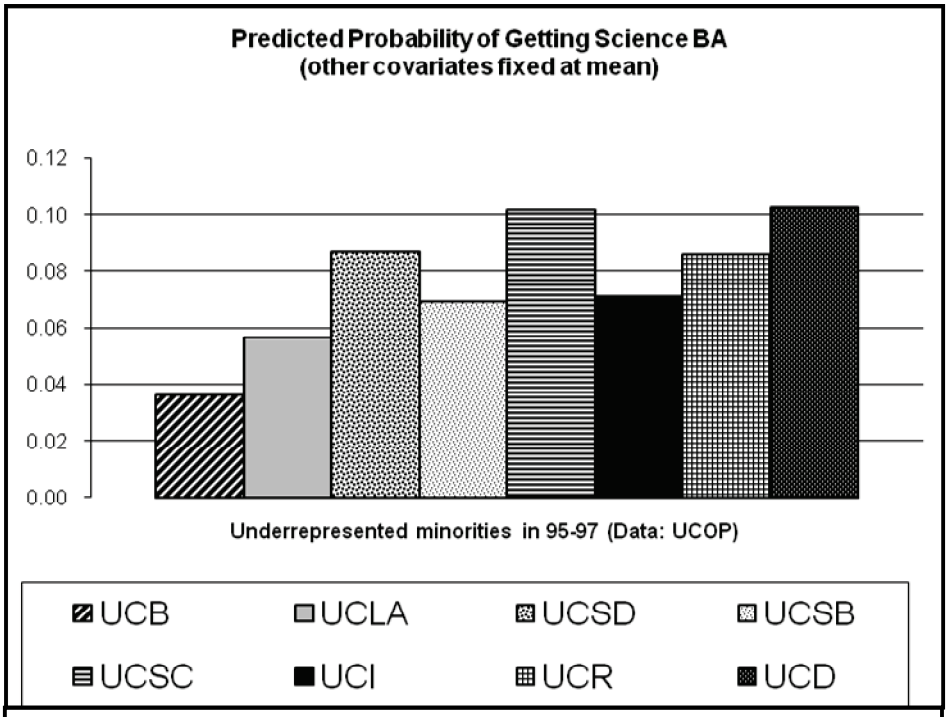
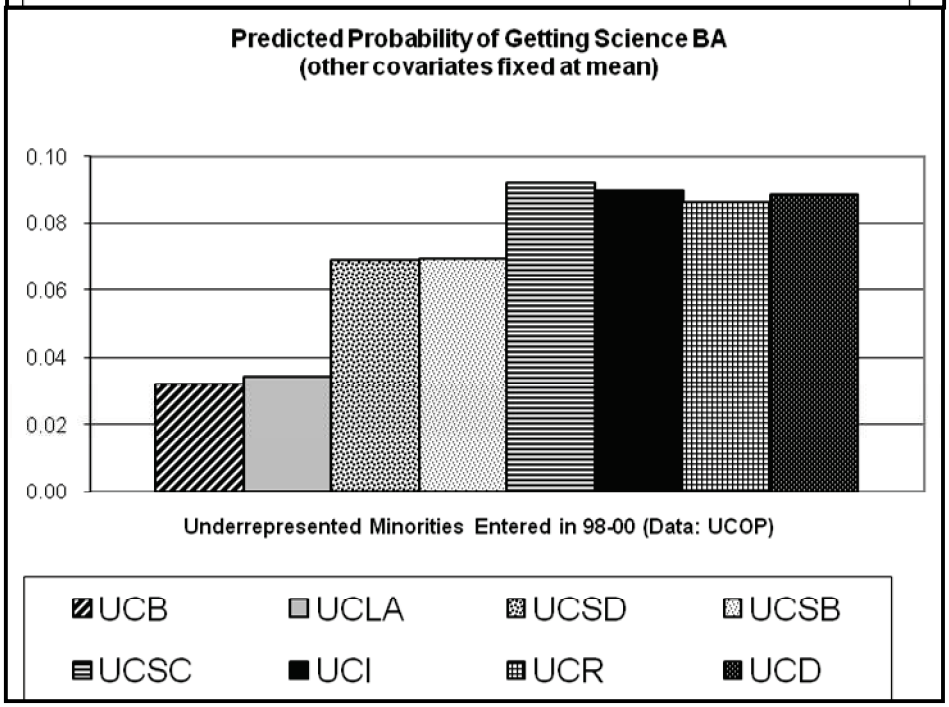
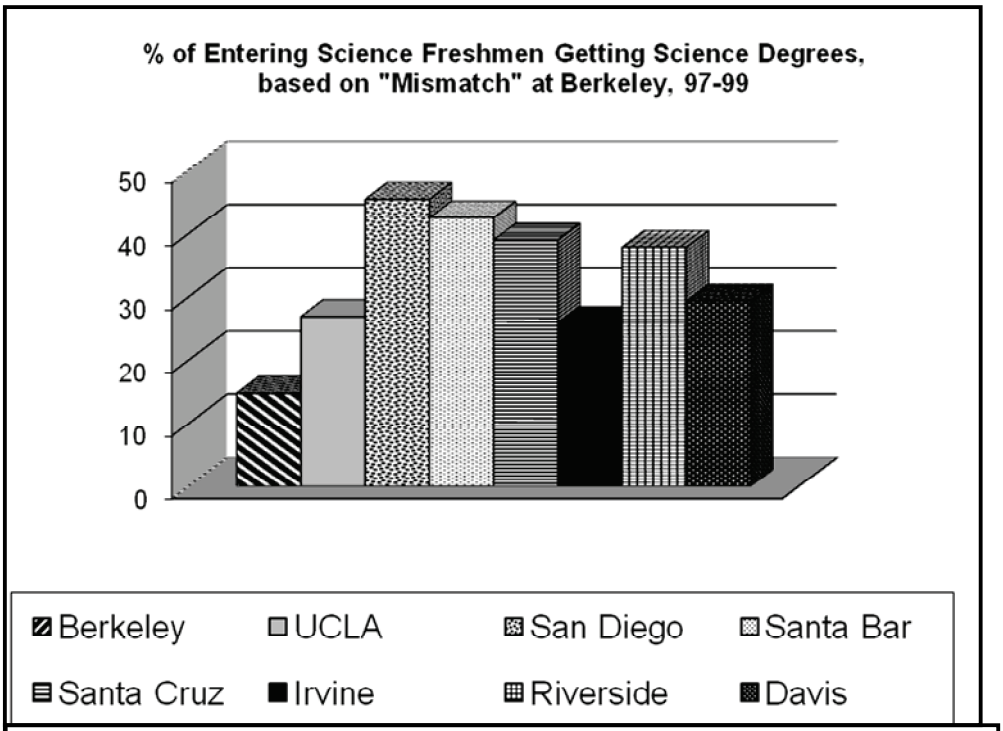


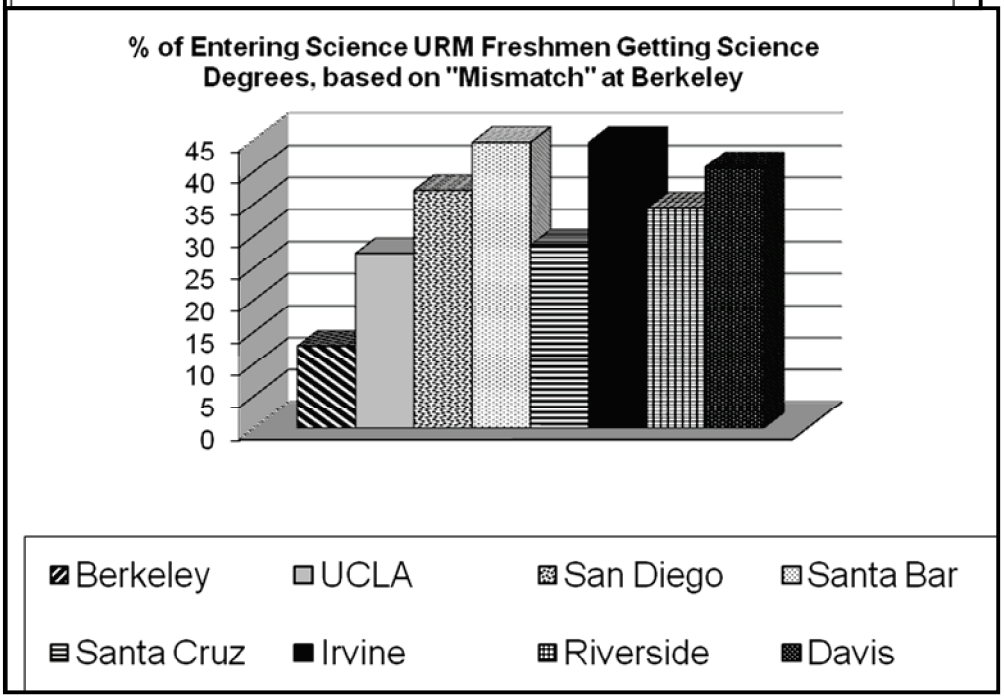
Slide 16



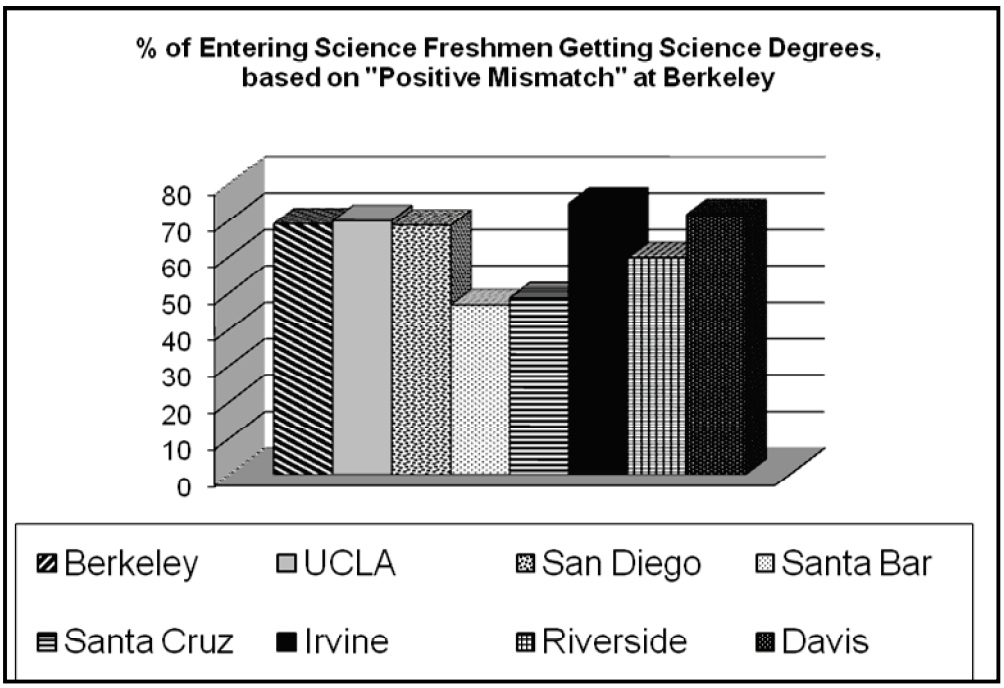
Slide 17



Slide 18



Slide 19



Slide 20

An analysis with CLA data
Examining Predictors of Being a Math Major
As A College Senior

Variable	Standardized Coefficient	Significance Level
Intercept	n/a	<.0001
SAT	.19	<.0001
Mismatch	-.25	<.0001
Gender	-.03	.41
Black	.006	.91

Richard Tapia

Dr. Richard Tapia,[10] Rice University Professor of Engineering and Director of the Rice Center for Excellence and Equity in Education, stated that under his leadership, Rice University has produced what he believes is likely the largest number of underrepresented-minority math, science, and engineering doctoral graduates in the country. Unlike the testimony of Dr. Sander and Dr. Elliott, Dr. Tapia's testimony centered on graduate, rather than undergraduate, education. He noted that Rice University is a highly competitive top research university.

Dr. Tapia recounted his personal history as an underrepresented minority whose parents came to the United States from Mexico, and his early education at a below-average high school in Los Angeles where he was not counseled to attend college despite his mathematical talent. He praised math teachers at the community college he attended for directing him to UCLA, where he earned a doctorate in math. He described his achievements, such as being the first native-born Hispanic elected to the National Academy of Engineering, first minority mathematician promoted to the rank of University Professor, and an appointee to the National Science Board under President Clinton. Dr. Tapia also cited minority STEM graduates who have gone on to distinguished careers.[11]

He stated that the STEM disciplines are a fundamental asset to national economies, and that the United States leads the world in STEM higher education, producing STEM leaders for most of the world's industrial nations. He stated that top research universities choose faculty with doctorates from top research universities, and that professors with doctorates from minority-serving or less prestigious schools are not considered for faculty positions in top schools.

Dr. Tapia did not dispute Dr. Sander's and Dr. Elliott's data supporting the mismatch theory.[12] He did state, however, that in his view, minority students and faculty must have an "equitable presence" at top research universities to serve as role models and mentors. He asserted that including the larger number of Ph.D.s from lesser universities in data showing total numbers of minority STEM graduates would perpetuate the stereotype that minorities receive inferior STEM education. He said the proper form of affirmative action is ensuring that very capable students are not excluded by an overly rigid use of standardized test scores. In his program, he applies a cutoff score, both to exclude those who have little chance of succeeding and to include those who may be on the threshold but will succeed with good mentoring. He stated that applicants with combined math-verbal scores of 1400 or above are well able to succeed, and he does not base admissions judgments on scores that are at or above that level. With regard to cutoff scores, Dr. Tapia agreed with Dr. Sander that there is

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[10] Tr. at 23-24.
[11] *See* Dr. Tapia's statement in the "Statements" section.
[12] In his written statement, Dr. Tapia stated: "The mismatch theorists have focused light on a huge problem that I have been fighting at Rice for 20 years. The data they present are entirely credible to me because they reflect what I have seen at Rice. So I do not dispute the data. It is the recommendations they make based upon the data that are terribly flawed." See Tapia Statement below at page 35 of this report.

much more predictive information at the lower ranges of SAT scores than there is at the top, meaning that someone with combined math-verbal scores below 800 will probably not be successful in any STEM discipline. He stated that each year his program rejects several applicants with perfect 1600 SAT scores because test scores are not enough to predict success.

Dr. Tapia claimed success in graduate student retention by providing peer/faculty mentoring and community-building, eliminating deficiencies in preparation, and combating minority students' perceptions of isolation, which he considers the chief problem in many cases.

At the same time, he agreed that admission without retention is of negative value.[13] Moreover, he conceded that most efforts to increase minority presence in STEM graduate programs and faculties have not been effective.

He nevertheless stated that bringing a minority-serving school up to the level of Rice is not as realistic as creating retention programs at Rice that would have the same retention success rate as those at the minority-serving institutions. Dr. Tapia stated that a student with lower STEM grades from a top research school is stronger than a student with top grades from a minority-serving school. He concluded his remarks by emphasizing that "treating everyone the same is not good enough,"[14] and "if we leave schools alone and don't fix them, then the disaster that is happening will continue."[15]

Rogers Elliott

Dr. Rogers Elliott,[16] Emeritus Professor of Psychological and Brain Sciences at Dartmouth College, stated that his data supported Dr. Sander's findings concerning mismatch (Dr. Elliott noted that his analysis and data published in 1996 formed an early instance of what Dr. Sander termed "the mismatch hypothesis."[17]) and that race preferences in admissions were harming the aspirations of some black students seeking to be scientists. He asserted that the differences are largest at the most selective universities because of their high admissions standards (two standard deviations above average in developed ability), which some minorities, especially some black students, fail to meet.

Dr. Elliott described his research among 5,300 students in four Ivy League schools between 1988 and 1992.[18] He reported that the black versus white/Asian gap in SAT scores has actually widened since 1988, and is now about 209 points. His data included the students' high school and college transcripts, and SAT scores. The results (slide 1) showed that an

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[13] Tr. at 28.
[14] Tr. at 34.
[15] *See* http://www.caam.rice.edu/~rat/cv/minority/mismatch_theory_statement_2008-09-12.htm (accessed Jan. 8, 2009).
[16] Tr. at 34–43.
[17] Rogers Elliott, A. Christopher Strenta, Russell Adair, Michael Matier and Jannah Scott, "The Role of Ethnicity in Choosing and Leaving Science in Highly Selective Institutions," 37 Res. in Higher Ed. No. 6 at 681-709 (1996).
[18] Dartmouth College; Brown, Cornell, and Yale universities. Tr. at 39.

equal portion (about 43 or 44 percent) of incoming students of the three major racial/ethnic groups (with whites and Asians combined as one group) intended to major in science, but that the science persistence rates were considerably lower for Hispanics and blacks: 34 percent for blacks and 56 percent for Hispanics, versus 62 percent for the white/Asian group.[19] These data showed that the average incoming SAT math score for whites and combined white/Asian groups interested in science majors was 715 (the 50th percentile of all incoming students); the average SAT math score for Hispanics was in the 16th percentile, and the average SAT math score for blacks was in the 4th percentile of the white/Asian distribution, a difficult competitive position.[20] A general college preparedness score called the academic index, which consists of high school grades and rank, and achievement and SAT test scores, showed similar percentiles for the racial groups in Dr. Elliott's data.

Dr. Elliott emphasized that because science knowledge is hierarchical (meaning that a student must understand material in one course before advancing to the next) students who arrived unprepared for the level and pace of work at the highly selective schools in his study were unable to advance successfully through the course sequence compared to the 90 percent of students who were well prepared. His data showed that science grades broken down by SAT math scores reflect this.[21] More specifically, 90 percent of science majors had SAT math scores of 650 or better; of that group, 80 percent were white or Asian students. Only 25 percent of black students in the four Ivy League schools reached that score. Since the score of 650 appeared to be a break point in the function describing the relation between SAT math scores and the probability of majoring in science (slide 2), blacks were clearly at a disadvantage.

Dr. Elliott's STEM retention data for white/Asian students was 63 percent, 56 percent for Hispanic students (Dr. Elliott viewed this figure as quite good), and 34 percent for black students. He stated that for the year 2008, SAT math score data indicate that only about 3,200[22] black students in the country reached 650, a number he viewed as problematic for STEM recruitment to elite research institutions. He contrasted the 50 percent chance that someone in the top third of SAT math scores in a very selective school would get one of the science degrees awarded, with the 15 percent chance that a student in the bottom third would get a science degree. At a less selective institution, a student with an SAT score that would

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[19] Students who dropped out of science programs did not usually drop out of school; they may have switched to other majors.

[20] Dr. Elliott's data as presented to the Commission in three slides, showed an entering average Hispanic SAT math score of 653 and an entering average score for black students of 607. The slides are reproduced immediately after this summary.

[21] For a more detailed explanation, please see the attached statement of Dr. Elliott, also available at http://www.seaphe.org/pdf/elliott-ethnicity.pdf (accessed Jan. 8, 2009).

[22] Dr. Elliott submitted corrections by communications dated April 1, 2009 and July 7, 2009. SAT score data for 2008 show that black students who scored at or above 650 on the SAT math section were at the 98th percentile of black SAT-takers that year. *See* http://professionals.collegeboard.com/profdownload/sat_percentile_ranks_2008_cr_m_w_gender_ethnic_groups.pdf (accessed Feb. 20, 2009).

be relatively low for a very selective institution would increase his chances of getting a science degree.[23] (slide 3).

Dr. Elliott acknowledged the value of a degree from a top school.[24] He stated that he did not know how to address this dilemma, other than to point out that it is probably better for an aspiring black scientist to go to a school where he or she could get a science degree than to suffer the consequences of relative unpreparedness in a school where he or she was overmatched.

Dr. Elliott's slides are reproduced below.

Slide 1

Table 2, Revised and Simplified
Preadmission and College Performance Measures for Students Initially Interested In Science

Measures	White/Asian (N=1782)		Hispanic (N-95)		Black (N=157)	
	M	Percentile	M	Percentile	M	Percentile
A. Preadmissions						
% initial interest	43.3		44.0		44.2	
Number HS Science Courses	9.95	50	9.58	38	9.47	35
HS Science Grades	3.76	50	3.62	33	3.44	15
HS Other Grades	3.68	50	3.51	38	3.46	34
SATM	715	50	653	16	607	4
SATV	626	50	563	20	541	13
SAT II, ACH	678	50	630	23	573	6
Academic Index	207.2	50	193.7	15	182.4	4
B. College Performance						
Science Grades	2.98	50	2.46	23	2.21	14
Other Grades	3.23	50	2.97	32	2.85	24
% Science Majors	62.3		55.8		33.8	
% Termination	4.1		10.5		14.6	

Note. – "Percentile" refers to the place on the White/Asian distribution of the average member of each group

[23] Dr. Elliott referred during his testimony to three slides on view during his briefing testimony. This is labeled "Slide 3" in this Commission report. This table can also be found at page 701 of that article and is entitled, "Table 4. Percentage of Earned Degrees in the Natural Sciences as a Function of Terciles of the SATM Distribution in 11 Institutions."

[24] Dr. Elliott noted that the biggest undergraduate science degree-granting schools for blacks in this country were not considered prestigious.

Slide 2 (Figures for four Ivy League schools)

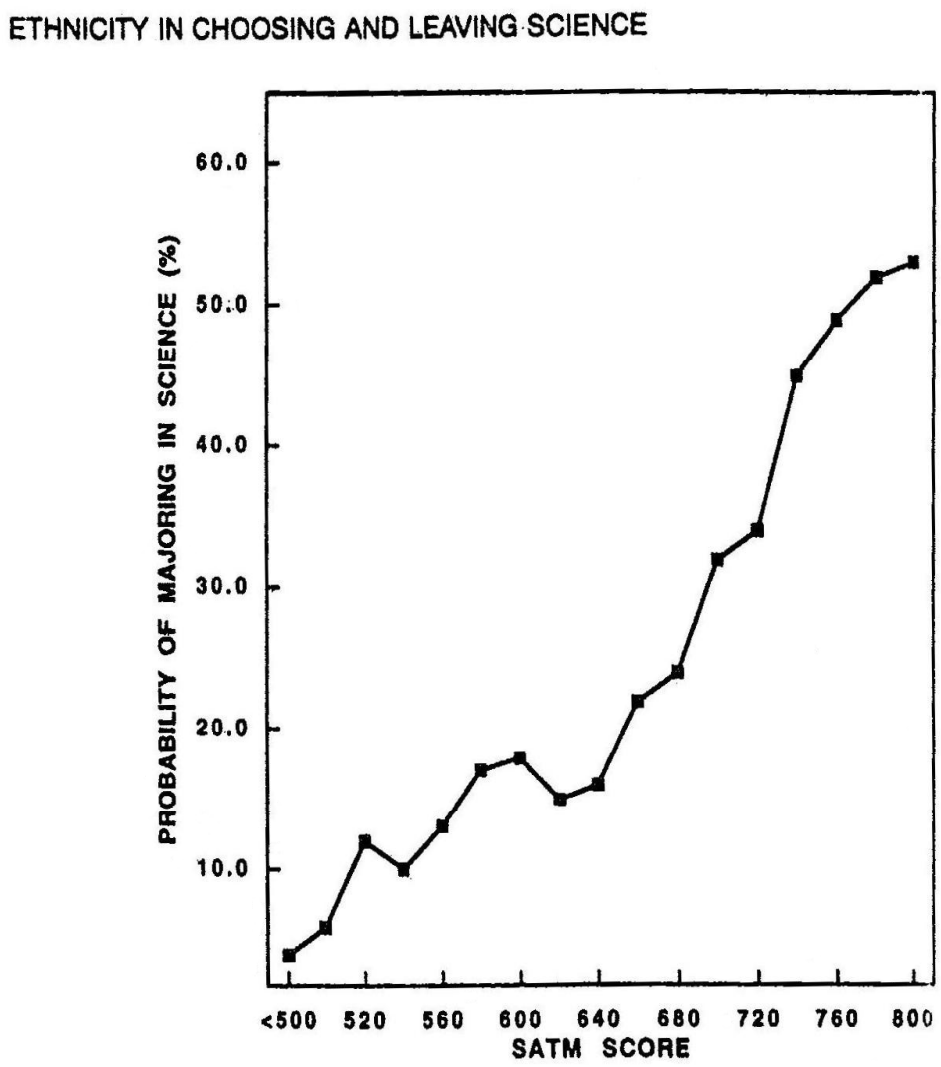

FIG. 2. Probability of majoring in science given a particular SATM score.

Slide 3

	Tercile 1		Tercile 2		Tercile 3	
Institution	**% Degrees**	**SATM**	**% Degrees**	**SATM**	**% Degrees**	**SATM**
Institution A	53.4	753	31.2	674	15.4	581
Institution B	57.3	729	29.8	656	12.9	546
Institution C	45.6	697	34.7	631	19.7	547
Institution D	53.6	697	31.4	626	15.0	534
Institution E	51.0	696	34.7	624	14.4	534
Institution F	57.3	688	24.0	601	18.8	494
Institution G	62.1	678	22.6	583	15.4	485
Institution H	49.0	663	32.4	573	18.6	492
Institution I	51.8	633	27.3	551	20.8	479
Institution J	54.9	591	33.9	514	11.2	431
Institution K	55.0	569	27.1	472	17.8	407
Medians	53.6		31.4		15.4	

Note : Percentages indicate the proportion of natural science degrees awarded to students as a function of terciles of the SATM score distribution. SATM numbers are mean scores for each tercile, which vary depending on the selectivity and general level of developed ability that characterizes an institution. SATM is the score on the mathematical reasoning section of the Scholastic Assessment Test.

Thomas Fortmann

Dr. Thomas Fortmann,[25] who has an undergraduate degree in physics from Stanford and a doctorate in electrical engineering from MIT, provided a teacher's view of the two questions posed by the Commission's briefing topic: 1) why minority students disproportionately leave STEM disciplines, and 2) whether better matching between student and school means that more are likely to succeed.

His answer to the first question was that anyone who arrives in college with inadequate STEM preparation will have difficulty finishing a science major, and that certain minorities frequently have not had adequate K-12 science and math preparation. He described the cumulative nature of math knowledge, which requires that students master information in sequence.

He recounted his efforts to improve STEM teaching by founding an institute to train elementary school teachers in mathematics content. He stated that attempts by programs such as Massachusetts's STEM Pipeline Initiative[26] which attempts to prepare more K-12 students for further STEM study, are well-intentioned, but do not address the root cause of the problem. He offered as an example a simple fractions question given to fifth- and sixth-grade

[25] Tr. at 43-52.
[26] *See* http://www.massachusetts.edu/stem (accessed Apr. 3, 2009).

math teachers, only 24 percent of whom could answer it correctly.[27] He stated that Massachusetts will initiate an elementary teacher qualifying test and require college math courses to address this problem by the spring of 2009. Dr. Fortmann said that teacher quality is the most important underlying factor in student math achievement, and that math content knowledge among teachers in urban minority schools is very low.

Dr. Fortmann's view of affirmative action is that, in the absence of sustained remediation as propounded by Dr. Tapia, it does not address the underlying math deficiencies in K-12 education. Dr. Fortmann thus agreed with Dr. Sander and Dr. Elliott that it will consequently hinder some students' STEM progress. Dr. Fortmann argued that it was worth putting the limited resources available into increasing the pool of students able to enter STEM disciplines, rather than just recruiting harder from the same pool. He also recounted a statement by a dean of engineering at a major research state university that 50 percent of the people entering engineering majors eventually switch majors because of inadequate math preparation.[28]

He recommended that the Commission investigate, as a civil rights issue, why so many minority students graduate from high school with so little STEM preparation, i.e., why they need affirmative action at all, and what policymakers can do about it. He believes that the answers are, among other things, school choice; better teacher preparation and more demanding math certification requirements; and differentiated pay scales and incentives. He also mentioned collective bargaining, accountability, standards-based testing, and school leadership as important issues.

Robin Willner

Ms. Robin Willner,[29] Vice President of Global Community Initiatives at IBM, testified that changes in the global economy make it even more important that the U.S. provide the talent and leadership it needs to remain competitive, and to this end, IBM has begun a STEM program with Latino [Hispanic] students. Ms. Willner stated that other countries have realized that their competitiveness relies on producing and keeping STEM talent. IBM's view is that all sources of talent from all economic and ethnic groups need to be tapped, since the need for STEM graduates will grow by 50 percent, according to a U.S. Department of Labor study. Ms. Willner observed that the U.S. is the only industrialized country that will increase in population in the future, and that much of the growth will come from the Latino community; however, this community currently makes up a very small percentage (1.5 percent) of STEM doctorates. She asserted that the high school dropout rates for Latinos were twice that of blacks and three times that of whites.

Ms. Willner stated that commissioned research papers from Public Agenda, a nonprofit research organization, showed that the Latino educational pipeline is virtually broken in all subject areas, not just STEM, and that the major causes were poverty and lack of English

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[27] Tr. at 49.
[28] Tr. at 47.
[29] Tr. at 52-62.

language skills, role models, adequate parental involvement stemming from long work hours, language barriers, lack of formal schooling, and cultural attitudes.

She related some of the actions taken by IBM, such as providing translation programming software and early childhood reading programs, and described a joint meeting on Latino STEM careers that IBM hosted for global companies such as Exxon Mobil, Lockheed Martin, and AMD. The meeting produced four chief recommendations, the second of which bears on the testimony of Dr. Sander and Dr. Elliott: 1) recruit, prepare, and retain qualified STEM teachers, increase the number of second-career STEM teachers, and redesign existing teacher preparation courses and certification; 2) reduce attrition in minority STEM graduates by moving them to programs where they will succeed and also to make sure they can succeed at the highest levels by providing appropriate mentoring, support services, and financial aid; 3) increase the popularity of STEM careers in the Latino community; and 4) increase the Latino high school graduation rate by providing mentors, requiring performance standards of both high school and student, and providing internships.

Discussion

Vice Chair Thernstrom invited the panelists to respond to each other's testimony before opening the question period to Commissioners.[30]

Professor Sander began the discussion by summarizing the points of agreement among the panelists, such as the academic credentials gap between racial groups by the end of high school as the single biggest cause of the problems under discussion. He observed also that Dr. Tapia and Dr. Fortmann believed that such gaps might be counteracted by good academic support. Dr. Sander stated that most of the panelists did not deny that there was a mismatch problem, but differed on methods of handling it. Dr. Sander also posited that the credentials gap in large part was not caused solely by K-12 education, but by other environmental factors unrelated to schooling, such as low birth weight, parenting practices, socioeconomic differences, and reading habits. He also referred to studies[31] that show that race does not predict credential score gaps if such environmental factors are controlled. Dr. Sander concluded that policymakers should look beyond race to seek out those who need help and end racial preference programs, particularly in the most selective universities whose use of race leads to preferences chiefly for upper-middle and upper-class applicants.

Dr. Fortmann agreed that socioeconomic factors were important, as were parenting practices, and that K–12 education was not the sole cause of the credentials gap. He asserted, however, that there were schools, many of them charter, that improved the educational outcomes for students from disadvantaged backgrounds.[32] Ms. Willner and Dr. Tapia agreed that such schools could make a large difference. Dr. Tapia cited two viable K–12 programs in which he was involved,[33] and stated also that the practice of including all Hispanics in one group was misleading, since educational outcomes differ among subcategories such as Mexican-American, New York Puerto Rican, and Cuban, for example. He recounted coping methods he used as a UCLA student that included taking a reduced course load, and improving his performance in increments rather than all at once.

Commissioner Kirsanow asked the panelists, particularly Ms. Willner, whether minority STEM graduates of historically black colleges and universities (HBCUs) were in fact incompetent by private sector standards, and whether the private sector thought it was important that their new hires come from elite schools such as Harvard, Stanford, and Cornell.

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[30] Tr. at 63-149.
[31] *See*, e.g., Roland Fryer, Jr. and Steven Levitt, "The Black-White Test Score Gap Through Third Grade," NBER Working Paper Series, Working Paper 11049, National Bureau of Economic Research, http://pricetheory.uchicago.edu/levitt/Papers/FryerLevitt2005.pdf (accessed on September 21, 2009); 8 Am. Law Econ. Rev. 249-281 (2006).
[32] Dr. Fortmann cited a case study of 15 schools in "It's Being Done: Academic Success in Unexpected Schools," by Karin Chenoweth, published by Harvard Education Press (2007).
[33] "Rising Above the Gathering Storm," http://www.nap.edu/catalog.php?record_id=11463 (accessed January 13, 2009).

Dr. Tapia asserted that the HBCU STEM graduates were not incompetent, but insufficiently prepared to be competitive with graduates from schools such as Rice. Also important, in Dr. Tapia's view, was recognizing that a degree from a highly selective school is necessary in order to be hired as faculty at a similarly selective school. Part of the problem, he stated, was that some HBCUs are wholly nonselective and are unable to enforce academic standards for fear of failing too many students. Dr. Tapia questioned whether HBCUs were at a point where they should reevaluate their role, since their original purpose resulted from segregation and the nation's colleges are no longer segregated.

Commissioner Kirsanow asked Ms. Willner to comment. She answered that the most important qualification was the applicant's knowledge and skill, not the reputation of the school, but that more selective schools produced more highly skilled and creative graduates. Vice Chair Thernstrom asked whether IBM had its own testing process for applicants. Ms. Willner stated that it did, but that to some extent the company used the reputation of the school as a proxy for such evaluation because of IBM's familiarity with the schools' programs.

Professor Sander addressed Commissioner Kirsanow's question by differentiating between mismatch in undergraduate and graduate STEM programs. Dr. Sander asserted that faculty hires are dependent almost entirely on the graduate advisor and school attended, whereas the science minority STEM dropout problem was an undergraduate problem that could be alleviated by reducing the mismatch between student and school. He referred to social science studies that showed HBCU graduates in both STEM and non-STEM majors who perform well in college have slightly better outcomes over the years than students who perform poorly at elite schools.

Commissioner Gaziano asked Dr. Tapia if he thought it was better to have one successful STEM minority graduate from an elite school and a hundred STEM dropouts, or 100 STEM doctorates at slightly lesser schools. Dr. Tapia answered that 100 successful STEM graduates from lesser schools was a better outcome.

Commissioner Gaziano then asked how large a mismatch could be before it undermined success. Dr. Tapia answered that the question should be why so many top math graduate schools made no effort to retain capable minorities, particularly public universities. Dr. Elliott answered that if the top schools reduced the degree of the mismatch of their minority STEM admits by admitting only the top half of those currently admitted, then schools down the selectivity index would have a greater number of properly matched minority STEM students available to them. Such students would then be at the 30th percentile of competitiveness within their schools, as compared to the fourth percentile. He acknowledged, however, that schools that are less selective also have much less money with which to assist students, and minority students often need such help. Dr. Elliott supported some degree of affirmative action in public universities, but pointed out that at the graduate level, elite schools take very high-level students and push them to meet extremely high standards. The outcome is a high level of performance at such schools, which if lowered, would result in a loss of the school's reputation and elite status, and a loss in performance quality in their programs.

Dr. Tapia agreed with much of what Dr. Elliott had said concerning high levels of performance in elite private schools, but stated that public universities had a moral obligation to do more than just research using the highest performing students available regardless of racial or ethnic imbalances.

Vice Chair Thernstrom asked what effect there would be on K-12 schools with ill-trained teachers if colleges required uniform standards for every applicant; and whether such standards would result in increased pressure on such K-12 schools because they would be unable to ascribe blame to others.

Dr. Sander agreed that the mismatch effect is a problem for those students who receive the largest preferences, while his data concerning those students who receive modest preferences did not show a mismatch effect. He stated that socioeconomic preferences were less likely than racial preferences to produce mismatch effects because those credential gaps were smaller; economically disadvantaged students who persevered all the way to an elite school generally displayed essential elements for success, such as determination and drive. Dr. Sander also asserted that a student coming into a school at the 25th or 30th percentile in terms of credentials instead of at the 5th or 10th percentile could use the resources of the elite school more effectively.

Ms. Willner agreed with Dr. Tapia that the size of the preference (degree of mismatch) is what determines a student's success or failure in a STEM program. She stated that accepting an applicant whose credentials are far below those of the other accepted candidates is different from accepting a student at the top of the SAT scale (1400–1600) with some leeway for modest differences from the median. She agreed with Dr. Tapia that someone at the lower end of the SAT scale with a combined score of 800 would not succeed in a selective STEM program. She also agreed with Dr. Tapia that public universities have an obligation to provide effective support and interventions to students admitted to their programs, and that IBM views as critically important the existence of a diverse group of STEM graduates available to global companies. Dr. Tapia emphasized that it was important for potential minority students to see faculty of their own ethnicity or race because that gave them a sense that they were not alone, and that others of their ethnicity or race had succeeded.

Commissioner Gaziano asked Dr. Fortmann what minimum qualifications math teachers should have; for example, whether second-career STEM professionals need further certification to be able to teach in K–12 schools. Dr. Fortmann responded that Massachusetts allows someone to obtain a provisional license for immediate entry into K-12 teaching, but that requirements differ from district to district. He noted also that such teachers rarely enter elementary or middle schools, so there is still a need to improve the qualifications of existing K-8 teachers. Ms. Willner added that IBM offers its employees a teaching skills program that facilitates the transition to K–12 STEM teaching, because knowing the content area is not enough to become a good teacher. The program, called "Transition to Teaching," helps develop the other essential skills in teaching, and provides a paid leave of absence for student teaching before the employee leaves IBM.

Vice Chair Thernstrom observed that other programs also have been successful in placing non-education majors into classrooms after very short preparation, such as the Teach for America program. Ms. Willner agreed, but added that in her experience, most people who participate in that program claim that the first year of teaching was unnecessarily difficult because of inadequate preparation.

Dr. Fortmann agreed with Ms. Willner's support of more extensive teaching preparation than what is provided in the Teach for America program, but did not believe that an entire year of education courses, or the onerous certification requirements in many states, was necessary.

Commissioner Kirsanow stated that the U.S. Supreme Court's *Grutter* decision[34] set limits on a school's use of racial or ethnic preferences of any size in admissions. He pointed out that however important diverse points of view were in law schools for admissions purposes, and thus arguably within the bounds of the Constitution, the same could hardly be said of physics and math disciplines in which ethnic differences were irrelevant to the quantitative analysis performed.

Dr. Tapia believed that an ethnically broad student and faculty community teaches white students how to deal with people of different ethnicities and races. He also stated that such experience in a broadened academic environment allowed students to build a multi-ethnic academic community that would last throughout their lives. He added that, in his view, court decisions had significantly cut back affirmative action programs, with the result that colleges now recruited from abroad to the detriment of American minorities.

Professor Sander raised two points concerning the practical effects of race preferences. First, he stated that the use of preferences may produce both positive and negative results, meaning that preferences may combat negative stereotypes by the increased presence of minorities, but may also reinforce negative stereotypes if the ability differences are large—on the order of a two standard deviation gap. Second, he stated that large racial preferences further isolate such students socially from normally admitted students, resulting in increased self-segregation along racial lines. Professor Sander supported this statement by citing a recent study posted on Duke University's website by three economics professors at Duke University.[35] He also reported results of his own study of study groups in law school, which found that if there are large racial preferences, whites and Asians assume that the best students to invite into their study groups will be whites and Asians rather than blacks and Hispanics. He asserted that study groups are important in law school because they improve students' grade point averages, and that study groups composed only of minority students do not improve grades.[36]

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[34] *See Grutter v. Bollinger*, 539 U.S. 306 (2003).
[35] Peter Arcidiacono, Shakeeb Khan, and Jacob Vigdor, "Representation versus Assimilation: How do Preferences in College Admissions Affect Social Interactions?" November 5, 2007, available at http://www.econ.duke.edu/~psarcidi/knewminisk.pdf (accessed Jan. 23, 2009).
[36] Tr. at 111–12.

Vice Chair Thernstrom observed that Harvard undergraduate admissions does not give large racial preferences, but that before the ban on preferences in California, the racial gaps at Berkeley between underrepresented minorities and whites or Asians was enormous. The Vice Chair also observed that the pool of high-SAT-score underrepresented minorities is small, and absorbed by very few schools.

Commissioner Taylor said he found it disturbing that schools were not communicating information about mismatch and its consequences to minority students and their families before they determine which college to attend, and how much success they might achieve relative to other students. He stated that a student needs to know what the range is at any particular school and whether he or she is within that range; if the student is below that range, no additional help from the school or anyone else will be sufficient. He emphasized that the critical public policy perspective should focus on what will help the minority community to do well.

Professor Sander articulated four policies to address Commissioner Taylor's points that he believed all the panelists would endorse. First, he recommended transparency, meaning that African-American or other minority students ought to know before selecting a college what the ultimate outcomes have been for students with their credentials. Commissioner Taylor asked the panelists whether they would agree with Professor Sander's first point, and they replied affirmatively. Ms. Willner added that she thought the colleges also owed students evidence demonstrating that they had given needed help to similar students in the past. Commissioner Taylor endorsed this suggestion and pointed out that this information was no different than providing prospective athletic students a coach's track record of success. He observed that policies of affirmative action had been more concerned with enrolling a target number of black and Hispanic students than helping them make sound decisions about the best colleges for them as individuals.

Professor Sander next suggested that colleges be held accountable to all prospective and current students, meaning a) they disclose their record of retaining science majors to graduation; b) they take responsibility for improving their record; c) they change their admissions practices; or d) all of the above. His third suggestion was that college admissions emphasize socioeconomic preferences over racial preferences. Lastly, he recommended that colleges curtail large mismatches in admissions that have clearly shown negative effects on minority students.

Commissioner Kirsanow asked Professor Sander for his view of the extent of current transparency and accountability. Professor Sander stated that on a scale from zero to 100, it was a 3. Dr. Tapia agreed that getting such information was extremely difficult, and said the recommendation for greatly increased transparency and accountability was excellent. He also gave examples of successful programs, such as Rice's, that were able to recruit able students by word-of-mouth because of a reputation for producing minority successes. He gave as a cautionary example a student who told Dr. Tapia that he had been accepted to Princeton with

a 940 combined SAT score, and had been told (and believed) that the average SAT score at Princeton was 950. Dr. Tapia said he urged him to check further.[37]

Commissioner Taylor stated that he strongly opposed any public policy that masked discussion of such information, and further, that he believed concealing such information was intentional.

Dr. Elliott agreed that the size and significance of mismatch in schools was hard to obtain, and that schools concealed such data in order to meet their quotas or goals for enrolling minority students. Vice Chair Thernstrom asked whether colleges cared more about showing off diversity of their freshman classes than results of such policies in senior year with respect to the numbers of minority students in STEM majors. Ms. Willner agreed that letting a student in was easy, but should be matched by a college's willingness to help that student succeed.

Dr. Tapia stated that he visited Berkeley and UCLA frequently and was saddened to see the effects of the California ban on racial preferences there, since administrators had made no effort to create other programs that would work for minorities, such as the "Ten Percent Plan" in Texas. The Texas law requires the flagship campus to accept the top 10 percent of students in each Texas high school regardless of SAT scores, which Dr. Tapia believed has been successful because the university supports the students in special programs once they arrive on campus.

Vice Chair Thernstrom asked Dr. Sander why he thought socioeconomic preferences were less likely to result in mismatch than racial preferences. Professor Sander responded that by broadening the definition of diversity to include socioeconomic preferences, colleges would increase the size of the applicant pool and decrease the size of the mismatch they would have to accept. Second, his data indicated to him that credentials more likely understate potential in lower socioeconomic status (SES) applicants, and they perform better than expected. Third, the resulting smaller gap would not, in his view, create social isolation problems of the kind discussed earlier in the hearing. His experience with expanding admissions to include low SES at UCLA after Proposition 209 passed in California showed that this approach worked. He added that this program was not continued because it didn't produce enough African-American students to satisfy administrators, and that in its place the law school started a "Critical Race" program[38] for minority students admitted with large credential gaps. Professor Sander stated that the Critical Race program was a subterfuge that produced even fewer black law students; during the course of the program, 30 white applicants were denied

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[37] Princeton's current average SAT verbal and math combined score is 1485. *See* http://collegesearch.collegeboard.com/search/CollegeDetail.jsp?collegeId=4221&profileId=6 (accessed Feb. 24, 2009).

[38] One definition is as follows: "Critical Race Theory (CRT) is an intellectual movement of progressive law scholars–primarily of color–who view the law as complicitous in sustaining white supremacy, and, by extension, upholding similar hierarchies within gender, class, and sexual orientation." http://tarlton.law.utexas.edu/lpop/etext/lsf/isaksen24.htm (accessed September 17, 2009).

entry with Law School Admission Test (LSAT) average scores of 163 and eight black applicants were admitted with an LSAT median of 154.[39]

Dr. Tapia interjected a comment that UCLA law school had produced Johnny Cochran; Professor Sander responded that that was an example of entirely race-neutral policies. He added that UCLA's preference programs produced great successes for some individuals, but large preferences had counterproductive effects.

Vice Chair Thernstrom observed that the Bok and Bowen study was of undergraduate admissions only, and that about half the underrepresented minorities had not needed preferences. Professor Sander agreed, noting that Barack Obama had not needed preferences. Dr. Tapia added that the Bowen and Bok study was limited to African-Americans and did not include Hispanics.

Commissioner Kirsanow asked whether schools are discouraging the participation of Asians, who are overrepresented in science programs. Professor Sander said probably not, although he hoped to study that issue. Dr. Tapia stated that to the contrary, U.S. Asians are becoming underrepresented because of assimilation, and schools are bringing in more foreign-born Asians. Professor Sander disagreed in part, referring to his U.S. Census data that showed Asians still hold a large proportion of science doctorates.

Vice Chair Thernstrom asked whether the decreasing portion of Asians in graduate school just showed that they were understandably turning to well-paying business careers, as were other minorities. Dr. Tapia suggested that they were turning to other careers simply because they believed, incorrectly, that a few low grades disqualified them from graduate school.

Commissioner Yaki observed that it is misleading to consider all Asians as one group, since there are great disparities within that group based on assimilation over generations into American society and outcome differences between Japanese or Chinese groups and other Asians. Both Vice Chair Thernstrom and Dr. Tapia agreed. Dr. Tapia stated that a group label is also misleading for those considered "Hispanic" since the disparities in outcomes within such a group are extreme. He stated also that there have been changes in cultural adherence to educational expectations over time within some ethnic groups, resulting in some preference for taking well-paying jobs versus aspiring to attend graduate school, or, in other cases, reduced educational aspirations.

Commissioner Yaki also claimed that since the passage of Proposition 209, the University of California system is accepting foreign Asian students who pay full tuition as a means of avoiding payment of subsidies that accompany in-state students. Professor Sander agreed that the University of California is attempting to maximize its tuition revenues but asserted also that the poorest students in the Los Angeles area are in fact Cambodian, not black or Hispanic.

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[39] This represents about a one standard deviation gap in the LSAT.

Vice Chair Thernstrom stated that it is not clearly in the public interest that students enter graduate programs instead of the business world. Dr. Tapia agreed, but asserted that it is bad for University of California and Ivy League math departments to have no African-Americans.

Commissioner Kirsanow asked Professor Sander to what degree the mismatch in STEM disciplines differed from the mismatch in other disciplines, such as law. Professor Sander answered that the STEM mismatch gap at the undergraduate level is uniquely problematic as a result of the linear sequence required for science and math courses, and the impossibility of watering down the required curriculum to push students through to graduation. He observed that law is similar in that it requires bar passage, whereas the academic discipline of English, in his opinion, has no good outcome measures.

Dr. Tapia added that as a result of his frequent work with lawyers as an expert witness in federal court trials, he viewed law and science differently. He claimed that creativity was not a necessary part of success as a lawyer, whereas it is for STEM graduates.

Commissioner Yaki observed that Professor Sander had narrowed his definition of mismatch and that the gap may be due to factors not discussed in this briefing. He also stated that affirmative action in higher education, characterized by Professor Sander as dying, was instead being killed by initiatives across the country. Commissioner Yaki also stated that although he was not criticizing the panelists who were in attendance, he did not believe that they represented a balanced panel on the subject. He further indicated that he was glad that panelist Hazel O'Leary (President of Fisk University and former Secretary of Energy), who had accepted an invitation to participate in the briefing (possibly to speak about the role of HBCUs in STEM) and then cancelled, was not attending this briefing. He stated that the easier accessibility of HBCUs was used as an excuse for doing away with affirmative action, and noted that Dr. Tapia had testified that the HBCUs were insufficient with regard to STEM graduates. Commissioner Yaki stated that affirmative action is about measuring potential, and that closing off access to selective research universities because of statistics would not be acceptable. The briefing then ended.

Statements

(Note: Statements are unedited by the Commission and are the sole work of the author. Professor Sander submitted slides in lieu of a written statement that are appended to the summary of his testimony, supra.)

Richard Tapia

The Flaws in the Mismatch Theory
Picture the nation's research universities in the mid-1960s. Legal and discriminatory obstructions had allowed only a very few underrepresented minorities to gain admission to the nation's top science and engineering institutions. For instance, until 1964, when its board petitioned the courts for a change of its charter, Rice University had been constrained to educate only the "white inhabitants of Houston and Texas." Raymond Johnson then became the first African-American student admitted to Rice and went on to earn his Ph.D. in mathematics in 1969.

His Rice Ph.D. launched a very successful career, including the chairmanship of the Department of Mathematics at the University of Maryland. Stories of early minority scientists and mathematicians produced in this country are amazing, but reflect a truly sad component in our educational history. The few that were produced in those early times invariably were so brilliant with so much potential in their fields that someone in their department would champion their admission, and of course these students were quite successful. But what about all of the other minorities who could have made it, yet had no champions? Certainly this has been a great loss to the country's productivity and leadership.

In the mid-1960s, affirmative action was born. America's universities began to use affirmative action policies to increase the participation of minority groups in higher education. Designed to level the playing field, university admissions policies attempted to normalize for differences in the quality of academic preparation. Admissions criteria were developed to identify students with the capacity to succeed but who were not identified through traditional admissions criteria. Yet these policies have been controversial throughout their history and have faced repeated legal challenges—with much of the controversy centering on whether affirmative action is reverse discrimination and unfair to white students rejected in favor of minority applicants who are perceived as "less qualified."

Recent controversy about the fairness of affirmative action now raises a very different question. Some are now claiming that affirmative action policies can be unfair to the minority students that they are intended to help. The current "Mismatch Theory," promoted

by Panelists Rogers Elliott[40] and Richard Sander[41], suggests that minority students are more likely to leave science and engineering when affirmative action has placed them into colleges for which they are not prepared. They contrast this failure with the success that underrepresented minority students experience at less rigorous schools, especially at Minority Serving Institutions (MSIs), and suggest that minority students would be better served by attending less competitive schools where they can be more successful.

It is clear that what many, including several of my colleagues who are underrepresented minorities, want is a strong refutation of the Mismatch Theory as a whole--that it is totally wrong with no foundation or no basis. I claim that the Mismatch Theory is terribly flawed, that it could set underrepresented minorities back 40 years in science participation and achievements, but its flaw is not in its data but in the conclusions drawn by Professors Elliott and Sander. The mismatch theorists have focused light on a huge problem that I have been fighting at Rice for 20 years. The data they present are entirely credible to me because they reflect what I have seen at Rice. So I do not dispute the data. It is the recommendations they make based upon the data that are terribly flawed.

I should explain why I believe that I was asked to serve on this panel. I have been a mathematician at Rice University since 1970. I received a B.A. in mathematics from UCLA in 1961, and a Ph.D. in mathematics from UCLA in 1967. I have received numerous awards for my accomplishments as a mathematician: I was elected to the National Academy of Engineering, appointed to the National Science Board by President Clinton, and at Rice University promoted to the position of University Professor, of which there have been only six named in the history of the university. Upon first glance this appears to look like any traditional academic path to success. We make all kinds of assumptions about the background of such individuals, including the certainty and predictability of the path to success. In my case, most of those assumptions would be wrong.

I was born in Los Angeles to parents who immigrated from Mexico. I attended a below-average high school in the Los Angeles Unified School District. I was not directed to college by my teachers or counselors although I had demonstrated strong mathematical talent. I started to work at a muffler factory where a co-worker recognized my talent and daily insisted that I go to college. I often think of how different my life would have been if this hadn't happened. I was very fortunate. I began at community college, where I was strongly directed to UCLA, and away from less selective four-year colleges, by two of my community college math professors. Little did I know that this advice would be critical to my career. I went on to get a Ph.D. because I saw other students with less mathematical talent than I had who were going on and felt that if they could, I could too.

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[40] Elliott, Rogers, et al. "The Role of Ethnicity in Choosing and Leaving Science in Highly Selective Universities." *Research in Higher Education.* Vol. 37, No. 6 (1996). http://www.springerlink.com/content/l662845727427n33/

[41] Sander, Richard, 2005. "A Systemic Analysis of Affirmative Action in American Law Schools," *Stanford Law Review* 57 (2) 367-484.

After receiving my Ph.D. from UCLA, I was directed and guided by David Sanchez, the only underrepresented minority faculty member in the UCLA Mathematics Department, to faculty positions at Wisconsin, Stanford, and Rice. This intervention and guidance was probably the most important in my entire professional life. At many junctures, my life could have taken a very different path rather than to University Professor. Like so many I could have easily fallen through the many dangerously wide cracks. I owe my success to my education at a research university. While at Rice, I have served as dissertation director or co-director for many successful minority doctoral recipients in science, technology, engineering, and mathematics (STEM). Some of them, perhaps most of them, would fit the pattern of the Mismatch Theory, entering Rice less prepared than the majority of their fellow Rice students. Also, I have taught many underrepresented minority Rice undergraduates, and again, some, perhaps most, fit the pattern of the Mismatch Theory. Over the years, I have been frustrated at the number of Rice's underrepresented minority students who migrate from science and engineering to humanities or social sciences, where they have experienced more success.

Selective research universities recruit some of the nation's most capable minority students, who enter intending to pursue a career in science or engineering, and then lose disproportionate numbers of them to other disciplines. I agree with Sander and Elliott that admission of minority students without retention is of negative value. This is what I have, for years, called the "loss of the precious few." Where I strongly part with Sander and Elliott is in what we should do about it. Sander and Elliott say that we should steer students to less challenging schools where they are more successful. According to them, this will be better for the students and better for the nation because it will increase the numbers of underrepresented minority students receiving degrees in science and engineering. I say we should insist that elite research universities put into place programs that have proven successful at supporting students so that they *are* successful. Simply stated, in a "sink or swim," non-mentoring, non-supportive environment, which is what we see at many of our elite research schools, those with poorer preparation will rarely succeed, minority *or* majority. Why are we not demanding from public and private universities that receive federal funds that which is critical for the health of the nation--quality education of all our citizens? Why are we letting them off the hook as they conveniently build an ever increasing base of foreign STEM graduate students and faculty[42]?

Creating a Permanent Underclass

What is wrong with Sander's and Elliott's resolution of this problem? Why do I find it a huge mistake? In my opinion, nothing can do more to establish minorities as a permanent underclass in science and engineering than this.

If the goal is *just* to produce larger numbers of underrepresented minority scientists, then the Mismatch Theory is a great idea, but numbers of degrees alone are not a good measure of success. Underrepresented minorities must be competitive with the overall population; how else can we break the stereotype? The distribution cannot be skewed toward weaker schools. Steering minorities to lesser schools reminds us of the separate but equal mantra. It turns out

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[42] Tapia, Richard A. "True Diversity Doesn't Come From Abroad." Chronicle of Higher Education, p. B34. September 28, 2007.

that separate but equal is always separate, but never equal. But this is worse. This assumes from the start separate and *weaker.* This would take us back to the pre- to mid-60s, where only the very rare minority student who has been prepared well and tests well under traditional admissions criteria would be admitted to the nation's research institutions.

Race and ethnicity should not dictate educational destiny. Steering capable students to lesser schools puts a cap on their potential achievements. Top research universities choose faculty from Ph.D.s produced at top research universities. If we underrepresented minorities are ever to be an equitable presence as faculty at our top-level schools, then our students must be schooled at those same institutions. Leadership in science and engineering comes from top research institutions. MSIs do some things very well. Their students speak warmly of how confident and supported they felt in their experiences there. Research universities should learn from them how to nurture that kind of confidence, but Ph.D.s produced at MSIs will not become faculty at top research universities. We need minorities who will become national STEM leaders, and these have to be produced by institutions that are recognized as giving credibility to the scientific accomplishments of the individual.

Below is a list, which is not exhaustive, that I quickly generated with a few examples of people that I know who received their Ph.D. in science or engineering from an elite research school and who have gone on to assume national scientific leadership.

National Leaders in Science and Mathematics who are Underrepresented Minorities

Name	Ph.D.	Current Leadership Position
African-Americans		
Shirley Ann Jackson	MIT	President, RPI
Freeman Hrabowski	Illinois	President, University of Maryland Baltimore Co.
Shirley Malcom	Washington	Head of Education Programs, AAAS
William Massey	Stanford	Professor, Princeton
Arlie Petters	MIT/Princeton	Professor, Duke
Sylvester Gates	MIT	Professor, Maryland Director, Center for String and Particle Theory
Mexican-Americans		
Hector Ruiz	Rice	Executive Chairman of AMD
Rodrigo Banuelos	UCLA	Head, Mathematics, Purdue
Francisco Cigarroa	UT/Harvard	President, UT Health Science Center, S. Antonio
Richard Tapia	UCLA	University Professor, Rice University
Carlos Castillo-Chavez	Wisconsin	Regent Professor, Arizona State

Where is the list of individuals with Ph.D.s from lesser universities who have outstanding scientific accomplishments or outstanding scientific leadership accomplishments?

The Systems Are Broken
Consider three systems that prepare minority students: A) K-12 schools, B) MSIs, and C) research institutions. For very different reasons, none of these adequately promotes equitable representation in science and engineering. But consider, which problem is easier to solve?

A. Transform urban K-12 schools that educate the vast majority of underrepresented students so that they prepare students equally to the best K-12 schools,

B. Bring MSIs up to the academic excellence of research institutions so that capable minority graduates will be competitive with students from elite schools in the industrial job market, professional leadership positions and graduate and professional school, or

C. Design and implement programs at the most selective research universities so that capable minority students have the same retention rates and confidence levels in science and engineering as those at minority serving institutions.

Clearly C has the most viable solution. A by-product of this solution is the added bonus of enhanced training and opportunities and a greater likelihood of ascending to leadership positions. It has taken more than a century to build the sophisticated machinery of research universities.

So What Do We Do Now?
Solving the three problems described in A, B, and C above would require a giant overhaul of the entire systems. While we should keep such an objective in view, we cannot wait for this change. There are things that we can do short term that I believe will have a significant impact on improving the representation of underrepresented minorities in STEM careers and leadership positions across the full spectrum of opportunities. My recommendations are as follows.

Recommendation for Dealing with Problem A
Talented underrepresented minorities should be identified early in their education (elementary and middle school) and motivated and directed to attend the best magnet secondary schools in the city. This activity would involve working with the parents and the school districts to facilitate and implement these plans. This recommendation has been influenced by the following experience. At the present time at Rice University I am working with three outstanding minority Ph.D. candidates in mathematics and in computer science. All three have distinguished themselves in their research and in their academic accomplishments, including being awarded prestigious National Science Foundation graduate fellowships. Two are African-American and one is Mexican-American. All three were born and raised in the minority areas of large U.S. cities. However, each was directed to a STEM magnet school in their city, performed well, and was encouraged to apply to selective research universities for undergraduate training. All three attended Rice as undergraduates, where I met them and encouraged them to attend graduate school (not necessarily Rice). They received excellent high school and undergraduate preparation and are

now outstanding graduate students. I expect to hear in the somewhat near future that they are excellent STEM faculty at research universities in the country.

Recommendation for Dealing with Problem B

Many MSIs are open admissions (all who apply are admitted) and also try to be all things to all people. I have a colleague who teaches chemistry at a local Historically Black College and University. He says that in his introductory classes he has some outstanding students and some students who are extremely poorly prepared, and that there is no way that he can do justice to either group of students when they are all in the same class. His level of frustration is extremely high. I recommend that MSIs adopt a magnet secondary school format. They should develop excellent undergraduate courses in selected disciplines and only allow selected, well-prepared students to take these classes. In this way the best students will be well prepared for graduate work in the appropriate discipline at a research university. The details involved in implementing this suggestion would require more thought, but I believe that the direction is correct.

Recommendation for Dealing with Problem C

The challenge is to admit underrepresented minority students in larger numbers in science and engineering at the nation's research institutions and then support them to be successful. The research schools must be held accountable for both admission and retention of minority students in their chosen disciplines through the completion of their degrees.

To address admissions, we must evaluate our admissions criteria. I refer to this as second stage affirmative action. Is it excluding individuals with talent to succeed? At Rice, in both graduate and undergraduate admissions, we have successfully turned to what I call the Threshold Approach. We pick a threshold level at which students will be successful that has been determined from years of experience of working with all students. Actually the threshold level is a fuzzy interval of scores. Those students with scores significantly above the threshold are deemed equivalent as far as the test score goes, and the score is dismissed and admission decisions are guided by other factors. 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. My 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 combined SAT score of 1500 over one with a combined score of, say, 1300.

The same can be said for a graduate student whose GRE score is in the 95th percentile versus one whose GRE score is only in the 85th percentile. However, I have never seen an undergraduate student at Rice succeed in math, science, or engineering with a combined SAT score below 900.That is, there is much more predictive information at the low end of the scale than there is at the high end of the scale. Indeed, each year Rice rejects a good number (say five or so) of undergraduate applicants who have earned perfect 1600 SAT scores. Of course, the Rice admissions officers feel that some of the high-scoring SAT students were lacking in other significant evaluation components. The misuse of standardized test scores, guided by the belief that there is predictive power at the upper level of the scale, is one of the worst enemies of underrepresented minorities. I have seen underrepresented minority students graduate from Rice with honors, and yet they entered with modest SAT scores,

albeit, the highest scores in their minority school. At Rice this is particularly true of Hispanic women.

Following these guidelines, we have produced a very large number, probably the largest number in the country, of underrepresented minority doctoral recipients in mathematics, science, and engineering. In the last 10 years approximately 1,000 STEM Ph.D.s have been produced in the country, and Rice has produced more than 60 of these doctoral students. One year the National Science Foundation informed Rice that in that year we had produced approximately half of the nation's doctoral recipients in the mathematical sciences. The Mathematics Departments at the University of Iowa, through the leadership of David Mandersheid, Cornell University, and Arizona State also have good Ph.D. productivity rates for underrepresented minorities in mathematics; in the latter two situations the champion has been Carlo Castillo-Chavez. Again, success comes from strong commitment, aggressive support, and a champion. These successes demonstrate that it is possible to produce minority Ph.D.s at a high rate at research universities. We now offer a success at the undergraduate level, as well. Due to the Texas Top 10% Rule[43], the Mathematics Department at the University of Texas Austin has the highest percentage of underrepresented minority undergraduate mathematics majors (nearly 30%) of any research university in the country. With innovative support programs they retain minority students through graduation at a rate above the majority student rate.

My summarizing point here is that underrepresented minorities need not be sent to MSIs to succeed. With support and caring we can succeed at the best schools in the country. Indeed, many of us have. And more of us will.

The Consequence of the Mismatch Theory

I suspect that many faculty and administrators from research universities would breathe a big sigh of relief when they read about the Mismatch Theory. It certainly lets them off the hook, doesn't it? What it does is reduce expectations and set the country's research institutions back to pre-1964. It ignores all that we have learned about educating minorities and guarantees the formation of a permanent science underclass in America. A two-tiered America is certainly not healthy for the country.

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[43] Created to avoid the impact of *Hopwood v. Texas*, the case banning the use of race as a factor in admissions, 1997's Texas House Bill 588, guarantees Texas students who graduate in the top ten percent of their high school class automatic admission to all state-funded universities.

Rogers Elliott

(Note: Professor Elliott submitted the following article in lieu of a written statement, which may also be found at http://www.seaphe.org/pdf/elliott-ethnicity.pdf (accessed July 27, 2010). It is reprinted by permission of the copyright holder.)

The Role Of Ethnicity in Choosing and Leaving Science In Highly Selective Institutions

From *Research in Higher Education, Vol. 37, No. 6, 1996*
Authors: Rogers Elliott, A. Christopher Strenta, Russell Adair, Michael Matier, and Jannah Scott

(Foreword: This study sought to assess the role of ethnicity in both initial choice of, and persistence in, science majors. Standardized test scores, high school records, initial concentration preference, college grades, and final majors of all the white, Asian, black, and Hispanic students who enrolled in 1988 at four highly selective institutions provided the database. Despite relative deficits in scores on measures of preparation and developed ability, blacks entered college with a strong interest in majoring in science. Black students interested in science also suffered the highest attrition from it; Asians were lowest, with whites and Hispanics near the average attrition of 40%. Ethnicity did not add significantly to ability and achievement variables in predicting attrition from science. The results are discussed in terms of two main issues: first, the effect of different standards of selection for the various groups on their success in science curricula; and second, the relevance of various well-known intervention strategies to the problems of minority attrition in science in highly selective institutions.)

The question of why much larger proportions of non-Asian minorities leave the science pipeline than do whites or Asians has long concerned all persons and organizations interested in the vitality of science and in equality of opportunity to become a scientist. Science is a rewarding career for those inclined to pursue it, and many of the world's serious problems cannot be solved without science and technology. If large pools of potential scientists are being shut out by action of educational institutions themselves, that fact needs to be known, and the problem needs to be described and examined, so that effective ameliorative policies might be devised.

Our first reports (Strenta et al., 1993, 1994) concerned general issues about choice of, persistence in, and attrition from science, along with the way gender affected those issues in our population. Here we will examine these questions with respect to ethnicity.[i] Our strategy and goal is as it was with gender: to describe and analyze the predictors of initial interest in science, and then the predictors of persistence in science—that is, actually majoring in science—in terms of variables measuring intellectual achievement and developed ability.

The situation with respect to minorities differs from that for women very likely in several ways, but surely in one important respect: minorities are at least as interested in pursuing science as whites (Astin and Astin, 1993; National Science Board, 1993; White, 1992), and the attitude toward science, at least for African-Americans, is very positive—more positive,

other things being equal, than that of whites (Dunteman, Wisenbaker, and Taylor, 1979; see also citations in Oakes, 1990). In large unselected samples of college-bound students, just about a fifth of the whites, blacks, and Hispanics taking the SAT or filling out a student information form in their first college term intended to major in science or engineering (College Board, 1988a, or any recent year; National Science Board, 1993), with whites being slightly lower in rate of interest than blacks or Hispanics; over a third of Asians intended to major in science. In the somewhat more selective longitudinal sample reported by Astin and Astin (1993), the rates of initial interest were higher but in similar ethnic order: Asians, 53%; whites, 27%; Hispanics (Chicanos), 36%; and blacks, 34%.
Recent accounts (Oakes, 1990; Suter, 1993; White, 1992) of race, ethnicity, and science make it clear that non-Asian minorities are relatively low on most measures of preparation and developed ability, and that these deficits begin early in their schooling careers. They are considerable just before the point of entrance to college. Both the average SAT mathematics (SATM) scores and the math and science proficiencies of twelfth-grade blacks are about a standard deviation (S.D.) behind, and those of Hispanics are about .75 S.D. behind, those of whites (Suter, 1993). Thus, black grade 12 achievement in math is about the same as, and in science a little worse than, white grade 8 achievement. And while blacks and Hispanics are a little closer to whites on scores on College Board Achievement Tests and Advanced Placement (AP) tests, that is in part because very small and selected proportions of those minority groups take such tests (White, 1992).

Partly for these reasons, not many minority students actually enter science in higher education, and many who do drop out along the way. White (1992) and the National Science Board (1993) have reported that blacks received about 5.3% of the bachelor's degrees in science in 1989 and 1991, though they constituted about 13% of the population and about 9% of the higher education enrollment; Hispanics, who were about 7% of the general population, and 5% of the higher education enrollment, had 4% of the science degrees. Asians (9%) and whites (82%) together had 91% of the science baccalaureates given in 1991, with Asians obviously greatly overrepresented.

The recent study by Astin and Astin (1993) illustrates the disproportionately large losses of blacks and Hispanics (in their case, Chicanos). The final pool of blacks in science was only 47% of the size of the pool of those initially intending to major in science, and of Hispanics only 37%, whereas the corresponding percentages for Asians and whites were 68% and 61%, respectively (all these figures are overestimates of persistence rates, because there was some recruitment from nonscience pools into science). This result occurred even though in the original pools of those initially interested in science and engineering as freshmen, as shown above, blacks and Hispanics had just over a third of their numbers declaring initial interest in science majors and were 7-8% more likely to do so than whites. Other large and possibly more representative samples (National Science Foundation, 1990) have found persistence rates of only 21% for minorities, compared with 43% for majority students. And Hilton, Hsia, Solorzano, and Benton (1989) reported persistence rates for the high school and beyond database (high school seniors who had intended to go to college and major in science or engineering and who were in college still doing or intending to do science 2 years after graduation) as 54% for Asians, 44% for whites, 36% for blacks, and 29% for Latinos; considering only those students who had actually gotten to college and remained there, the

corresponding rates were 61%, 58%, 54%, and 48%. Finally, in Phillips's recent report (1991) of a large representative sample of engineering students from predominantly white schools, the 5-year graduation rates were as follows: for whites, 67%; for Hispanics, 47%; and for blacks, 36%.

Rates of persistence depend on its definition—they are lower measured in the senior than in the sophomore year of college, and lower in less selective pools—but it appears that of students who actually begin their first year in college and intend a science major, Asians will have the highest proportion, they will be best prepared (White, 1992), and they will persist most strongly; whites will have the lowest proportion of students interested in science, but those will be well prepared and about as highly persistent; blacks will be strongly represented in initial interest, but they will be the least well prepared and over half will leave science; and Hispanics[ii] will be represented as much as, and a little better prepared than, blacks, but slightly more likely to drop out.

There is some evidence, however, indicating very substantial persistence rates among non-Asian minority students. Hilton et al. (1989), studying gifted (i.e., SATM scores of 550 or more) students interested in science, found that the persistence of non-Asian minority students in math and science fields in (usually) the spring of their second year beyond high school was higher than that of matched whites (61% vs. 55%). Because the black and Hispanic samples of this study were, like our own, highly selected, we will have more to say about them below; but the study certainly supports the view that equally developed ability among students interested in science predicts equal persistence, regardless of ethnic or racial affiliation. Finally, historically black colleges and universities (HBCUs) have a strong record of B.S. (and, later, science Ph.D.) production, more so than more elite, predominantly white institutions (Culotta, 1992; Thurgood and Clarke, 1995), despite student bodies that are on average much less well prepared than black students in elite institutions.

This last fact makes clear that persistence is not just a matter of average preparation, but of competitive position as well: a reasonably well-prepared student at an HBCU who would be in a strong competitive position in his or her institution would be in a far less strong one at an elite institution. The context for judging equality of developed ability is at least as salient within institutions as between them. At white-majority institutions non-Asian minorities are, by virtue of race-preferential admission policies, at an often serious disadvantage with respect to validly predictive indices of talent, and if equally developed ability predicts equal persistence, unequally developed ability should predict differential persistence. For example, Ramist, Lewis, and McCamley-Jenkins (1994) have shown that for thousands of students in various racial and ethnic categories, from dozens of predominantly white institutions of higher learning, blacks averaged nearly 100 points and Hispanics nearly 50 points lower than whites in SATM, a strong predictor of science and math performance (Astin and Astin, 1993; Ramist, Lewis, and McCamley-Jenkins, 1994; Strenta et al., 1993), and the differences were larger for more selective schools. Since the standard deviation of SATM within their institutions was 85 to 90 points (and less than that in highly selective institutions), these are substantial differences.

Not only SATM but other preadmission indicators (SATV, high school grades, achievement tests) are significant predictors of success in science courses. Basic science courses are difficult, fast-paced, impersonal, and competitive (Hewitt and Seymour, 1991; Manis et al., 1989; Tobias, 1990), and the more selective the school, the more this is likely to be the case. Science is also hierarchical, so that relative failure at the basic levels is not only discouraging but to some extent incapacitating for the next courses. We would expect, for the foregoing reasons, that the relative deficit in preparation and ability-achievement measures of the black and Hispanic students who go to very selective and predominantly white schools will be especially damaging to their prospects in science. There have been dozens of studies showing associations between ethnic differences in SAT scores and corresponding differences in college grades. We know of none, however, in which both the high school and college grades of different ethnic groups have been separated into science and nonscience categories for differential prediction of science-relevant outcomes. Such a level of analysis is important, we think, to a more complete understanding of differential persistence in science.

It is sometimes alleged that predominantly white institutions are difficult for blacks and Hispanics to deal with for reasons that go beyond achievement and ability. In a recent special report on minorities in science (Gibbons, 1992, p. 1194), Treisman is quoted as follows: "There is a belief that [minority] kids that are strong will make it anyway. In fact, national data show that's false. If you control for socio-economic background and class rank in high school, black kids still do less well than nonminorities. These [lower performances] are measures of institutional inhospitality." The controls Treisman mentions, however, do not control for SAT total scores: matching on parental income or education preserves from 75% to 90% of the mean black-white population difference of about 200 points on SAT (e.g., College Board, 1988a). High school grades are moderately correlated with SAT scores (about $r = .55$ in the whole population, and less in selective schools; see Ramist, 1984; Ramist et al., 1994; Strenta et al., 1993). However, SAT scores contribute more to the prediction of individual course grades, especially at selective colleges, than do high school grades (Ramist et al., 1994). In the Ramist et al. sample, blacks were only .36 S.D. lower than whites in high school grades, and Hispanics were actually slightly higher than whites, which means that with respect to freshman grade-point average, on which those groups were .7 and .4 S.D.s lower than whites, both groups were greatly overpredicted by high school grades. (They were overpredicted by the SAT as well, but only by about half as much.)

A test of whether there is an "inhospitality" effect or any other ethnic effect is to use a regression analysis of persistence with ethnicity as a predictor, along with high school grades and test scores—if there is no ethnicity effect, there is nothing to explain in terms that go beyond the preadmission measures. Both Hilton et al. (1989) and Astin and Astin (1993) have done such analyses, with no reported ethnic effects, but their students were attending an enormous number and variety of institutions. We wished to study institutions that were very much alike in being high in selectivity and high in the production of scientists and science practitioners. We have chosen for study four Ivy League schools that are so similar in admission practices and academic standards that they may be treated, as we do here, as one superinstitution with four campuses.

The group of students we are investigating here, especially those initially interested in science, is obviously representative of students in highly selective private research universities, of which the present four are a part. These four alone are collectively an important producer of scientists, even though the 1,625 science majors in this group represent only I% of the total science B.A. degrees given by U.S. institutions (National Science Board, 1993: about 165,000 degrees in natural sciences, math and computer science, and engineering were conferred in 1991, or about a sixth of all baccalaureates). But however highly selected these students are, and however elite their institutions, we think that they are not very different from natural science and engineering majors at other selective colleges or public research universities. There are some 30 private universities and technical schools with average SAT totals of about 1,200 or more, and about 25 smaller colleges that are similarly selective. We believe that 8-9% of the total science degrees is a reasonable estimate of their production.

There are at least 15 great public research universities, where the culture, curricula, and standards of high-level science are similar to those that prevail in the ones we are investigating here. Though they are less selective overall than the highly selective private universities, they are closer to them in science than in other areas, because the degree of selection for developed ability in the science departments of selective public research universities is severe: smaller proportions of students enter such institutions initially interested in science, and persistence rates are lower (see the review in Strenta et al., 1993). But the select few who remain include many very talented students. Thus, for example, Humphreys and Freeland (1992) have shown that the SAT scores for four successive groups entering the UC Berkeley School of Engineering are very close to the average for the engineering schools or departments of the group of schools we are studying (Strenta et al., 1994). These public universities are huge by private standards, a fact that offsets to some extent the smaller proportions of science concentrators in them. We assume that they give at least another 10-12% of the total of science degrees. Finally, we assume that these degrees represent the best of science education of students in the high end of the ability range, so that the roughly 20% under discussion will constitute a far larger percentage of postbaccalaureate science, engineering, and medical students.

In short, though our argument rests heavily on plausibility grounds, we would not expect the major factors affecting choice of and persistence in science to be very different at such public research universities as Washington, Michigan, Berkeley, Illinois, San Diego, Texas, UCLA, Wisconsin, Virginia, or North Carolina than they are at Rice, Stanford, Notre Dame, Duke, Chicago, Northwestern, Tufts, Georgetown, Carnegie-Mellon, Washington University, or Johns Hopkins. Chipman and Thomas (1987, p. 425), noting that high-ability students were not much studied, went on: "Yet they are the population of real interest with respect to participation in mathematics and science. It would be particularly important to study minority students of high ability." That is what we do here.

METHOD

Subjects

In 1988 an average of about 13,000 students applied to each of the four highly selective institutions whose data are combined here for analysis. These institutions accepted between a

fifth to a quarter of them, and matriculated about half of those. The population of students under investigation was thus highly selected by the institutions, and also highly self-selected in applying.

With respect to the four ethnic groups targeted here for study, an average of 8,250 whites, averaging a total SAT of 1,268, applied to each institution; 22% were selected, yielding a group of white matriculants with an average SAT of 1,325. Similarly, an average of 735 black students applied to each institution, averaging a SAT score of 1,089; 35% of them were selected, with a resulting group of matriculants having an average SAT of 1,160. Of the 1,620 Asian applicants per institution, with an average SAT of 1281, 23% were selected, producing a matriculant group averaging 1,345; and of the 490 Hispanic applicants per institution (SAT = 1,152), 29% were selected, resulting in a matriculant group with a 1,219 average SAT. The matriculant groups averaged 410 points above their respective population 1987-88 SAT means, ranging from 390 for whites to 425 for blacks.

Measures

The basic data came from high school transcripts, admissions office data, and college transcripts through June 1992. We employed the following pre-matriculation measures in many of our analyses: SAT verbal score and SAT math score (SATV and SATM); the average of the best three achievement tests (ACH); the number of high school science and mathematics courses (NSCI); average grade earned in these courses (HSSCI); average grade in high school nonscience courses (HSNON); stated initial interest (INT) in a major (the first stated if more than one), coded 0 for nonscience and 1 for science, where science is defined as natural science and engineering. Students who were undecided or wrote nothing were classified as nonscience. Other prematriculation measures occasionally employed were the standard measures used by admission departments: the high school percentile rank in class converted to a normal deviate with mean 500 and standard deviation 100 (CRS, or converted rank score), and the Academic Index (AI), which is one-tenth the sum of (a) the average of the two SAT scores (e.g., 670), (b) the ACH (e.g., 680), and (c) the CRS (e.g., 690 for someone who was third in a class of 100); in the examples, the AI would be 204. Finally, we coded participation and performance in high school science courses.

College performance measures included the grade-point average for science and mathematics courses taken during the first 2 years (SGPA), the counterpart measure for nonscience courses (NGPA), and the broad area of actual concentration (MAJ, coded, like INT, as 0 or 1 for nonscience and science, respectively). Other measures occasionally used were the yearly and cumulative GPAs.

We were conservative in what we classified as science, not including history of science, cognitive science, psychology, environmental science, science and ethics, biology and society, or other interdisciplinary concentrations, which were placed into social science (usually) or humanities as seemed most appropriate. We were interested in analyzing science concentrations like those that are traditionally part of natural science divisions: hierarchical, laboratory-based disciplines with several prerequisites, usually including many mathematics courses, and usually with heavy workloads and frequent assignments.

RESULTS AND DISCUSSION

Preparation

The top panel of Table 1 shows the percentage of each group that took the indicated Advanced Preparation (AP) science course, and the average group grade for each course. The most frequently recorded course was AP Biology, closely followed by AP Chemistry; AP Physics and AP Calculus BC were substantially less often chosen. With but three exceptions for grades and one for percent participation, the order of grades and participation was Asian, white, Hispanic, and black. Regardless of these differences, the overall participation in advanced high school science courses was well above the national average (College Board, 1988b). Group differences on these variables, as on those of the lower panel, were highly significant, which simply means that much of the effect of ethnicity occurred prior to college matriculation. We take such differences into account in examining whether there were further ethnic effects during college.

The bottom panel of Table 1 shows the values of the preadmission variables used in various analyses. Most of the preadmission data are standard, but we have included as a variable the number of science and math courses (NSCI), and disaggregated the overall high school GPA into science (HSSCI) and non-science (HSNON) components. The standard predictors, SATM, SATV, and Achievement Test average (ACH), are shown in rows 4-6; as noted, these, along with high school record, make up the Academic Index (Al—shown in row 7), which is the chief predictor of grades used by the admission departments of these schools. In this population, AI correlated $r = .50$ with first-year GPA, and .45 and .46, respectively, with NGPA (the average grade in courses outside the science division in the first 2 years) and SGPA (the average grade in science division courses in the first 2 years). The eighth row indicates the percentage of each group that expressed an intention to major in science or engineering.

These credentials shown in the bottom panel are the ones that admissions officers look at, and they manifested extensive course work in science and math, very good high school grades, and high scores on standardized tests. As the introduction and the AP science course data suggest, the Asian students showed the greatest preparation and the most highly developed ability, especially with respect to science-related scores, averaging just over a third of an S.D. above the general average on those. Asians and whites together constituted about 77% of the students who were initially interested (and 82% of the students who finally majored) in science, with blacks and Hispanics together making up about 11% of those interested (and 7% of those who finally majored) in science. (The remainder was made up predominantly of foreign students, many of them Asian, and students of unknown ethnicity, many of them white.) From the point of view of the non-Asian minorities, then,

TABLE 1. Preadmission Data by Ethnic Group

A: Advanced Placement Science Courses: Percent Participation and Grades

	Asian *N* = 582		White *N* = 3534		Hispanic *N* = 216		Black *N* = 355		M Total *N* = 4687	
AP Courses	%	GPA	%	GPA	%	GPA	%	GPA	GPA	SD
Biology	33.2	3.71	22.5	3.64	21.5	3.44	26.4	3.52	3.63	0.47
Chemistry	33.4	3.65	20.0	3.70	17.0	3.55	14.7	3.19	3.65	0.52
Physics	23.6	3.52	17.7	3.61	12.5	3.43	5.2	3.29	3.56	0.58
Calc (BC)	22.4	3.62	14.3	3.50	5.0	3.30	4.3	3.19	3.51	0.57

B: Admission Data

	Asian		White		Hispanic		Black		M Total	
Variables	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.
NSCI	9.91	1.33	9.29	1.39	9.25	1.37	8.94	1.37	9.34	1.40
HSSCI	3.75	0.31	3.62	0.38	3.52	0.44	3.33	0.46	3.61	0.39
HSNON	3.75	0.51	3.67	0.52	3.59	0.62	3.44	0.59	3.66	0.54
SATM	712.	54	692	62	641	73	597	73	685	68
SATV	633	79	633	70	578	81	563	75	625	75
ACH	680	57	663	62	628	70	577	64	657	67
AI	208.4	11.8	204.6	13.2	193.7	14.0	183.6	14.2	203.1	14.5
& Interest in Science	55.0		41.4		44.0		44.2		43.4	

Note: Panel A includes the percent of students in each ethnic group taking indicated high school AP courses and their mean grade point average. In Panel B, NSCI is the mean number (M) and standard deviation (S.D.) of all math and science courses taken in high school; HSSCI is the high school science GPA; HSNON is the nonscience GPA; SATM and SATV are the math and science portions of the SAT; ACH is the mean of the highest three Achievement Tests; AI is the Academic Index; and % Interest is the percentage of each group expressing an intention to major in science or engineering. Mean totals are weighed. Ns listed are maxima; some data are missing in every cell.

their colleagues and competitors in science classes were overwhelmingly whites and Asians, and we take the combined white-Asian mean as the reference for non-Asian minority disadvantage in preadmission and college performance variables.

For blacks, that disadvantage was a third of an S.D. in number of high school science courses taken (NSCI), and four-fifths of an S.D. in high school science grades (HSSCI). On SATM, ACH, and AI, blacks were 1.3 to 1.5 S.D.s behind. The relative disadvantage for Hispanics was about half that for blacks on the most science-relevant variables—HSSCI, SATM, ACH, and Al. Note, as Ramist et al. (1994) showed (particularly at selective colleges of the sort under study here), that high school grades evinced far smaller disadvantage for blacks and, especially, for Hispanics, than SAT scores. Note also that nearly all of these minority disadvantages would be larger if measured against the Asian-white standard deviation.

Apart from the Asians, these differences in preparation and developed ability for science did not affect the proportion of each group having an initial intent to major in science (row 8 of the lower panel of Table 1), with blacks and Hispanics having been a little more interested initially than whites, despite relative deficits in high school preparation, performance, and test scores. Such a result implies an ethnic effect of the sort suggested in the literature: blacks, especially, aspire to be in science, all other measures held equal (Dunteman, Wisenbaker, and Taylor, 1979; Oakes, 1990). This implied finding is important, because intention to concentrate in science is by far the strongest predictor of actually doing so (in our group overall, the *phi* correlation was .55).

The implication of an ethnic effect was tested by analyzing the residuals from the multiple regression equation predicting initial interest (Science = 1; Nonscience = 0). In the predictive equation, all the preadmission variables were highly significant ($p < .0001$), with $R^2 = .20$; number of high school courses in math and science (NSCI), the average grade in them (HSSCI), and SATV were by far the most powerful predictors, the last one being negative. High school nonscience grades (HSNON), SATM, and ACH were weaker predictors, with the first being negative. Analysis of variance of the residual scores by ethnic group yielded a significant ethnic effect ($F(3, 3662) = 5.05$, $p < .002$). Blacks were more likely than predicted to express an intention to major in science (mean residual, .10), and, by Bonferroni t-tests, were more likely than the other groups (whose mean residuals were .00, .00, and — .01 for Asians, Hispanics, and whites, respectively) to do so.[iii] The interactions of ethnicity with the preadmission variables were separately assessed by the tests for covariate-by-treatment interactions outlined by Stevens (1992, pp. 344-355). No single covariate-by-treatment interaction was significant, nor was the lumped covariate-by-treatment interaction.

It does appear, once more, that blacks would be very well represented in science if intention to be a scientist were the decisive controlling variable. The present data on rates of initial interest in natural science and engineering agree with data cited in the introduction: Asians and whites are high and low in interest, with blacks and Hispanics close together in the middle.

Table 2. Preadmission and College Performance Variables by Ethnic Group and Initial Interest

	Asian		White		Hispanic		Black		Total	
Variables	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.
A: Initial Interest in Science										
N	320		1462		95		157		2034	
NSCI	10.24	1.26	9.89	1.20	9.58	1.33	9.47	1.22	9.90	1.23
HSSCI	3.80	0.25	3.75	0.29	3.62	0.37	3.44	0.31	3.73	0.31
HSNON	3.74	0.51	3.67	0.54	3.51	0.62	3.46	0.55	3.66	0.55
SATM	721	52	714	52	653	74	607	72	704	63
SATV	621	81	627	68	563	84	541	78	617	76
ACH	685	58	677	58	630	78	573	66	669	66
AI	208.6	12.0	206.9	12.1	193.2	15.4	182.4	15.0	204.9	14.2
SGPA	2.94	0.64	2.99	0.70	2.46	0.68	2.21	0.71	2.89	0.72
NGPA	3.23	0.48	3.23	0.52	2.97	0.63	2.85	0.58	3.19	0.54
% Sci. Major	70.0		60.6		55.8		33.8		60.00	
& Terminated	4.0		4.1		10.5		14.6		5.2	
B: Initial Interest Not in Science										
N	262		2070		121		198		2653	
NSCI	9.50	1.30	8.85	1.35	8.98	1.35	8.53	1.34	8.90	1.36
HSSCI	3.68	0.35	3.53	0.41	3.44	0.47	3.24	0.49	3.52	0.43
HSNON	3.76	0.52	3.68	0.52	3.65	0.61	3.42	0.56	3.67	0.53
SATM	701	54	677	63	632	71	589	74	670	69
SATV	648	74	637	71	590	76	579	69	632	74
ACH	673	55	653	63	626	63	580	62	648	66
AI	208.1	11.5	202.9	13.7	194.1	13.0	184.5	13.6	201.6	14.5
SGPA	3.08	0.75	3.02	0.82	2.73	0.92	2.22	0.96	2.96	0.85
NGPA	3.32	0.39	3.25	0.49	3.08	0.54	2.80	0.55	3.22	0.51
% Sci. Major	14.9		8.6		5.8		2.5		8.6	
& Terminated	4.6		4.7		10.7		11.1		5.5	

Note : For both Panels, N = sample size. Total sizes exclude unknown ethnicity and foreign students. NSCI is the mean number (M) and standard deviation (S.D.) of all math and science courses taken in high school; HSSCI is the high school science GPA; HSNO is the nonscience GPA; SATM and SATV are the math and science portions of the SAT; ACH is the mean of the highest three Achievement Tests; AI is the Academic Index; SGPA is the grade point average for science courses in the first two undergraduate years; NGPA is the average for nonscience courses in the first two years; % Sci Major is the percentage of each group who majored in science or engineering; and % Terminated is the percentage of each group no longer matriculated in the 1991-92 year (i.e., students who left or were separated).

Performance

Table 2 shows data for the same variables shown in the lower panel of Table 1, now subdivided by initial interest in either science or nonscience majors, and it adds data on college performance variables of interest. These are grades in the first two undergraduate years in science courses (SGPA), courses not in science (NGPA), and the percentages of each group who finally majored in science. The chief differences between the two major interest groups were, understandably, on three variables very strongly predictive of interest in science—number of and grades in high school science courses (NSCI and HSSCI), and SATM, where the differences exceeded a half standard deviation—and on ACH, where the difference amounted to a third of an S.D. Because grades in nonscience high school courses were nearly the same in each major group, and SATV scores only moderately favored those not initially interested in science, the students initially interested in science had a modestly though significantly higher AI, a common result (Green, 1989; White, 1992) with respect to the relatively high overall quality of academic preparation among science students.

Despite these differences, science grades in the first two college years were slightly greater for the group not initially interested in science than for the group that was. We analyzed this anomaly in the earlier paper (Strenta et al., 1994): science departments offer fairly easy courses for nonscientists and do not grade them as rigorously as courses that are part of their majors. Here, however, we are primarily concerned with ethnic differences, in particular differences in persistence among the students who came to their colleges intending to concentrate in science. Some can be accounted for by differences in preadmission measures of preparation and developed ability; whatever cannot be so accounted for may be fairly attributable to ethnicity or to variables associated with it.

Of the students initially interested in science, the relative position of blacks and Hispanics on science-relevant variables was worse than it was among all students (as was shown in Table 1), another example of the rule that the more rigorous the selection from groups differing at the mean, the greater the relative disadvantage of the groups with the lower means. The deficits were particularly large on the Academic Index (Al), about 1.7 and 1 S.D., respectively, below the average of similarly interested white and Asian students. There were somewhat smaller but still substantial deficits in high school science grades (HSSCI of about 1.0 and 0.5 S.D.s, respectively) and ACH (about 1.6 and 0.7 S.D.$), so that the deficits in the Academic Index were about the same as in SATM (in these comparisons we have used as divisors for units of effect size the S.D.s for the students interested in science, since they are the ones populating the serious introductory science classes—if the white-Asian S.D.s are used, the differences grow by 15% to 20%).

Persistence

The expected consequences of these differences on science-relevant variables are differences in persistence, the proportion of students initially interested in science who actually majored in science, shown in the next-to-last row of the top panel of Table 2. Such persistence varied predictably: the rate for Asians, at 70%, was twice that for blacks (34%); and rates for whites (61%) and Hispanics (55%) were intermediate. The differences shown in percent who majored in science were highly significant ($x^2 = 58.99$, $df = 3$, $p < .0001$), as were the ethnic

differences, in the same order as just given, in rate of recruiting to science majors (next to last row of the lower panel) from those students who had not expressed an initial intent to major in it ($x^2 = 23.37$, $df = 3$, $p < .001$). The high rates for Asians and whites resemble those given in the High School and Beyond (in Hilton et al., 1989) and the Astin and Astin (1993) data discussed in the introduction.

The most serious form of nonpersistence, leaving school altogether, manifested similar differences (final row of each panel). For students initially interested in science, the ethnic termination rates were significantly different ($x^2 = 37.91$, $df = 3$, $p < .001$), as were the differences among the highly similar termination rates among those students not initially interested in science ($x^2 = 21.40$, $df = 3$, $p < .001$). By national standards, of course, the termination rates shown in Table 2 are very low loss rates.

Hispanics appear to have persisted more, and blacks less, than preadmission variables might have indicated. The R^2 for the regression of persistence on preadmission variables was .10, with the strongest predictors being number of, and grades in, high school science courses (NSCI and HSSCI), ACH, and (negatively) SATV (all $p < .0001$). We again analyzed the residuals from this regression by ethnic group. The F-ratio (2.54, $df = 3, 1631$, $p < .06$) was nonsignificant. Blacks averaged a residual score of — .08 (they persisted less than predicted); Hispanics averaged .09 (they persisted more than predicted); whites (— .01) and Asians (.04) averaged closer to prediction.[iv] The interactions of preadmission variables with ethnicity were again assessed for covariate-by-ethnicity interactions (Stevens, 1992), which were again nonsignificant.

The marginal ethnic effect of the main analysis perhaps warrants some speculation. The decrement for blacks may be to some degree the complement of the "excess" initial interest beyond what preparation and developed abilities would have predicted. The Hispanic increment over the predicted rate may have to do with the uncommonly large proportion, over 50%, of their science-interested group who wanted to go into engineering, the science area where persistence is highest. These speculations notwithstanding, however, the main result of this analysis of ethnic group residuals is not significant: preadmission variables accounted for a significant fraction of the variance of persistence decisions and ethnicity did not. This lack of ethnic effects on persistence echoes similar noneffects in the Hilton et al. (1989) and Astin and Astin (1993) regression analyses.

Overview

For our subjects, the combined effects of persistence, recruiting, and termination left 45.2% of the entire incoming group of Asians, 30.1% of whites, 27.8% of Hispanics, and 16.6% of blacks still majoring in science after 4 years. By comparison, a recent NSF report (National Science Board, 1993) gives corresponding percentages of all science degrees (among all bachelor's degrees given in 1991) as 33.1% for Asians, 14.0% for whites, 10.3% for Hispanics, and 12.4% for blacks. Astin and Astin (1993) reported corresponding figures of 35.9%, 16.6%, 13.1%, and 16.1%. The Asians, whites, and Hispanics in our selective sample did much better, but the blacks, though also highly selected, did not.

Figure 1 shows the conventional grade-point averages (GPAs) of the different ethnic groups, for each year and by kind of major: science in panel A and nonscience in panel B. As is typical, grades in humanities and social sciences were generally higher than those in science, even though the average Academic Index (AI) in the nonscience majors was significantly lower, by 0.4 S.D., than that in science. Grades in nonscience majors rose more steeply from the first to the final year; indeed, grades of science majors did not on average rise at all in the second year, and for minority groups they fell. The ordering of the ethnic groups was the same, regardless of year or category of major.

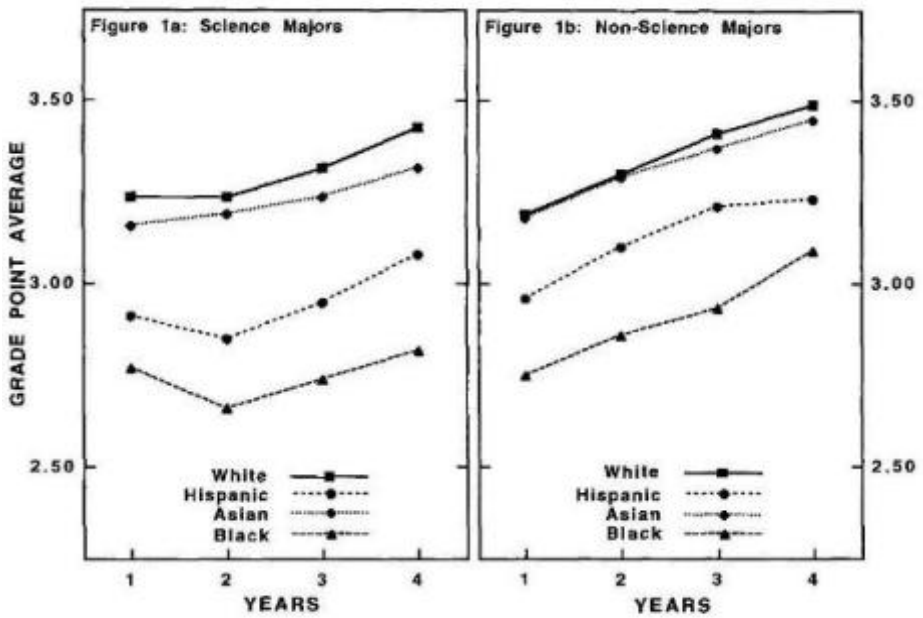

FIG. 1. Average grades by year, ethnic group, and division.

We used these data to test a common hypothesis, the "late bloomer" hypothesis: that is, that non-Asian minority groups will close the initial gap with whites and Asians after they have made their adjustments to a putatively strange, unsettling, elite, largely white collegiate world. The dependent measure was the difference between first- and fourth-year GPA, by group and category of final major. The effect of major category was very large (FBI, 4186) = 64.5, $p < .0001$), the effect of ethnic group nonexistent ($F < 1$), and the interaction of ethnicity and major category marginal ($F_{(3}$, 4186) = 2.37, $p < .07$). This last result arose from the very small net upward shift over years for blacks who majored in science, and it may have something to do with the fact that their average science grade in the first 2 years (SGPA = 2.40) was 1.3 S.D.s lower than the average SGPA of white and Asian science majors (3.16), a very difficult competitive position. But the chief result here was one found in every longitudinal test of the "late bloomer" hypothesis we know of (Elliott and Strenta, 1988; Wilson, 1980, 1981): non-Asian minorities do not catch up with whites and Asians over time. Astin and Astin (1993) reported, in fact, that the African-Americans in their longitudinal sample had lost relative ground on quantitative tests (e.g., from SATM to GREQ) over 4 years, probably because they were less likely to have studied in quantitative areas.

Many discussions of choice of, and persistence in, science do not employ many of the variables used here—achievement test scores and scores derived from high school transcripts—because they are unavailable or difficult to get. But many investigators do have SAT scores for analysis. We therefore present a more detailed analysis of the SATM scores—their relation to various choices and their distribution—to facilitate comparisons with other work. Figure 2 illustrates the general relation between SATM scores and the rate, at any score level, of majoring in science in this sample. For scores below 640 the rate was low and moderately rising. Above 640, there was a steep increase in rate with score level until at the top two score levels over half the students majored in science. Indeed, 89% of all

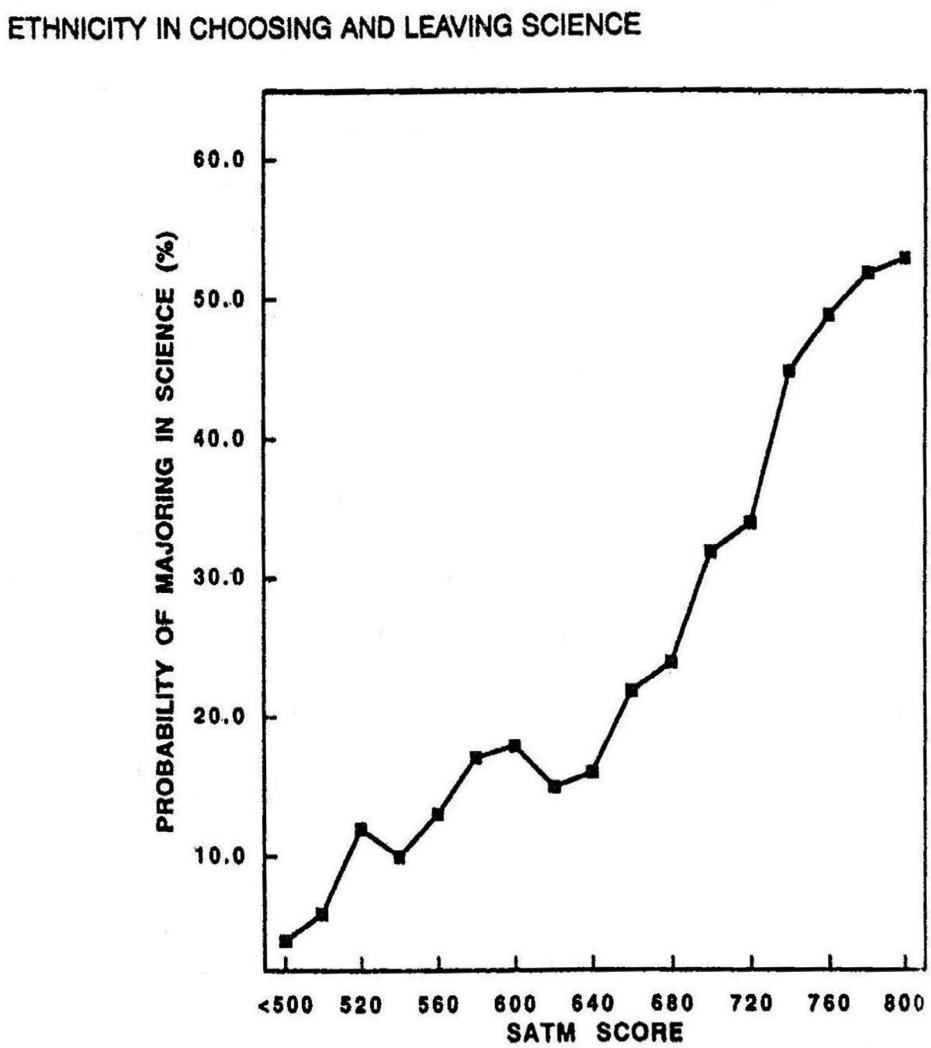

FIG. 2. Probability of majoring in science given a particular SATM score.

science majors had SATM scores of 650 or more, and 70% had scores at or above 700. The implications of these figures for the representation in science majors of Hispanics and blacks, of whom only 53% and 25%, respectively, had scores of 650 or more, are negative.

The leftmost panel of Table 3 shows the SATM score distribution for each ethnic group, as proportions of each group falling within three broad score categories: <550, 550-640, and 650-800. The middle and rightmost panels show the proportions within each score category who were interested in or who majored in science, respectively. The rightmost panel shows that, given a score of 650 or better, the Asians were more likely than all others to major in science[v] ($x^2 = 32.2$, $df = 3$; $p < .001$); the proportions for the other groups were not different. Given a middling score of 550-640, both Asians and Hispanics were relatively more likely to major in science ($x^2 = 25.3$, $df = 3$, $p < .001$) than blacks and whites, and

TABLE 3. Distribution of SATM Scores and Science Choice by Ethnic Group

	Percent in Each Score Category								
	Of All Students			Interested in Science			Who Majored in Science		
Group	<550	550-640	>640	<550	550-640	>640	<550	550-640	>640
ASIAN	—[a]	10.0	89.1	—[a]	36.8	57.3	—[a]	26.3	47.6
WHITE	2.1	18.8	79.1	11.3	22.3	47.4	5.6	13.0	35.4
HISP.	10.0	37.0	53.1	23.8	46.2	46.4	4.8	32.1	29.5
BLACK	23.8	51.0	25.2	33.3	46.6	48.8	7.4	13.2	30.2
TOTAL	3.9	21.0	75.1	24.2	29.6	48.9	6.7	15.4	36.9

[a]Cell size <10.

within each of those pairs there was no difference. Particularly noteworthy is the fact that, score level for score level, roughly the same proportions of blacks as whites majored in science, and at the highest level where the vast majority of the majors came from, Hispanics were also the same as blacks and whites.

These data may assist us in dealing with the most obvious disparity in results concerning persistence in science among talented non-Asian minority students. We refer to the results of Hilton et al. (1989) on students who aspired to major in science or engineering and had SATM scores of 550 or better. Our persistence rates of 70% for Asians, 61% for whites, and *55%* for Hispanics are similar to the corresponding rates of 70%, 55%, and about 60% for the groups of students studied by Hilton et al., but their rate for persistence by blacks was nearly double ours, 62% vs. 34%. Can this disparity be reconciled?

Whether it can be completely or not, we think the size of the discrepancy is more apparent than real, for several reasons.

First, to mention probably the smallest contribution to it: over half the non-Asian minority subjects in Hilton et al. (1989) were prospective engineers (compared with 42% of our black and Hispanic science intenders), and engineering is the field of highest persistence. Second, their subjects were selected from SAT takers who had SATM scores of 550 or higher in 1984-85, intended to major in science or engineering, and were later asked, in February 1987, what they were doing. Of the half who responded to the questionnaire, 61% were in a 2-year or 4-year college or university and either majoring or intending to major in science or engineering: i.e., they were persisters. But a few of those persisters had less than a year of higher education, and virtually none would have completed more than three semesters. Persistence in sciences, especially outside of engineering, can by no means be assumed at

that point in a career-there is a substantial outflow from the science pipeline after the second year (NSF, 1990; Massey, 1992). In a large-scale study of persistence in engineering, for example, a third of black and a fifth of Hispanic attrition occurred after four semesters (Phillips, 1991).Thus, the 61% overall figure would probably have diminished in the next 2 to 3 years by some nontrivial amount.

Third, and most challenging, Hilton et al. (1989) give the figures for black persisters in six Ivy League schools, including three of those studied here, and they show 58% persistence, well above our 34%. Perhaps the postsophomore attrition just mentioned would bring the figures together, but so might other influences. The 93 black students in those institutions in the Hilton et al. sample were, we estimate, about a third of all the black students on those campuses interested in science, and they may well have been among the best ones, both because none were below 550 in SATM, and because, within the study sample, self- and institutional selection may have worked to that end. In our sample, nearly a quarter of the black students had SATM scores below 550, and while a third of that group was initially interested in science, only a fifth persisted. At the other end, the persistence rates of blacks in our sample with SATM scores of 650 or more was 59%, about the same as the figure of 61% for whites.

Finally, Phillips (1991), reporting on engineering students who began higher education, as most of Hilton et al. (1989) students did, in 1985, and who also had SATM scores of 550 or more, gave graduation rates as of 1990 as 62% for blacks, 58% for Hispanics, and 83% for nonminority students (these high rates for all groups presumably result from engineering being the science under investigation). Here, in very large samples going well past the third semester, the majority-minority persistence difference reasserts itself, even in talented groups. Whites and Asians in such selected groups will still have higher means on SAT scores and high school grades, as they did in the Hilton et al. samples, and can be expected therefore to persist more.

We believe, in short, that the Hilton et al. (1989) results are unusual: the facts that their sample was truncated at the low end, and that their students attended a wide range of institutions and were very early in their college careers when they responded, complicate the comparison with other results, including our own.

GENERAL DISCUSSION

Though non-Asian minority students in this sample had strong interests in pursuing science as a concentration, their persistence in that choice was below average, by a small amount for Hispanics and a large one for blacks. It was the preadmission variables describing developed ability—test scores and science grades—that accounted chiefly both for initial interest and for persistence in science, though being black clearly added something to initial interest. These results—the noneffects of ethnicity on persistence—echo those of Hilton et al. (1989) and Astin and Astin (1993), who in predicting persistence using elaborate regressions with large data sets found no significant ethnic effects. Even so, the persistence of blacks was in our case very low.

Why are so many talented minority students, especially blacks, abandoning their initial interests and dropping from science when they attend highly selective schools? The question has many possible answers, but we will begin with the factor we think most important, the *relatively* low preparation of black aspirants to science in these schools, hence their poor competitive position in what is a highly competitive course of study. As in most predominantly white institutions, and especially the more selective of them (Ramist, Lewis, and McCamley-Jenkins, 1994), whites and Asians were at a large comparative advantage by every science-relevant measure (see Table 2), and on the composite predictor, the academic index, they were at a 1.75 S.D. advantage.

That it is the comparative rather than the absolute status of the qualifications is clear from two strands of evidence. First, students at historically black colleges and universities (HBCUs) have quite low average SAT scores and high school grades *(The College Handbook,* e.g., College Board, 1988c, or any recent edition; *Barron's Profiles of American Colleges,* e.g., 1988, or any recent edition), but they produce 40% of black science and engineering degrees with only 20% of total black undergraduate enrollment (Cullotta, 1992; Phillips, 1991). For example, with SATM scores averaging about 400, half the students at Xavier University are reported to be majoring in natural science (Cullotta, 1992); with scores somewhat higher (about 450), Howard University is the top producer of black undergraduate science and engineering degrees (Suter, 1993; Cullotta, 1992). It may be that many of these students will not progress to higher degrees in science in the same proportions that students with an Ivy League science education do; but it is a virtual certainty that no one goes on in science without either majoring in it or taking a well-prescribed premedical (or predental or preveterinarian) science program. You can't play if you don't stay, and leaving science or premed for education or history usually means leaving science or premed forever.

And enough of the graduates of HBCUs do go on in science to establish an interesting and significant fact: of the top 21 undergraduate producers of black Ph.D.s during the period 1986-1993, 17 were HBCUs and none were among the 30 or so most selective institutions that so successfully recruit the most talented black secondary school graduates (Thurgood and Clarke, 1995, Table 5). Cullotta (1992) quoted a biology professor from one of the HBCUs: "The way we see it, the majority schools are wasting large numbers of good students. They have black students with admission statistics [that are] very high, tops. But these students wind up majoring in sociology or recreation or get wiped out altogether." In fact, at our institutions, non-Asian minority students tend to shift out of science rather than to drop out altogether.

We think it certain that more of the black students in our sample would have persisted in science had they been, say, at Howard, but more of them would also have persisted at any of several majority white institutions as well, and that brings us to the other strand of evidence for the competition argument. It appears in Table 4, which we calculated from data tapes kindly supplied to us by Warren Willingham from the data sets on nine private colleges he studied for his book, *Success in College* (1985). We have added the data of two others. The table shows how science degrees are distributed within each institution as a function of terciles of the SATM distribution; institutions are listed in descending order of average

SATM score. Thus, in institution A, over 53% of all the science degrees given were earned by students whose SATM scores were in the top third of its SATM distribution, averaging 753. A similar percentage of all the science degrees given in institution J were earned by students in the top tercile of *their* SATM distribution, but the average of that tercile was much lower, at 591. That figure lies just below the figure for black students in our sample (Table 1), but it is also just above the score of 581 that characterizes the bottom tercile of Institution A, where only 15% of the science degrees were awarded.

TABLE 4. Percentage of Earned Degrees in the Natural Sciences as a Function of Terciles of the SATM Distribution in 11 Institutions

	Tercile 1		Tercile 2		Tercile 3	
Institution	% Degrees	SATM	% Degrees	SATM	% Degrees	SATM
Institution A	53.4	753	31.2	674	15.4	581
Institution B	57.3	729	29.8	656	12.9	546
Institution C	45.6	697	34.7	631	19.7	547
Institution D	53.6	697	31.4	626	15.0	534
Institution E	51.0	696	34.7	624	14.4	534
Institution F	57.3	688	24.0	601	18.8	494
Institution G	62.1	678	22.6	583	15.4	485
Institution H	49.0	663	32.4	573	18.6	492
Institution I	51.8	633	27.3	551	20.8	479
Institution J	54.9	591	33.9	514	11.2	431
Institution K	55.0	569	27.1	472	17.8	407
Medians	53.6		31.4		15.4	

Note: Percentages indicate the proportion of natural science degrees awarded to students as a function of terciles of the SATM score distribution. SATM numbers are mean scores for each tercile, which vary depending on the selectivity and general level of developed ability that characterizes an institution. SATM is the score on the mathematical reasoning section of the Scholastic Assessment Test.

The table makes clear two things about these and presumably similar schools: first, the the proportions of science degrees awarded, by terciles of the SATM distribution, are about 54%, 31%, and 15%. Second, the same SATM score may be associated with any of these terciles, depending on the selectivity and general level of developed ability that may characterize an institution. Put concretely, a student with an SATM score of 580 who wants to be in science will be three or four times more likely to persist at institutions J and K, where he or she is competitive, than at institutions A and B, where he or she is not.

Institutions F—K are only about half as likely to give science degrees—with only about 15% of their degrees in science—as institutions A—E, which average 28% science degrees. Still, a 54% chance of getting one of the 15% of the degrees that are in science is nearly twice as good as a 15% chance of getting one of the 28% of degrees that are in science. Our institutions are collectively like A: 51.6% of the science degrees were given to top tercile students, 31.5% to middle tercile students, and the rest, 16.9%, to the bottom tercile. The associated mean SATM scores were, respectively, 753, 695, and 607, the last figure being exactly the mean score for blacks interested in science in our sample.

The gap in developed ability between the white-Asian majority and non-Asian minorities, especially blacks, especially in science, results from institutional policies of preferential admission from pools differing in measures of developed ability and achievement at the point of entry into higher education, as the Method section (see Subjects) made clear. These

policies subserve the several goals collectively categorized as diversity or affirmative action goals, and these institutions are firmly committed to these admissions practices. That being the case, non-Asian minority students initially aspiring to science will continue for some time to bear a cost in lower grades and in altered academic and vocational goals. It may well be a cost such students regard as worth bearing in return for benefits in quality of education, variety of points of view, richness of social experience, prestige of degree, or enhancement of career prospects. Still, it is a serious cost that should be acknowledged, and minimized if possible.

There are several methods and combinations of methods that have been proposed to reduce the gap, and they can be categorized into three general groups: direct inducements to, or requirements for, greater study, more general support (mentoring, advising, group work and meetings, internships, and monetary incentives), and the elimination of institutional racism. It is possible that some features of some of the better-known intervention programs designed to increase the number of minority scientists are transportable to highly selective institutions. We discuss three of them briefly.

The Meyerhoff scholars program (Gibbons, 1992; Hrabowski and Maton, 1995; Mercer, 1994) at the University of Maryland, Baltimore County (UMBC), selects some 40 bright African-American students (who must have a B average and, currently, a minimum SATM of 600, and whose average SATM is 650) from among some 600 applicants from schools throughout the state; offers tuition, fees, room and board, and a stipend; requires a 6-week program of science and math courses in the summer prior to matriculation; requires a B average to be maintained (this motivational device could not be employed at our schools, which give only need-based aid); provides a program community, including group meetings and common housing; encourages group study and the use of tutoring; links the students with scientists and engineers as mentors; and provides summer internships in various labs.

The program appears to be very successful both in grade performance (no student had gotten a grade below C) and persistence (only three had left the program, which began in 1989) as of the June, 1994, report in the *Chronicle of Higher Education* by Mercer. A recent study of its first three cohorts (Hrabowski and Maton, 1995) found the Meyerhoff scholars getting freshman GPAs averaging 3.5, while a historical comparison group of black science students (most of whom who had entered UMBC between 1980 and 1989), matched on SAT and high school grades, averaged only 2.8, with the biggest part of the difference coming in science courses, particularly calculus and chemistry. There are some problems with historical comparisons, as the authors recognize. Also, Meyerhoff students may get special instruction in calculus and chemistry in their summer program, and perhaps be graded somewhat less rigorously in summer.

Still, it is easy to believe that the Meyerhoff scholars are doing well, and it would be easy to believe that they are doing somewhat better than they would have done without the program features that exercise and reward the further development of their talent for science. But UMBC is not an unusually selective institution (the white students there average well below 650 SATM): an SATM average of 650 characterizes African-Americans at such places as Harvard and MIT, but virtually nowhere else. So the competitive advantage of the Meyerhoffs

should not be taken lightly as a contributor to their success. The program is selective and voluntary, which makes control for motivation by random allocation nearly impossible. The hypothesis that the white-black performance gap, at least in the case of the Meyerhoff scholars, has been eliminated at UMBC simply by eliminating any gap in entering developed abilities cannot, therefore, be rejected on any evidence given so far.

One of the public technical schools vying for the enrollment of talented non-Asian minority students is Georgia Institute of Technology (Georgia Tech), which also has a well-known program, the Challenge Program, devoted to the recruitment and retention of black and Hispanic scientists and engineers. In its present form, as described by Smothers (1994), this voluntary program begins with a 5-week summer program of the study of calculus and chemistry, with an option to take a credit course in psychology in order to reduce the regular fall term course load. There are also provisions for mentoring and counseling, and an annual awards banquet, but before the introduction of the summer program in 1990, these had done little to improve grades and retention. A report of the program's results (Hume, 1994) shows that the black participants now get grades that are better than those of their black nonparticipating compeers, and nearly as good as those of all Tech students (primarily whites, but including the minority students). Retention rates for classes entering in 1990 and 1991 appear to be higher than those of all Tech students entering in those years. For the Hispanic students, the Challenge program has made little difference, but their grades and retention rates appear to equal or surpass the average for the institution anyway. The advantage for the program participants in GPA is highest in the first term, and drops off to varying degrees thereafter, a fact that points to the summer session as perhaps the chief contributor to program success. (The somewhat longer summer session of the Meyerhoff program may have played a similar role in its effect on freshman grades, cited above. We do not know whether the advantage conferred by that program, however large it might be, also fades with time.)

Again, it is difficult to tell how much is contributed by the Challenge Program without knowing the data on the level of developed ability brought to it by the various groups. Because participation is voluntary, a random allocation study is unfeasible, so motivation would remain uncontrolled; but a regression of retention or GPA on preadmission scores and grades, with program status added as a predictor, might indicate how much might be due to the program itself. It looks to us as if the largest effect in both of these programs, Meyerhoff and Challenge, may be on retention. Why might that be?

A relatively ill-prepared student has a higher than average likelihood of getting one or more shockingly bad grades, perhaps his or her first bad grades, in a rigorous college science course in the first term. One response is to leave school or leave science. But if the student has just finished a 5- or 6-week summer course emphasizing the very materials offered in that first term, or making possible a reduced first term course load, there is less chance for such failure, and less defection from science. The improvement in grades may fade—after all, there will be no more preparatory summer programs—but the student will have gotten over the first and most difficult hurdle. In data cited by Massey (1992), 40% of black students entering college immediately after high school left in the first year, and the figure for science aspirants may well have been higher. The summer sessions of these two

programs are ideally suited to provide help when it is most needed. An important feature of them, emphasized by both sponsoring institutions, is that they demand hard work on college-level material.

How might such a program be adapted for our institutions? To require it of non-Asian minority-aspiring scientists below some level of preparation would be coercive and might be stigmatizing and unpopular. If the program were voluntary, and were minority only, it might have some of the effect of the Challenge or Meyerhoff programs, though such exclusiveness might be neither necessary nor wise. In our sample, the number of students initially interested in science, and who had SATM scores less than 600, was 139-67 blacks, 42 whites, 23 Hispanics, and 7 Asians—or about 35 per institution. It might be feasible to offer these students such a summer session, and if voluntary and multiracial, it would scarcely be stigmatizing. There might be equity problems near the border—What about students scoring 600 or 620 or even 640—but even if the cutoff were raised to 650, there would be only 81 students eligible per institution (46% black and Hispanic), and many would not come. At the higher cutoff, because of the increased numbers, there is some tension between the ideals of compensation (minorities only) and integration (all students who are eligible) when money is, as it usually is, tight, but the lower cutoff at 600 might serve most goals quite well. Similar calculations could be done by any majority white selective school.

Most of the other features of the two programs considered seem to us less useful than working on essential course material—nothing is quite so motivating to a student as succeeding at the serious business of learning. For that reason, any method of encouraging continued hard work would be important. One of the best-known methods of encouraging hard work among minority students was devised by Treisman (1992; see Fullilove and Treisman, 1990, for an evaluation), who recruited black and Hispanic students at Berkeley and later at Texas to special sections of calculus classes where they put in an extra 4 hours beyond what they would ordinarily have done, spent in small groups working on challenging problems, inevitably teaching and learning from each other and doing whatever remedial work might be necessary in that context. Calculus is prerequisite to most sciences, so that its successful completion is critical to advancement in science.

Such selected students had stated an interest in a science or math career, had been specially invited to "honors" sections, and had accepted. Clearly they were more motivated than the average student in their comparison groups, and they also had slightly but not significantly higher SATM scores than those who elected not to participate, with both groups having medians in the 470-540 range. That they did significantly better than their comparisons, both in grades and in persistence, is no surprise. More persuasive of the program's power is the evidence that the nonparticipant minority controls performed the same as all the minority students (the comparisons reported were exclusively concerned with black students) had done prior to the intervention, which means that the program was offering a new way of enlisting the motivation and realizing the potential of at least some substantial fraction of the black population.

A later evaluation of the method (Bonsangue, 1994), done on a largely Hispanic population of beginning science students at California Polytechnic State University, arrived at similar conclusions and added data on comparisons with white and Asian students not in the program. Again, minority students who volunteered for the program did far better in the first quarter of calculus, by close to a full grade, than nonprogram minority students with similar SAT scores and high school grades. They also scored half a grade better than the large group of whites and Asians taking calculus, even though the latter averaged 70 points higher on SATM. Some of the gains faded in the second year, when the program group got slightly lower calculus grades than the white-Asian group, but the 3-year persistence rate of the program students was far better than that of any other comparison group.
The relevance of the Treisman model to highly selective institutions is uncertain. Certainly the establishment of so-called "honors" sections exclusively for blacks and Hispanics would have doubtful merit—the white-Asian "nonhonors" students in calculus would average over 700 on the SATM. But making available sections devoted to workshop problem solving would be undoubtedly useful for those of any ethnicity who volunteered for them. We do not feel that excluding all or most white or Asian volunteers from such groups is a good idea, particularly at private institutions. Race relations are difficult enough without keeping majority students from access to curricular methods of presumed efficacy. There seems every reason to encourage, though little to require, students to attend such groups; they would appear to be especially effective for students who are highly motivated and near some threshold of advanced understanding.

In sum, we believe there are some grounds for considering that prematriculation summer sessions, as described, and the provision of group problem-solving sessions associated with calculus and perhaps other science courses, would palliate the effects of relatively poor preparation for science. It seems especially important that these curricula be demanding and not remedial. The white-black gap is sufficiently large and these interventions are sufficiently small in scope and unproven in effect that we would anticipate continued large differences in persistence, though a little smaller than what now obtains. In addition, we can repeat a suggestion we gave in our report on science and gender (Strenta et al., 1994): Let secondary schools know quite specifically what sort of preparation typical successful science majors at these institutions have had. Black and Hispanic students in our sample took far fewer AP courses in physics, chemistry, and calculus than did whites and Asians, and they should learn early in their high school careers what they ought to be taking if they aspire to study science in highly selective institutions.

Finally, with respect to the question of institutional or any other sort of racism, it was in our sample remarkable for its absence. The only significant ethnic effect in our analyses of full-sample data was in initial interest, a measure that preceded matriculation. On a questionnaire[vi] answered by 33 black and 25 Hispanic science majors, and 36 black and 26 Hispanic dropouts from science, only one (a defector from science alleging a lack of support for a woman of color engineer) said anything about racism. Neither these comments nor anything else in the questionnaire seemed to us to constitute even a small indictment of these institutions as being inhospitable, much less racist. The chief problems for non-Asian minority students aspiring to science majors would appear to be not institutional racism, but rather a relative lack of preparation and developed ability.

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NOTES

1. "Ethnic" includes "racial" in our discussion. We omit Native Americans as a group because there were too few of them (34, with only 9 interested in science) for analysis. Also excluded were foreign students *(N* = 266) and "others" *(N* = 333).
2. The precise mix of Mexican-Americans, Cubans, Puerto Ricans, and others will usually not be known. Because of the varying subgroup composition of Hispanic samples, their place in relation to other groups will vary from study to study.
3. The same result was found when a MaxR^2 stepwise regression model was employed. The variable "black" entered after the six preadmission variables, was significant ($p < .0001$), and raised the R^2 from .203 to .207. Neither "Hispanic" nor "Asian" was significant.
4. MaxR^2 regression analysis produced a similar result: in the nine-variable model (six preadmission variables plus the three nonwhite ethnic groups), "black" was marginally significant ($p < .10$) and the other groups were not.
5. This fact does not contradict the lack of an ethnic effect on persistence, since it is based on SATM alone, with regard neither to initial interest nor to the several other predictors employed in that analysis.
6. The analysis of the questionnaire, contained in a report of these data to NSF, is available from the authors.

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Thomas E. Fortmann

Mathematics is ruthlessly cumulative
—Steven Pinker

The Commission poses two questions about science, technology, engineering and mathematics (STEM):

1. Why minority students disproportionately abandon their STEM aspirations,

2. Whether students in institutions matched to their own academic preparation are more likely to remain and succeed in STEM, and to what degree affirmative action policies affect this.

I will attempt to answer the first question and comment briefly on the second, based on my STEM career and recent experience in K-12 education.

My background includes a physics degree from Stanford, a doctorate in electrical engineering from MIT, four years of university teaching, and 24 years as a high-tech engineer and executive. In recent years I have taught mathematics to minority high-school students in Boston, founded a math institute for elementary teachers, and served on the Massachusetts Board of Elementary and Secondary Education.

Accumulating Mathematical Proficiency

Many minority college students avoid or abandon STEM majors for the same reason as nonminorities: insufficient math (and science) preparation in K-12. The disproportionality is surely related to the well-documented lower quality of math/science (and all other) instruction in minority and high-poverty schools. Does affirmative action in college exacerbate that? Perhaps. But the problem begins long before college, and it is most acute in math and math-related fields because math is more cumulative than, say, history or literature.

Steven Pinker made this point rather eloquently when he said:[44]

> "Calculus teachers lament that students find the subject difficult not because derivatives and integrals are abstruse concepts—they're just rate and accumulation—but because you can't do calculus unless algebraic operations are second nature, and most students enter the course without having learned the algebra properly and need to concentrate every drop of mental energy on that. Mathematics is ruthlessly cumulative, all the way back to counting to ten."

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[44] Steven Pinker, *How the Mind Works* (Norton, 1977), p. 341

I would add that the same is true of algebra: students who don't understand fractions and use a calculator to multiply by ten can't make progress with algebra problems because they're bogged down in the arithmetic (imagine factoring a polynomial if you don't know your times tables).

And so it goes, right down to first grade.

Preparation for STEM

We need more students of every classification in STEM, and in Massachusetts our STEM Pipeline Initiative uses outreach, summer programs, and other marketing tactics to entice more of them, especially minorities and females, into these fields. The problem with this approach is that the "pool" of entering college students who are actually prepared for STEM work is quite small. It would be more cost-effective to concentrate limited resources on increasing the number of STEM-capable students rather than on recruiting harder from the same small pool.

The small proportion of students entering college able to handle STEM courses and majors reflects the dreadful state of mathematics learning in K-12, particularly among minorities. Ask high -school teachers why this is so and they often point to middle school, while middle -school teachers lament students' poor preparation in elementary -school arithmetic. So far no one has blamed the obstetricians.

Unfortunately, this cascade of blame is based in reality. The root problem, in my judgment, is an appalling dearth of mathematics content knowledge among elementary and even middle school teachers; until we solve that, improvements and innovations at the high -school and college levels will have little effect.

Liping Ma was the first researcher to focus national attention on this issue.[45] In fact, my experience suggests that the problem is even worse than she describes. In a group of veteran 5th-6th grade teachers, for example, 57% were unable to answer "75 is 30% of what number?" and 76% could not find two numbers between 1 and 2/5 and 1 and 41/100.

Teachers' attitudes about mathematics range from trepidation to full-blown math phobia, a disease that is highly contagious. This is not the fault of elementary teachers but of preparation programs and certification systems that virtually ignore mathematics.[46] [47] And it creates a vicious cycle in which each generation of teachers is recruited from a group that leaves high school with weaker math knowledge than the last. Massachusetts has begun to

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[45] LIPING MA, KNOWING AND TEACHING ELEMENTARY MATHEMATICS (Lawrence Erlbaum Associates, 1999). For a review and summary see www.aft.org/pubs-reports/american_educator/fall99/amed1.pdf.

[46] NATIONAL COUNCIL ON TEACHER QUALITY, NO COMMON DENOMINATOR: THE PREPARATION OF ELEMENTARY TEACHERS IN MATHEMATICS BY AMERICA'S EDUCATION SCHOOLS (June 2008): www.nctq.org/p/publications/reports.jsp.

[47] NATIONAL MATHEMATICS ADVISORY PANEL, FOUNDATIONS FOR SUCCESS (Final Report, March 2008): www.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf.

address this issue with regulation changes that require more college math courses and a math test for elementary teacher certification.[48]

It's well known that teacher quality is the most important factor driving student achievement, and that teacher quality—including math content knowledge—is generally lowest in poor urban districts serving minority populations. Thus the disproportionality that the Commission cites is no surprise.

Affirmative Action

It seems self-evident, given the cumulative nature of mathematics, that affirmative action will hinder some students' STEM aspirations unless it is accompanied by vigorous and sustained efforts to raise their mathematical capacities to the level of their classmates.

In the absence of effective remediation, should those students be placed in colleges where their peers' proficiency in mathematics is similarly lacking? Doing so may result in more STEM majors, but it masks their (and their peers') low achievement and limited career opportunities. The place to address those crippling math deficits is back in K-12, where poor instruction and math-challenged teachers, along with low standards and social promotion, allow too many students to reach high school and graduate without the mathematical skills and understanding they need.

In other words, affirmative action comes into play late in the game and doesn't address the underlying mathematical deficiencies that deflect minority (and other) students from STEM majors and careers.

Recommendation

I encourage the Commission to investigate, as a civil rights issue,[49] why so many minority kids arrive in college unprepared for STEM majors—i.e., why they need affirmative action at all, and what we can do about it. The answers—far beyond the scope of today's briefing—will get to the heart of education reform and teaching quality. There are numerous worms in that can, including school choice, teacher preparation and certification, professionalization of teaching, career ladders, differentiated pay scales and incentives, collective bargaining, accountability, standards-based testing, and school leadership.

That is a tall order, but necessary in order to get beyond the symptoms and treat the disease.

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[48] Details are in the Commissioner's Guidelines for the Mathematical Preparation of Elementary Teachers (July 2007): www.doe.mass.edu/mtel/MathGuidance.pdf

[49] Robert Moses, voting-rights pioneer and founder of the Algebra Project, argues in his marvelous book RADICAL EQUATIONS (Beacon Press, 2001) that math literacy is a civil right.

Robin Willner

Let me congratulate the Commission for convening today's discussion and focusing attention on the very critical issue of minority participation in Science, Technology Engineering and Math (or STEM) careers.

I'm honored and pleased that you have asked IBM to participate today. And while I would not hazard to speak for an entire industry or the private sector, I do believe that my comments would gain a good deal of support from my colleagues. There is widespread concern about the future labor needs in the growing areas of the economy -- every major corporate leader recognizes that the U.S. labor force must continue to provide the talent and leadership that we need for a robust economic future and to remain competitive in a global economy. I also want to take this opportunity to tell you about a recent initiative at IBM that focuses on the Hispanic community and share what we've learned about both the challenges and potential solutions.

Before addressing today's topic, let me briefly provide some important context. While it has always been important for business to nurture and prepare a workforce in the U.S. with the necessary skills, there have been profound changes in the global economy that make this more important than ever before. In a global economy, the world is not only smaller; it's full connected, or, if you will, networked.

There will always be some businesses that will not need to worry about what is happening around the world, more and more, successful businesses will take the form of what we at IBM call the Globally Integrated Enterprise. U.S. companies like IBM create great opportunities for American workers and generate important economic return in the U.S. precisely because we are globally integrated and functioning on a global scale.

In a connected world, we have access to huge new markets. We also can organize our business around the globe to optimize operations. If everything is connected, then work flows throughout the network. And the most important consideration is TALENT. Localities, states and nations are striving to become places where knowledge is generated and transformed into new commercial and societal value. They recognize that, of course, we need employees with basic skills; but more importantly, we need employees who can innovate. A knowledge-based society creates jobs, raises living standards and generates growth that competitors can't duplicate rapidly.

The real wealth generators in today's global economy are technical people. A recent report by the U.S. Labor Department suggests that over the next 10 years, the need for technical people in this country is going to grow by 50 percent.

At the same time, there is a serious shortage of professionals and students studying the fields of science, technology, engineering and mathematics. I won't repeat the detailed statistics that you've heard from other speakers and that your own preparatory research uncovered. But let me be very clear on this point. There are plenty of reasons to make sure that every child in

this country has the opportunity and access to be prepared to be an engineer, scientist or mathematician or whatever their dreams dictate. But more importantly, this is an issue of our economic survival. If the key to prosperity is having the right talent, then we must take advantage of the gifts and promise of every child. We ignore any community at our peril. If the U.S. is to remain competitive, we need children from every ethnic and economic background prepared for STEM studies and potential careers in the STEM disciplines.

In our efforts to nurture all of this nation's talent, we need to attend to students from every minority group and young women as well. American ingenuity has always been the product of our rich and diverse heritage and the foundation for our economic strength. Each group has distinctive challenges and opportunities, and IBM has a range of programming to serve the full range of students. However, with our Latino population, we have the classic paradox of challenge and opportunity. Or, as our engineers describe it, "the tyranny of large and small numbers." And let me use a few compelling statistics to explain.

Over the next 40 years, the United States will be the only developed country that will grow its population. Much of that growth will come from the Latino community, who are estimated to constitute 25 percent of the total U.S. population – a growth rate of 30 percent. This segment of the population will certainly be relied upon, heavily, to help drive our nation's economic future.

However, current numbers of Latinos in STEM degree attainment and careers show that they are grossly underrepresented. According to the National Action Council for Minorities in Engineering (NACME), Latinos accounted for only 4.2 percent of engineering degrees awarded in 2005, and merely 1.5 were awarded doctorate degrees. Dropout rates among Latino youths are the largest at 24 percent compared to 12 percent for African-Americans and 7 percent for non-Hispanic whites.

The reasons behind these statistics are extremely complex and deeply entrenched.

That is why IBM, along with Exxon Mobil and Lockheed Martin and 150 leaders from education, business and the community, convened at the *America's Competitiveness: Hispanic Participation in Technology Careers Summit* in May. The objective was to address this once-hidden, but now clearly visible crisis and, more important, to take action. We also commissioned a number of research papers from Public Agenda and The Tomas Rivera Policy Institute to enhance our understanding and help shape our agenda for action.

Perhaps the most compelling information came from Public Agenda, after conducting a series of interviews with national leaders from every sector. The title of their report tells the story: "Out Before the Game Begins."

"Nearly all of the interviewees said that when it comes to Hispanic and Latino students, the educational pipeline is all but broken. Respondents across the board believed that the current educational system is not serving the Hispanic population well. This failure extends to all subject areas, not just science and math. Before these specific subjects can be taught well, most said, the nation needs to bring basic education up to par. According to nearly all of

those we spoke with, the overall poverty of Hispanic-Americans is perhaps the largest contributing factor to poor quality education; Hispanics tend to live in areas of concentrated poverty with struggling public schools and a less-than-adequate tax base for funding them. A wide swath of the Hispanic population also lacks the necessary English language skills."

As a first step, we need more teachers that are qualified to teach math and science. For example, Education Trust-West found that 44 percent of math courses at high-poverty-level high schools – where there are large concentrations of underrepresented groups - were led by teachers without mathematics certification. Given this, it's no surprise that these schools are not offering the challenging math and science preparation that students need. In 2006, IBM announced Transition to Teaching, our initiative to address the K-12 STEM teacher pipeline issue by leveraging our greatest asset – IBM employees.

But it's not just an educator problem. The absence of role models for Latino students is a major inhibitor, according to our research. Parent involvement is a factor as well. Immigrant parents face several obstacles that include long work hours, language barriers, lack of sufficient formal schooling, and cultural attitudes carried over from home countries that hinder a parent's ability to be an advocate for their child.

IBM has made a commitment to focus a variety of education initiatives on schools and communities serving Latino students -- for example, offering free automatic translation software to any school district to improve the communication between Spanish-speaking parents and English-speaking teachers, and increasing our mentoring programs so students can interact with role models. I'd be happy to discuss any of these in more detail, and I've provided more information with my written testimony. But, these are problems that cannot be solved by one company or one sector alone. Clearly the private sector, no matter how much it contributes, is only one part of the solution. There were four key recommendations from the meeting.

The first recommendation is to recruit, prepare and retain qualified math and science teachers. We need to create and fund new career paths that encourage the best and brightest to leverage industry experience to enhance their classroom skills and vice versa while developing more competitive salaries with a cross-industry career. In the short term, we need more second career teachers from the ranks of our math and science professionals. The private and public sectors must collaborate to develop financial incentives for tuition, in-service professional development and competitive salaries. At the same time, we need to redesign current teacher preparation programs, encouraging – indeed, demanding that – universities, state education departments, school districts and teacher unions work together to prepare and support excellent teachers.

The second recommendation is to find ways to reduce undergraduate attrition rates for Hispanics in STEM majors. We need to focus on those young people who have expressed an interest in STEM careers and made it as far as a community college, college or university program and surround them with the necessary mentors, support services and financial aid to stay the course and succeed. Other supports could include internships that expose them to

STEM careers, job placement services and other connections into the private sector to start their careers.

The third recommendation is to increase the popularity of STEM careers in the Hispanic community. The public and private sector should sponsor a major marketing campaign that educates the Latino community on exciting and lucrative STEM careers, along with information on how to attain them.

The fourth recommendation is to increase the Hispanic high school graduation rate prepared for STEM career training. Every high school must offer the same challenging curriculum we offer at the most successful schools, and all of the students must participate. As part of this, we must ensure that STEM education starts early and continues throughout a student's schooling. One compelling idea is to establish a formal certification for schools that offer an effective STEM program and meet a standard for student achievement across all socio-economic and ethnic groups. Public recognition and financial incentives would encourage all high schools to strive to secure the certification. Middle and high school students should have mentors from industry who embody the best that STEM has to offer, as well as internship opportunities that encourage students to dream big and work hard.

Finally, we must find ways to eradicate cultural barriers – such as language – that prevent Latino parents from participating in their children's education.

America's goal must continue to be to raise the standard of living for our children. To do so, we must take aggressive action. We must capture more minds, more hearts, more souls, more passion for the STEM disciplines if we are to retain our competitiveness and attain greater heights of leadership. It is an economic imperative as well as a moral imperative. Whether you are in business, education or a community leader, I encourage you to get involved today.

Speaker Biographies

Richard Sander

Professor Sander received his bachelor's degree from Harvard and a law degree and doctorate in economics from Northwestern. He has taught at UCLA's School of Law since 1989, where he does empirical research on social policy. Sander has done major studies of inner-city banking, housing segregation, central city poverty, and living wage laws. He is probably best known for his research on legal education; in this area, Sander has studied academic support programs, class-based affirmative action, the third year of law school, the market for lawyers, and, most recently, the systemic effects of racial preferences in legal education and law firms. Sander has worked to improve the enforcement of fair housing laws in southern California, and helped to start a program that substantially increased the participation of low-income Los Angeles workers in the Earned Income Tax Credit program.

Richard Tapia

Dr. Tapia currently serves as the Maxfield-Oshman Professor in Engineering at Rice University. While at Rice, he has directed or co-directed more underrepresented minority and women doctoral recipients in science and engineering than anyone in the country. He has received numerous national awards, including the National Science Foundation's inaugural Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring for his work with these students. Dr. Tapia is recognized as a national leader in diversity and for many years has received dozens of requests to give invited addresses, serve on university diversity committees, and provide leadership at a national level. Leading professional organizations have recognized Dr. Tapia's contributions to diversity by naming two professional conferences in his honor, describing him as a seminal figure who inspired a generation of African-American, Native American and Latino/Latina students to pursue careers in mathematics.

Rogers Elliott

Dr. Rogers Elliot is Professor Emeritus of Psychological and Brain Sciences at Dartmouth College. He has served as Chairman of the Department of Psychological and Brain Sciences (1983-86), Chairman of the Department of Education (1975-1980), and as Chairman of the Master of Arts in Liberal Studies Program (1990-1992). He retired from the College in 2001, but has continued to teach a course each year, alternating between psychology and law and individual differences in abilities, with an active appointment as Research Professor. He is the author of Litigating Intelligence, which addressed legal challenges to intelligence tests. With colleagues such as A.C. Strenta, he has studied the issue of student interest in and persistence in science, as functions of gender and race/ethnicity. Dr. Elliot went on to finish his Juris Doctor degree in 1986.

Thomas Fortmann

Tom Fortmann received a B.S. in Physics from Stanford University and a Ph.D. in Electrical Engineering from M.I.T. After four years teaching at Newcastle University in Australia, he spent 24 years as a high-tech engineer and executive at BBN Technologies in Cambridge, MA. Since his retirement from BBN, he has spent over a decade teaching mathematics as a volunteer in two Boston high schools, founding a math content professional development program for elementary teachers, and working on math/science policy issues in the Commonwealth of Massachusetts. He was appointed to the Massachusetts Board of Elementary and Secondary Education in 2006. He was instrumental in modifying state regulations to require a mathematics test for elementary certification, and he wrote the state guidelines specifying college mathematics courses for elementary teacher candidates. He is the author of an undergraduate textbook on linear control systems, a graduate textbook on multitarget/multisensor tracking, and numerous papers and articles.

Robin Willner

Robin Willner is Vice President of Global Community Initiatives for the IBM Corporation. She joined IBM in March 1994 to design and implement *Reinventing Education*, a philanthropic initiative in K-12 school reform. This $75 million global program now includes 25 grant partnerships with school districts and states throughout the United States plus 12 other countries, each focusing on a collaborative effort to develop new applications of technology to overcome common barriers to school improvement and increase student achievement. In addition, Ms. Willner oversees a range of global philanthropic and volunteer programs, including the Global Citizens Portfolio, Corporate Service Corps, World Community Grid, Transition Programs, online mentoring, literacy and work force development projects, school-to-career programs and other efforts to apply technology to specific societal issues. She also manages IBM's humanitarian response to disasters, including IBM's response to the China earthquakes, 9/11, the December 2004 tsunami in south Asia, Hurricane Katrina and dozens of others. Prior to joining IBM, Ms. Willner served for three and a half years as Executive Director for Strategic Planning for the New York City Public Schools. In that position, she was the chief policy advisor to Chancellor Joseph A. Fernandez and oversaw all evaluation, research, testing and data collection activities in the nation's largest school district. As Deputy Executive Director of INTERFACE, a New York City-based not-for-profit agency, for more than a dozen years, she directed over 100 research reports on public policy in the areas of education, job training and child welfare. Ms. Willner serves on the Boards of Directors of Grantmakers for Education and the Center for Education Policy, and the National Academy of Engineering's K12 Task Force.

Commissioner Statements and Rebuttals

Statement of Commissioner Gail Heriot

The assumption behind the fierce competition for admission to elite colleges and universities is clear: The more elite the school one attends, the brighter one's future. That assumption, however, may well be flawed. The research presented at this briefing provides strong reason to believe that attending the most competitive school is not always best--at least for students who aspire to a degree in science or engineering.[50]

Majoring in science or engineering can be difficult.[51] As one Yale University student told the *Wall Street Journal*, the science course he took "scared the hell out of me." "In other classes, if you do the work, you'll get an A," he complained. "In science, it just doesn't work that way."[52]

Well ... yes ... the feeling that one is flailing about in science or engineering courses can be very disconcerting. Many students who start out with such a major switch to something easier. Others drop out or even flunk out. And it should surprise no one that those who fail to attain their goal of a science or engineering degree are disproportionately students whose entering academic credentials put them towards the bottom of their college class.[53] Not all stereotypes about science and engineering students are accurate. But the basic notion that they tend to be highly-credentialed and hardworking is largely on target. They have to be.

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[50]Apart from the considerations discussed in this report, there may indeed be something special about the education available from America's most academically competitive colleges and universities. It should be noted, however, that some of the most sophisticated research available suggests that when it comes to increasing one's income, elite schools are not exactly the ticket. See Stacy Berg Dale & Alan B. Krueger, Estimating the Payoff to a Highly Selective College, 117 Quarterly J. Econ. 1491 (2002). Graduates of Ivy League institutions are indeed high earners. But, if this research is correct, this is simply a reflection of the fact that very talented students attend those schools. If the same students had attended less prestigious schools, they would have done on average just as well financially–or so this research suggests.

In any event, the competition for admission to elite colleges and universities is not a bad thing in itself. To the contrary, students who work hard to hone their skills in order to get into their first-choice school have improved their skills even if ultimately they are not admitted to that school. But occasionally the competition can be over-the-top. Some parents, for example, are willing to fork over as much as $40,000 for advice from so-called experts in getting their son or daughter into an Ivy League school. Susan Berfield & Anne Tergeson, I Can Get Your Kid into an Ivy: Michele Hernandez Boasts that 95 percent of Her Teenage Clients are Accepted by Their First-Choice School. Her Price: As Much as $40,000 a Student, Business Week (October 22, 2007).

[51] In general, when I refer to science and engineering in this statement, I mean to include science, technology, engineering and mathematics, which are collectively referred to as "STEM" in the summary of the proceedings. The exception is when I discuss the findings of individual empirical studies. There I use terms as they are used in the particular study being discussed.

[52] Dana Milbank, Education: Shortage of Scientists Approaches a Crisis As More Students Drop Out of the Field, Wall Street Journal (September 17, 1990).

[53] *See* infra at Part C.

What some do find surprising is this: *Part of the effect is relative*.[54] An aspiring science or engineering major who attends a school where his entering academic credentials put him in the middle or the top of his class is more likely to succeed than an otherwise identical student attending a more elite school where *those same credentials* place him towards the bottom of the class. Put differently, an aspiring science or engineering major increases his chance of success not just if his entering credentials are high, but also if those credentials compare favorably with his classmates'.[55]

The reasons for this comparative effect are doubtless complex. But they are based on a common everyday observation: A good student can get in over his head and end up learning little or nothing if he is placed in a classroom with students whose level of academic preparation is much higher than his own, even though he is fully capable of mastering the material when presented at a more moderate pace. Discouraged, he may even give up–even though he would have persevered had he been in a somewhat less competitive environment.[56]

Science and engineering are ruthlessly cumulative. A student who has difficulty with the first chapter in the calculus textbook is apt to have difficulty with the second, third and fourth chapters. Indeed, the subsequent courses in the mathematics curriculum may be a problem. By contrast, an English literature student who simply fails to read the Chaucer assignment is not necessarily at a serious disadvantage when it comes to reading and understanding George Eliot. Since quitting science and engineering is easy–ordinarily all one has to do is switch majors–the attrition rate is quite high. By senior year, there are significantly fewer science and engineering majors than there were freshmen initially interested in those majors.

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[54] See infra at Part C.

[55] As one early researcher on this topic put it, there is an academic advantage to being a "big frog" in the "frog pond." James A. Davis, The Campus as a Frog Pond: An Application of the Theory of Relative Deprivation to Career Decisions of College Men, 72 Am. J. Socio. 17 (July 1966). This article was written well before the concept of mismatch came to be associated with the controversy over affirmative action and was not focused specifically on science and engineering. Davis found that college GPA is more strongly correlated with career choice than is quality of institution. In other words, while students take both their college grades and the academic quality of the school they are attending into account in evaluating their career choices, they tend to place more emphasis on college grades than is justified. A student at the bottom of his very elite class will discount his abilities more than is called for, while a student at the top of a class at a mediocre school will over-estimate his ability. Davis concludes: "[T]hese ideas have some implications for educational policy. At the level of the individual, they challenge the notion that getting into the 'best possible' school is the most efficient route to occupational mobility. Counselors and parents might well consider the drawbacks as well as the advantages of sending a boy to a 'fine' college, if, when doing so, it is fairly certain he will end up in the bottom ranks of his graduating class." Id. at 30-31.

[56] While the observation that a student is more likely to learn in a classroom where his academic credentials are not at the bottom of the class is common sense, it is not necessarily true in all contexts. Take, for example, a school with 100 first graders. If one were to divide the class into thirds according to their achievement test scores, it is not necessarily the case that all three groups would learn more than if they were divided into three groups at random. Students with behavioral problems may tend to be over-represented in the group of students with the lowest scores for the simple reason that their behavior has interfered with their own learning. Concentrating them in one group may create havoc in the classroom that interferes with the ability of all students, not just those with behavioral problems, to learn.

Some call this comparative effect the "mismatch" effect.[57] And although there is reason to believe that it applies to other kinds of learning, science & engineering examples are perhaps the easiest to imagine: I have every confidence that I can learn basic physics, despite the fact that I have never taken a course in it and my mathematics skills are a little rusty. If I ever lose my job as a law professor, I suspect that I am fully capable of re-tooling as a physics teacher if that is where the available jobs turn out to be. But if I were thrown into the Basic Physics course at Cal Tech, with many of the very best science students in the world, I would be lost and likely learn little if anything. I would be mismatched.[58] On a good day I might make a few lame jokes about my unhappy situation; on a bad day I might even get a little testy about it. But I would be unlikely to come out of that class as competent in the basic principles of physics as I would have in a less high-powered setting.[59]

That doesn't mean, however, that those who aspire to a career in science or engineering must graduate from high school already prepared for the rigorous science curriculum at the world's most competitive science-oriented university. There are many careers in science and engineering. Many have been filled by latecomers to these fields. It simply means that for those who are not already well-prepared when they begin to study science or engineering in earnest, the best strategy may be to avoid going immediately head-to-head with better prepared students.

The interest of the Commission in mismatch centers mainly on its effect on members of underrepresented racial minorities–primarily African-Americans, Hispanics and American Indians. Since admissions standards are frequently relaxed in order to admit a more diverse student body, minority students constitute a disproportionate share of the students with entering academic credentials towards the bottom of any particular class.[60] Obviously,

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[57] *See*, e.g., Thomas Sowell, Inside American Education: The Decline, the Deception, the Dogmas (1993).

[58] Mismatch may be positive or negative. If a typical Cal Tech freshman were to take a Basic Physics class designed for law professors like me, many of whom have never excelled at science, she would likely learn less than she would have in a class with her fellow Cal Tech students. Coasting through a "Basic Physics for Dilettantes" course, she would be the victim of positive mismatch, while I am negatively mismatched in the hypothetical.

[59] The empirical studies discussed in this statement, see infra at Part C, do not distinguish among the reasons that mismatched students might drop out of science and engineering more often than non-mismatched students with similar credentials. They simply record that they disproportionately do so. Is it just because they perceive that they aren't doing well relative to other students and hence lack confidence in themselves? Or are they actually learning less than their similarly-credentialed counterparts who persevere in science or engineering at somewhat less elite institutions? Or both? There is, at present, no national examination for science and engineering achievement that would allow researchers to determine whether college students who were mismatched and dropped out of science or engineering actually learned less than their counterparts at less elite schools who took similar courses. The intuitive answer is that they did and that their self-confidence was also shaken in the process. But it is unnecessary at this point to draw a distinction. The law school experience is clearer, since law students must pass a bar examination in order to practice law. There is empirical evidence that mismatched law students are less likely to pass the bar examination than their non-mismatched counterparts at less elite schools. Richard Sander, A Systemic Analysis of Affirmative Action in American Law Schools, 57 Stan. L. Rev. 367, 393 (2004).

[60] While the Supreme Court case of *Gratz v. Bollinger*, 539 U.S. 244 (2003), was pending before the Supreme Court, much publicity was centered around the fact that the University of Michigan routinely added the equivalent of an entire letter grade to the admissions index of underrepresented minority students. An African-

however, there are other categories of students, such as athletes, children of alumni and other special admittees, who should also be mindful of the risk of mismatch that comes with preferred treatment in admissions.

All such students have a dilemma to face. Should they accept the supposed "leg up" they have been offered? Or should they reject it and attend a school at which that leg up would have been unnecessary? The answer is likely to vary from student to student and may be a question of priorities. Which is more important–that student's desire to attend the most elite school or his or her desire to be a physician, engineer, or scientist?

The problem is that few students who receive a preference realize that their entering academic credentials are well below the institutional median. Fewer still realize that relatively low academic credentials are likely to handicap their ability to earn a degree in science or engineering there and that their odds would be better elsewhere. Instead, they are recruited, indeed romanced, by colleges and universities who allow the scramble for a racially diverse campus (or a winning football team or happy alumni) to overcome their commitment to full and fair disclosure.

It is for this reason that the Commission has recommended that colleges and universities inform the students they are attempting to recruit of the mismatch issue and its potential impact. Tuition for the 2010-11 academic year at Duke University, the University of San Diego and Yale University, for example will be $36,065, $36,950 and $38,300 respectively. That, of course, does not include room and board, books or various student fees. Many students are willing to incur such debt because they envision that their future career will be in a well-paying field like medicine, dentistry, or nuclear engineering. When they graduate four years later with a degree in a soft major, they may be saddled with a much larger debt than they would have been willing to undertake had they understood that the odds were stacked against their success in science or engineering. But no one told them.

American student with a high school grade point average of 2.95 would thus be preferred to an Asian American student with a high school grade point average of 3.94 (just shy of straight As) all other things being equal. The *Gratz* case rejected such a formulaic approach, but it did not reject the size of the preference granted to minority students. And indeed, the evidence suggests that the size of the preference grew at the University of Michigan in the period following the *Gratz* decision. See infra at n. 39.

Michigan's affirmative action policies were not more over-the-top than those of other universities. Lawsuits filed against the University of Georgia, the University of Texas and the University of Washington prior to the Supreme Court's decision in *Gratz* brought to light similar practices. Hopwood v. Texas, 78 F.3d 932 (5th Cir. 1996), cert. denied 518 U.S. 1033 (1996)(law school); Smith v. University of Washington, 233 F. 3d. 1188 (9th Cir. 2000)(law school); Johnson v. Board of Regents, 106 F. Supp. 2d 1362 (S.D. Ga. 2000), aff'd, 263 F.3d 1234 (11th Cir. 2001)(undergraduate admissions policies). See also Robert Lerner & Althea Nagai, Racial and Ethnic Preferences in Undergraduate Admissions at Six North Carolina Public Universities, Center for Equal Opportunity (May 28, 2007)(finding similar preferences at competitive universities in North Carolina), available at http://www.ceousa.org/content/view/442/100/.

Some of the most discriminatory policies are at professional schools. At law schools, for example, the average black student has an academic index that is more than two standard deviations below that of his average white classmate. Richard Sander, A Systemic Analysis of Affirmative Action in American Law Schools, 57 Stan. L. Rev. 367, 393 (2004).

At minimum, this is an issue that students should be informed of so that they, with assistance from their parents, high school teachers and guidance counselors and other advisors, can decide for themselves how to proceed. But let's look at the evidence step by step.

A. Minority Students Are Indeed Underrepresented in Science and Engineering.

There is no segment of the labor force that proportionally reflects the nation's demographic profile. Physicians are disproportionately Jewish. Jockeys are disproportionately Hispanic. The wine industry employs more than its share of Italian Americans. Even within professions, disproportionality is the rule, not the exception. Among lawyers, litigators are often Irish-American. Among physicians, radiologists are disproportionately Subcontinent Indian-American.

Lack of proportionality is not necessarily the result of systematic discrimination. There are many ways in which one's family background, language, and cultural traditions directly or indirectly affect career choices. As a result, it would be hard to find a single profession or occupation that looks, as it is often put, "like America." The world is always more complex than that.

But science and engineering are special. For one thing, they are not single fields. Instead, obtaining an initial degree in a field of science or engineering is the gateway to a large number of respected professions and occupations--aviation inspector, bio-chemist, computer software engineer, dentist, electrical engineer, forester, geophysicist, hematologist, insurance actuary, jet propulsion engineer, lighting engineer, mathematics teacher, nuclear engineer, optometrist, pharmacist, quantitative analyst, radiologist, science teacher, thoracic surgeon, urologist, veterinarian, waste engineer, x-ray engineer, and zoologist. These fields represent a significant portion of the most lucrative and dynamic sectors of the world economy. If African-Americans, Hispanics and American Indians are facing significant impediments in entering these fields, that is a situation that calls for attention.[61]

Using data from the National Survey of College Graduates conducted by the U.S. Census Bureau, UCLA law professor Richard Sander and senior statistician Roger Bolus have calculated the following racial gap in science among college graduates, including immigrants educated or partly educated abroad, age 35 and under:

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[61] In addition, many have asserted that there is a shortage of Americans trained in science and engineering and that this shortage will likely get worse. If a particular segment of the population is underrepresented in these fields, it is only prudent for colleges and universities, employers and government to look into what can be done to increase their participation. National Science Foundation, Future Scarcities of Scientists and Engineers: Problems and Solutions (1992).

***Table I: How Significant is the Racial Gap in Science*?**[62]

Frequency Relative to Population	White	Black	Hispanic	Asian
Gen. Pop.	100	100	100	100
Bachelor's Degree Science	100	36	41	454

As the chart indicates, blacks and Hispanics are only 36 percent and 41 percent respectively as likely as whites to have a bachelor's degree in science or engineering. An Asian, by contrast, is more than four and a half times more likely than a white to hold such a degree. Blacks are only 15 percent as likely as whites and Hispanics are only 26 percent as likely as whites to have a Ph.D. in science. Asians, on the other hand, are more than seven times as likely as whites. The underrepresentation of blacks and Hispanics in science and engineering is real (although these figures are in part a reflection of the immigration of highly-qualified individuals from abroad).[63]

Of course, concern over underrepresentation in science and engineering is not new. On November 13, 1992, the popular magazine *Science* issued a special news report entitled "Minorities in Science." In it, the editors lamented:

> For 20 years, science has been wrestling with "the pipeline problem": how to keep minorities from turning off the obstacle-strewn path to careers in science, mathematics, and engineering. Thousands of programs have been started since the late 1960s to bring diversity to the scientific work force. But their results have been dismal....[64]

One thing, however, is clear. The problem has not been an unwillingness to spend money. By 1992, the National Science Foundation had already spent over $1.5 billion on programs designed to increase the number of minorities in science or engineering. Officials at the National Institutes of Health estimated that they had pumped an additional $675 million into the system. Uncounted state, local, foundation and industry programs contributed millions more.[65]

But the consensus of opinion has been that much of the money had been spent unwisely. In their eagerness to qualify for the vast grants available to educate future minority scientists and engineers, many colleges and universities admitted minority students with little

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[62] Richard Sander & Roger Bolus, Do Credentials Gaps in College Reduce the Number of Minority Science Graduates, Working Paper 2 (Draft July 2009)(using data from 2003)(hereinafter "Sander & Bolus").
[63] Unlike African-Americans, Hispanics in science and engineering do not appear to be underrepresented relative to Hispanics in other college disciplines, such as the humanities. Id. Relative to their initial interest, however, they are underrepresented. Ordinarily one would expect a language minority to be overrepresented in science and engineering, since those disciplines do not require the same language skills as the humanities.
[64] Elizabeth Culotta & Ann Gibbons, Minorities in Science: Two Generations of Struggle: Special Report Overview, 258 Science 1176 (November 13, 1992).
[65] Calvin Sims, What Went Wrong: Why Programs Failed, 258 Science 1185, 1185 (November 13, 1992).

background in science or mathematics. In the early days of affirmative action, "colleges took any person of color who wanted to become an engineer, regardless of their background," said Mary Perry Smith, a former Oakland schoolteacher and founder of California's Mathematics, Engineering, Science Achievement (MESA) program, which promotes minority student participation in those fields. "They tried to turn students who barely knew algebra into engineers and it was a total failure."[66]

"The country cannot repeat the experiment of the last 20 years," said Luther Williams in 1992, then the assistant director of education and human resources at the National Science Foundation. Williams, who later went on to become provost of Tuskegee University, a historically black university with a reputation for emphasizing a science and engineering curriculum, was blunt: Those vast expenditures were "an incredible waste of financial and human resources."[67]

Was Williams being too harsh? Perhaps. Progress has been made and it will continue–even though it is not as much progress as we would like. But if the problem is going to be solved, it will not be solved by more of the same thinking that has characterized the efforts of the last forty years. A re-examination of the assumptions behind those efforts is in order–even if it will step on a few well-entrenched toes.

B. There is No Problem with Lack of Interest in Science and Engineering Among Minority Students. It is Disproportionate Attrition that is the Cause for Concern.

The problem with minority underrepresentation in science and engineering is not the result of lack of interest among college-bound African-Americans, Hispanics and American Indians. Study after study has found just the opposite.[68] Indeed, if anything, such students are slightly more interested in pursuing science and engineering degrees than white students. For example, Professors Alexander W. Astin & Helen S. Astin of UCLA's Higher Education Research Institute examined a sample of 27,065 students enrolling as freshmen at 388 four-year colleges in 1985. They found that the rate of initial interest in majoring in a biological science, a physical science or engineering was, in descending order, 52.6 percent for Asians, 35.7 percent for Chicanos, 34.5 percent for American Indians, 34.2 percent for African-Americans and 27.3 percent for whites.[69]

These findings were consistent with later efforts to study the issue. When Dartmouth College psychology professor Rogers Elliott and his co-investigators looked at a sample of 4,687 students enrolling at four elite colleges and universities in 1988, they found that 55 percent of

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[66] *Id.* at 1187.
[67] *Id.*
[68] Frederick L. Smyth & John J. McArdle, Ethnic and Gender Differences in Science Graduation at Selective Colleges with Implications for Admission Policy and College Choice, 45 Res. Higher Ed. 353, 357 (2004) (calling this finding "consistent" and citing a number of studies dating back to the late 1970s) (hereinafter "Smyth & McArdle").
[69] Alexander W. Astin & Helen S. Astin, Undergraduate Science Education: The Impact of Different College Environments on the Educational Pipeline in the Sciences 3-9, Table 3.5 (1993), available at http://www.eric.ed.gov/PDFS/ED362404.pdf (hereinafter "Astin & Astin").

the Asians, 44.2 percent of the African-Americans, 44 percent of the Hispanics, and 41.4 percent of the whites were initially interested in majoring in science.[70] Similarly, Richard Sander & Roger Bolus, in analyzing all students enrolling in the University of California between 2004 and 2006, found that 57.1 percent of Asians, 40.5 percent of African-Americans/Hispanics and 34.7 percent of whites declared an intention to major in science or engineering.[71]

To my knowledge, no one who has examined the evidence disputes these figures. They are as solid as any figures in social science. If there is a problem with lack of interest in science and engineering, it is with college-bound whites, not African-Americans, Hispanics and American Indians.

To be sure, that doesn't mean that there is no point in encouraging even more underrepresented minorities to aspire to careers in science and engineering. Programs that are proven to encourage such interest may well be money well spent. But if one wants to understand the root of the problem, one must look elsewhere.

And some researchers have. Their work has shown that the problem for minority college students comes a little further down the pipeline. While African-Americans, Hispanics and probably American Indians have high rates of initial interest relative to whites, they are less likely to follow through with that interest. Somewhere in college, the intention to graduate with a degree in science or engineering dies. Alexander & Helen Astin report, for example, that while 68 percent of Asians and 61 percent of whites in their sample followed through on their intention to major in biological science, physical science or engineering four years later, only 47 percent of African-Americans and 37 percent of Hispanics did the same. The rest had apparently changed majors, dropped out, or flunked out.

Consequently, while one might expect, given their level of interest, that African-American college students would be somewhat over-represented among science and engineering college graduates, they turn out to be underrepresented instead. Hispanics are a special case. With them, English mastery is sometimes a problem. One would therefore expect very high perseverance in science and engineering, since transfer to a discipline that requires verbal skills in English can be daunting. All other things being equal, over-representation in science and engineering should be expected for a language-based minority. But for Hispanics attrition rates in science and engineering were also unusually high.

Similar results were obtained by Rogers Elliott and his co-investigators. In their study, they found that 70 percent of Asians persisted in their ambition, while 61 percent of whites, 55

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[70] Rogers Elliott, A. Christopher Strenta, Russell Adair, Michael Matier & Jannah Scott, The Role of Ethnicity in Choosing and Leaving Science in Highly Selective Institutions, 37 Res. Higher Ed. 681, 692-93 (1996)(hereinafter "Elliott").

[71] Sander & Bolus, supra n. 13 at 3. Sander and Bolus also report that among the University of California students enrolling from 1992 to 2006, 52.6 percent of Asians declared an intention to major in science and engineering, as did 37.5 percent of Blacks/Hispanics and 34.7 percent of whites.

percent of Hispanics and 34 percent of blacks did.[72] Others had similar findings.[73] Again, I am aware of no contrary evidence.

C. Students with Low Entering Credentials in Science, Both in Absolute and in Comparative Terms, Are More Likely to Leave Science & Engineering.

It is tempting to ask the question "What accounts for disproportionate minority attrition?" first. But that temptation should be avoided. Instead, the first question should be "What accounts for student attrition in general?" Once that preliminary question is answered, the question about disproportionate minority attrition essentially answers itself.

It is no secret that entering science credentials–like Math SAT score and the number and grades received for high school courses in mathematics and science–are strongly correlated with persistence in science.[74] Since African-American, Hispanic and American Indian students tend as a group to have lower entering science credentials, they are almost certain to have a higher attrition rate from science and engineering.[75]

It would be nice if the disparities among the races, including the disparities between Asians and others, could be eliminated overnight by improving the performance of underrepresented minorities.[76] For that matter, it would be nice if disparities between individuals could be eliminated and everyone could perform better in mathematics, science, and all subjects.

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[72] Elliott, supra n. 21, at 694. See also National Science Foundation, Women, Minorities, and Persons with Disabilities in Science and Engineering (NSF Report 99-338) (1999); National Science Foundation, Future Scarcities of Scientists and Engineers: Problems and Solutions (1990)(finding persistence rates of 43 percent for majority students and 21 percent for minority students); T.L. Hilton, J. Hsia, D.G. Solorzano, & N.L. Benton, Persistence in Science of High Ability Minority Students (1989) (reporting that 54 percent of Asian, 44 percent of white, 36 percent of black and 29 percent of Latino high school seniors who had intended to attend college and major in science or engineering were doing so two years later).

[73] Smyth & McArdle, supra n. 19, at 361-63.

[74] Astin & Astin, supra n. 20, at 3-9, Table 3.5; Elliott, supra n. 21, at 694; Smyth & McArdle, supra n. 19, at 357; Sander & Bolus, supra n. 13.

[75] See id. See also William G. Bowen & Derek Bok, The Shape of the River: Long-Term Consequences of Considering Race in College and University Admissions (1998).

[76] Sadly, some of the most promising avenues for K-12 improvement are not being pursued. Consider the D.C. Opportunity Scholarship Program, which is (or more accurately was) the District of Columbia's federally-funded school voucher program, providing $7,500 in tuition per year to low-income students to attend private schools. The overwhelming majority of its beneficiaries were African-Americans or Hispanics. At the height of the program, it allowed over 1,700 students to escape the grasp of D.C.'s dysfunctional public school system and attend quality private schools.

The best hope that one day racially preferential admissions policies will be a quaint relic of the past comes from programs like it. Careful social science research, led by Dr. Patrick Wolf of the University of Arkansas College of Education and Health Professions, concluded that, after three years of study, students receiving these scholarships had improved reading skills–equivalent to 3.1 additional months of study--relative to their counterparts, who had remained in D.C. government schools. In other words, bit by bit, the achievement gap was closing.

The program enjoyed the warm support of D.C. Mayor Adrian Fenty and D.C. Public Schools Chancellor Michelle Rhee–both reform-minded Democrats. It was also supported by almost 70 percent of D.C. residents. But teachers' unions let it be known they opposed it–as they do all school choice programs. Buried in

There is no doubt that improvements can be made even within the constraints of the current system. Dr. Thomas Fortmann testified before the Commission, for example, that more needs to be done to ensure that mathematics and science classes at the elementary and secondary levels are being taught by qualified teachers. The Commission has responded by recommending that K-12 schools "recruit qualified math and science teachers using, if necessary, pay adjustments and incentives."[77]

But if there is one thing that we have learned during the many decades that this problem has been receiving attention, it is that few improvements can be made quickly. The mismatch problem, however, may be a partial exception. Matching students to the right college or university for their level of developed academic ability could increase the number of science and engineering majors in fairly short order.

As three independent studies have now concluded, absolute credentials are not the only thing that matters in keeping college students in science and engineering. Relative credentials are also important. A student whose entering credentials are at the bottom of the class at the school he attends is less likely to persevere in his quest for a degree in mathematics or engineering than a student with identical credentials who attends a school where those credentials place him higher in the class.

The first of these studies was that published by Rogers Elliott and his co-investigators in 1996.[78] The single most important culprit they found was the "*relatively* low preparation of black aspirants to science in these schools."[79] The Elliott team was careful to put the emphasis on "relatively." It wasn't just entering credentials demonstrating highly developed ability at science that mattered, but comparatively high credentials. A student who attended a school at which his Math SAT score was in the top third of his class was more likely to follow through with an ambition to earn a degree in science or engineering than was a student with the same score who attended a school at which his score was in the bottom third. The following chart was presented:

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the 1,000-page spending bill for 2010, was language that closed down the program to new students. The program was effectively gutted when President Obama signed the bill into law in December.

Three months later, Senator Joseph Lieberman (I-CT), joined by co-sponsors Robert Byrd (D-WV), Susan Collins (R-ME), John Ensign (R-NV), Dianne Feinstein (D-CA), Jon Kyl (R-AZ), and George Voinovich (R-OH), led a valiant effort to revive the program. Without support from the Administration, however, their effort was defeated by a vote of 55 to 42. The Washington Scholarship Fund, which administers the D.C. Opportunity Scholarship Program, closed its doors at the end of the school year in 2010.

[77] Dr. Fortmann testified: "The root problem, as I've seen and as I say I've been working intimately with some of these people is the dearth of mathematics content knowledge among elementary teachers. It's really quite appalling and it extends to many middle school teachers as well. And until we solve that, improvement and innovations at the high school and college levels really can't have much effect. And the reason they can't have much effect is the cumulative nature of mathematics that I just mentioned." Tr. at 47-48. Dr. Fortmann also directed the Commission's attention to evidence that fifth and sixth grade teachers responsible for teaching students mathematics were themselves not competent at arithmetic. Tr. at 38-49.

[78] Elliott, supra n. 21, at 681.

[79] *Id.* Among the credentials that mattered most were number of science courses taken, average grades in high school science courses and SAT-Math score.

Table II: Percentage of Earned Degrees in the Natural Sciences as a Function of Terciles of the SAT-M Distribution in 11 Institutions[80]

	Tercile 1		Tercile 2		Tercile 3	
Institution	% Degrees	SAT-M	% Degrees	SAT-M	% Degrees	SAT-M
Institution A	53.4	753	31.2	674	15.4	581
Institution B	57.3	729	29.8	656	12.9	546
Institution C	45.6	697	34.7	631	19.7	547
Institution D	53.6	697	31.4	626	15.0	534
Institution E	51.0	696	34.7	624	14.4	534
Institution F	57.3	688	24.0	601	18.8	494
Institution G	62.1	678	22.6	583	15.4	485
Institution H	49.0	663	32.4	573	18.6	492
Institution I	51.8	633	27.3	551	20.8	479
Institution J	54.9	591	33.9	514	11.2	431
Institution K	55.0	569	27.1	472	17.8	407
Medians	53.6		31.4		15.4	

According to the authors, the bottom line was this: A student with an SAT Math score of 580 "who wants to be in science will be three or four times more likely to persist at institutions J and K, where he or she is competitive, than at institutions A and B, where he or she is not."[81]

For some this is counter-intuitive. The more prestigious the school, they believe, the more adept it should be at graduating future physicians, scientists, and engineers, no matter what their entering credentials. But instructors everywhere must pitch the material they teach at a particular level. They can pitch to the top of the class, to the middle or to the bottom, but they can't do all three at the same time. At elite colleges and universities pitching to the bottom of the class is uncommon–especially in the science and engineering departments. The whole point of these institutions is to teach to the top. That is the reason that students, who may

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[80] *Id.* at 701.

[81] *Id.* at 702. This estimate, of course, was based on the assumption that the student started out with a desire to major in science or engineering. Whether a student with no particular plans to major in science or engineering is more likely to graduate with a science or engineering degree if he attends a school at which he is properly matched is a more complex matter. As the Elliott team demonstrated, students with higher SAT Math scores are more likely to begin college with a desire to major in science. Consequently, institutions A-E likely have more students interested in pursuing science than Institutions F-K and thus would naturally be expected to award a higher proportion of science degrees, since that is what their students desire. And indeed they did. The Elliott team reported that Institution A-E were about twice as likely to award science degrees as Institutions F-K, with about 28% of the first group's bachelor's degrees being in science and about 15% of the second group's. Nevertheless, as they point out, "a 54 percent chance of getting one of the 15 percent of the degrees that are in science is nearly twice as good as a 15 percent chance of getting one of the 28 percent of degrees that are in science." Id. at 702.

have been positively mismatched in high school, are willing to travel thousands of miles and incur significant debt to attend them. If they were to abandon that practice and resolve to teach to the bottom of the class, they would no longer be elite institutions.[82]

The extraordinary record of Historically Black Colleges and Universities was one source of evidence cited by the Elliott team in favor of their conclusion. With only 20 percent of total African-American enrollment, these schools produce 40 percent of the African-American students graduating with natural science degrees according to the National Science Foundation. These students frequently go on to earn Ph.D.s from mainstream universities. The National Science Foundation reports, for example, that of the approximately 700 African-Americans who earned a doctorate in science or engineering between 1986 and 1988, 29 percent earned their undergraduate degree from an HBCU. For biologists, the figure was 42 percent and for engineers it is was 36 percent.[83] Even those who have mixed feelings about HBCUs (and I am such a person) must admit this is impressive.

Why have HBCUs been so successful? Unlike at mainstream institutions with their high levels of affirmative action, African-American students at HBCUs are not grouped at the bottom of the class. Roughly half of African-American students at HBCUs will be in the top half of the class. Many will be honor students. As a result, systematic mismatch is just not an issue.[84]

The problem is not that there are no minority students capable of doing honors work at mainstream college and universities. There are many. But there are not enough at the very top tier to satisfy the demand for diversity. And when elite universities like Cal Tech, MIT or the Ivies lower their academic standards in order to admit a more racially diverse class, schools one or two tiers down feel they must do likewise, since the minority students who might have attended those schools based on their own academic record are instead attending the more elite schools. The problem thus cascades downward to the fourth and fifth tiers, which respond similarly. As a result, a serious gap in academic credentials between minority and non-minority students is created at all competitive levels at mainstream universities–a

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[82] In theory, intensive remedial instruction is supposed to bridge the gap between the top and the bottom. But not every theory works out in reality. The educational experience at elite institutions is meant to be a full-time job and then some. With only twenty four hours in a day, something has to give. Every hour a minority student spends in a remedial classroom, sometimes struggling to stay on top of material other students are having less trouble with, is an hour other students can spend getting a deeper understanding of that material. The game of catch-up is thus never-ending.

[83] Elizabeth Culotta, Black Colleges Cultivate Scientists, 258 Science 1216 (November 13, 1992)(hereinafter "Culotta").

[84] The Elliott team members were particularly impressed that HBCUs are able to graduate large numbers of students in science and engineering despite entering credentials that were significantly lower than those ordinarily found at elite institutions. Students at Xavier University, for example, were reported to have SAT Math scores averaging around 400, yet half of the class was majoring in science. If elite schools could do the same with minority students (or with students in the bottom third of the class generally), it would be astonishing. In fact they do the opposite. They are able to award far fewer science or engineering degrees to African-Americans than one would expect given the number of African-American students in their classes. Elliott, supra n. 21, at 700.

gap that results in seriously disappointing grades for many minority students, especially in science and engineering classes where good grades are hard to come by.

At least one HBCU faculty member–Professor Walter Pattillo, Jr. of North Carolina Central University–intuitively grasped the mismatch problem even before the Elliott team was able to demonstrate its existence empirically. As then-chairman of the biology department, he vented his frustrations to *Science* magazine in 1992: "The way we see it, the majority schools are wasting large numbers of good students. They have black students with admission statistics [that are] very high, tops. But these students wind up majoring in sociology or recreation or get wiped out altogether."[85]

Neither Professor Pattillo nor the Elliott study received attention from mainstream college or university administrators. Admissions policies at competitive schools continued to emphasize the importance of recruiting minority students even if their entering credentials would put them towards the bottom of the class.[86] Instead, emboldened by their perception that the Supreme Court had given a constitutional green light to racially preferential admissions policies in *Grutter v. Bollinger* (2003),[87] selective college and universities ramped up those policies.[88] The supposed beneficiaries of these policies–minority members aspiring to become physicians, engineers and scientists–were not informed.

Around that time, however, the tide of opinion among social scientists studying the issue was beginning to turn, even as is remained frozen among college and university administrators.[89] One of the milestones was the publication of *Increasing Faculty Diversity: The Occupational Choices of High Achieving Minority Students* in 2003. The long-term project was funded by the Mellon Foundation, which had been and remains one of the nation's most zealous institutional backers of race-based admissions policies. The authors' mission was to determine why more minority students are not attracted to careers in academia. Their conclusions, reached after extensively questioning 7,612 high-achieving undergraduates at 34 colleges and universities, pointed to mismatch as a significant culprit:

> The best-prepared African-Americans, those with the highest SAT scores, are most likely to attend elite schools, especially at the Ivy League. Because of affirmative action, these African-Americans (those with the highest scores on the SAT) are admitted to schools where, on average, white students'

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[85] Cullotta, supra n. 34, at 1218.

[86] Indeed accreditation authorities have often demanded it. See, e.g., Gail Heriot, Affirmative Action in Law Schools, 17 J. Contemp. Legal Issues 237 (2008)(symposium issue)(discussing the American Bar Association diversity requirements for law schools and its efforts to pressure law schools into increasing minority representation). See also Susan Welch & John Gruhl, Affirmative Action and Minority Enrollments in Medical Schools and Law Schools 80 (1998).

[87] 539 U.S. 306 (2003).

[88] Althea K. Nagai, Racial and Ethnic Preferences in Undergraduate Admission at the University of Michigan, Center for Equal Opportunity (October 17, 2006), available at http://www.ceousa.org/content/blogcategory/78/100/. See also Fisher v. University of Texas, 645 F. Supp. 2d 587 (W.D. Tex. 2009).

[89] Russell K. Nieli, The Changing Shape of the River: Affirmative Action and Recent Social Science Research, 17 Academic Questions 7 (2004).

> scores are substantially higher, exceeding those of African-Americans by about 200 points or more. Not surprisingly, in this kind of competitive situation, African-Americans get relatively low grades. It is a fact that in virtually all selective schools (colleges, law schools, medical schools, etc.) where racial preferences in admission is practiced, the majority of African-American students end up in the lower quarter of the class....
>
> African-American students at the elite schools (the liberal arts colleges and the Ivy League) get lower grades than students with similar levels of academic preparation (as measured by SAT scores) than African-American students at the nonelite schools (state universities and HBCUs). ***Lower grades lead to lower levels of academic self-confidence, which in turn influence the extent to which African-American students will persist with a freshman interest in academia as a career. African-American students at elite schools are significantly less likely to persist with an interest in academia than are their counterparts at nonelite schools***.[90]

To say that the Mellon Foundation was not happy with the conclusions of its grant recipients would be an understatement. Soon after publication, the *Chronicle of Higher Education* reported that the foundation was "trying to distance itself" from the book's findings.[91] Unlike similar projects with Mellon funding, this one did not receive a publicity push from the foundation.

Dr. Cole told the *Chronicle* that there was "no chance" that he would receive money again from the Mellon Foundation. "And I don't care," he said. "I was trained at a time before social science became so politicized." "I believe that social science should be objective and value-free, and you should design a study to answer a question and whatever the answer is, that's what it is."[92]

A year after Cole & Barber's research became public, a second study on the science and engineering mismatch issue was published. University of Virginia psychologists Frederick L Smyth and John J. McArdle used a very different methodology and a different database from those of Elliott and his co-authors. But they reported findings that "are consistent" with the earlier article's conclusion that "race-sensitive admissions, while increasing access to elite colleges, was inadvertently causing disproportionate loss of talented underrepresented minority students from science majors."[93]

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[90] Stephen Cole & Elinor Barber, Increasing Faculty Diversity: The Occupational Choices of High Achieving Minority Students 124, 212 (2003)(citations omitted)(emphasis supplied).
[91] Robin Wilson, The Unintended Consequences of Affirmative Action, The Chronicle of Higher Education 10 (January 31, 2003).
[92] *Id.*
[93] Smyth & McArdle, supra n. 19, at 373.

Indeed, Smyth & McArdle went further. They developed a model that attempts to measure how many more minority students would have succeeded in the goal of a science or engineering degree if colleges and universities had employed race neutral admissions criteria. They wrote:

> "According to our model ..., if all the [Science-Mathematics-Engineering]-intending underrepresented minority students had enrolled in similarly functioning colleges where their high school grades and math test scores averaged at the institutional means among [Science-Mathematics-Engineering] intenders, 72 more of the women and 62 more of the men would be predicted to persist in [Science-Mathematics-Engineering] (45 percent and 35 percent increases, respectively)."[94]

Smyth & McArdle's recommendation was very clear: "Admission officials are advised to carefully consider the relative academic preparedness of science-interested students, and such students choosing among colleges are advised to compare their academic qualifications to those of successful science students at each institution." Again, few college or university administrators were listening.

The latest contribution to the literature on mismatch in science and engineering is Do Credential Gaps in College Reduce the Number of Minority Science Graduates?[95] Using a number of sophisticated methodologies, Sander & Bolus arrive at conclusions like those of Smyth & McArdle and the Elliott team.

Sander & Bolus studied data obtained from the multi-campus University of California. All campuses of the University of California are quite selective. But some are more selective than others. The flagship campus at Berkeley is highly selective as are the UCLA campus and the more science-oriented UC-San Diego. At the other end of the spectrum, the campuses at Riverside and Santa Cruz are easier to gain admittance to, but nonetheless hardly "easy."

Employing what they call the "distance method," Smyth & Bolus measured the distance between each student's entering academic index and the median academic index of all science and engineering-interested students at that campus. This allowed the authors not just to compare students with equal academic indices attending different University of California campuses, but also to make comparisons based on the magnitude of mismatch. Since the UC campuses differ in their median academic index, students with equal academic indices but attending different campuses will differ in their level of mismatch.[96]

They found that students who are "mismatched" at one University of California campus are at a greater risk of failing to attain their initial goal of a science or engineering degree than otherwise identically-credentialed students attending a less selective campus of that same

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[94] *Id.* at 373.
[95] Sander & Bolus, supra n. 13.
[96] Sander & Bolus, supra n. 13, at 14-20.

university at which they were not mismatched. And the greater the mismatch, the greater the problem.

Not satisfied with confining their analysis to the "distance method," Sander & Bolus also employed what they dubbed the "first choice/second choice" method. This approach involves looking at pairs of students who were admitted to two different UC campuses, one more elite and the other less elite. In each pair, one student chose to attend the more elite school and the other the less elite. The results were the same: Mismatched students are at a disadvantage in science and engineering.[97]

"Minority attrition in science is a very real problem, and the evidence in this paper suggests that 'negative mismatch' probably plays a role in it," they wrote. The approaches they took yielded consistent results: "[S]tudents with credentials more than one standard deviation below their science peers at college are about half as likely to end up with science bachelor degrees, compared with similar students attending schools where their credentials are much closer to, or above, the mean credentials of their peers."[98]

D. Conclusion.

Decades ago, well-meaning administrators at selective college and universities resolved to "do the right thing" by extending preferential treatment to underrepresented minorities in admissions. One of the consequences of that policy has been systematically low college grades for the supposed beneficiaries of that preferential treatment.[99] No, it doesn't apply to all such students, but it is nevertheless a widespread phenomenon. And the reason is simple: While some students will outperform their entering academic credentials, just as some students will underperform theirs, most students will perform in the range that their entering credentials predict.

No serious supporter of affirmative action denies this. William G. Bowen and Derek Bok, authors of The Shape of the River: Long-Term Consequences of Considering Race in College and University Admissions and long-time advocates of race-based admissions policies, candidly admit that the credentials gap has serious consequences: "College grades [for affirmative action beneficiaries] present a ... sobering picture," they wrote. "The grades

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[97] Sander & Bolus, supra n. 13, at 20-23.

[98] Sander & Bolus, supra n. 13, at 23-24.

[99] The figures for law schools grades are available and particularly instructive: In elite law schools, 51.6 percent of African-American law students have first-year GPAs in the bottom 10 percent of their class as opposed to only 5.6 percent of white students. Nearly identical gaps exist at law schools at all levels (with the exception of historically minority schools). At mid-range public schools, the median African-American student's first-year grades corresponded to the 5th percentile among white students. For mid-range private schools it was 7th. With disappointingly few exceptions, African-American students were grouped towards the bottom of their class. Moreover, contrary to popular belief, the gap in grades did not close as students continued through law school. Instead, by graduation, it had gotten wider. Richard Sander, A Systemic Analysis of Affirmative Action in American Law Schools, 57 Stan. L. Rev. 367, 427-36, Tables 5.1, 5.3 & 5.4 (2004). I am not aware of anyone who disputes these figures, and indeed some critics of Sander's work appear to have conceded their accuracy. See Ian Ayres & Richard Brooks, Does Affirmative Action Reduce the Number of Black Lawyers?, 57 Stan. L. Rev. 1807, 1807 (2005) ("Richard Sander's study of affirmative action at U.S. law schools highlights a real and serious problem: the average black law student's grades are startlingly low").

earned by African-American students at the [schools we studied] often reflect their struggles to succeed academically in highly competitive academic settings."[100]

The long-term social and educational consequences of decades of race-based admissions policies and the artificially low grades for minorities those policies produce are only now beginning to be studied. The evidence examined by the Commission on Civil Rights focuses only on the effects on science and engineering majors. It suggests that, as a result of race-based admissions policies, we now have fewer, not more, physicians, dentists, engineers, scientists and other science-oriented professionals than we would have had under a policy of color-blindness.

While there are still a few unanswered questions, it is time for students to be advised of the issue and allowed to make their own decision about their future. Indeed, it is long past time. If higher education were held to the same standards of consumer disclosure as other businesses–from securities brokerage houses to children's toy manufacturers–disclosure would have come long ago.

Statement of Commissioner Ashley L. Taylor, Jr.

It is my sincere hope that readers of this report picked up on a significant yet subtle message in the second paragraph of the Executive Summary clarifying that this topic was limited to the acceptance of minority students to very rigorous academic programs at elite, selective institutions where the institution is very unlikely to provide any remedial assistance to overcome K-12 academic deficiencies. This report is not intended to address the admissions or success of all minority students who pursue a science, technology engineering or math (STEM) course of study at all universities. It is a narrow look at the fate of the students who find themselves selected by an institution into a course of study for which they are underprepared or have little support.

The STEM disciplines are difficult for all students, but especially for students whose K-12 experience, both in the school and at home, left them lacking critical academic skills or critical study skills. Unlike the humanities, arts, literature, even business courses of study, the STEM disciplines build quickly from one level to the next leaving little time or room to play "catch up" for a student who starts the program at a disadvantage. Unfortunately, there remains a persistent gap between non-Asian minorities and whites in K-12 preparation insofar as it relates to the profile of students admitted to elite institutions. It is that small but critically important high performing minority slice of the student population which needs information that can assist them in choosing the right college to attain their future goal.

I particularly support the first two recommendations of this report from a consumer protection standpoint. Minority students who are applying to or being recruited by elite institutions for STEM programs need to know certain fundamental realities. There is a

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[100] William G. Bowen & Derek Bok, The Shape of the River: Long-Term Consequences of Considering Race in College and University Admissions 72 (1998).

delicate balance between full disclosure and outright discouragement of students' ambitions. But, there is a higher price paid by the student (and the student's family) who drops out of a STEM program than is paid by the institution, and for that reason I prefer to err on the side of full disclosure.

That said, I believe that every student should be viewed as an individual. We should never place people in typecast such that we eliminate their opportunity to expand and excel. Students should be given every opportunity to do so, and we shouldn't make assumptions about any individual. That is the beauty of our country -- we don't do that. We don't have scripts for people depending on what class of society they come from. It is also important, however, that the student be made aware of the facts. Those facts could be brutal, those facts could be demoralizing and I understand the reluctance and hesitation of presenting those facts to an 18 year-old young adult who may not have the capacity to properly process and assimilate that information.

The schools have a duty to provide the support for every student they admit. Unfortunately, I believe that the schools focus a lot more on admissions and matriculation and not enough on graduation and success upon graduation. When the school doesn't uphold its end of the bargain, students doesn't know how much force they are going to have to apply to the situation or how much harder they are going to have to work than the person sitting beside them. I believe that the students we are talking about in this report would apply that pressure if they knew it was needed.

In life, the only way you can know how much pressure to apply to a situation is if you know what you are up against. I am very concerned that some minority students are walking into certain academic environments where the school fails to provide that support naturally. To those students who are in those difficult situations and are aware of the uphill climb, I want to encourage them. I want them to know there are people and resources that can help them if they seek it.

On a final note, I have intentionally elected not to use the term "mismatch" which was presented during the briefing and is used in the report. The word, in my view, carries connotations which may be easily misconstrued.

Dissent of Commissioners Michael Yaki and Arlan D. Melendez

We strongly dissent from this Report and most of its Findings and Recommendations for several reasons. Specifically, we dissent from: 1) Part A; 2) Findings 2, 3, 4, 5, 6, and 7; and 3) Recommendations 1, 2, 3, and 4. Our principal objection to this Briefing and Report is that they were fundamentally not about encouraging minorities to pursue careers in STEM fields. Rather, the major focus of the briefing and report was to promote Rogers Elliott, Richard Sander and their "mismatch" theory.

As was noted at the Briefing Hearing, the panel was unbalanced and stacked in favor of "mismatch" proponents.[101] Even Mr. Elliott conceded that his comments were substantially similar to those of Mr. Sander.[102] In addition to being mostly a reaffirmation of Mr. Sander's conclusions, Mr. Elliott's testimony was based on his paper which was already well over a decade old by the time of our Briefing Hearing.

Mr. Sander's efforts to promote the theory of "mismatch" with regard to law school and the legal profession[103] have been soundly debunked in a sustained manner.[104] Mr. Sander's attempts to address his critics and salvage his initial claims[105] have resulted only in further critiques that have supported the initial critiques and have pointed out that Sander's self-defense has resulted in self-undermining.[106] Perhaps in response to the discrediting of his initial claims concerning the effect of "mismatch," Sander himself has avoided using the term "mismatch" in his most recent work.[107]

The Report's recommendations are largely premised on claims regarding the effect of so-called "mismatch." This effect has been exaggerated by both Elliot/Sander and their admirers on the Commission.[108] We are concerned that the recommendations, grounded as they are in these out-sized claims, would have the effect of discouraging minorities from pursuing careers in STEM fields. This outcome would be diametrically opposed to the stated purpose of this report.

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[101] United States Commission on Civil Rights, STEM Briefing Transcript, p. 146 (Commissioner Yaki speaking).
[102] *Id*. p. 34.
[103] Richard H. Sander, *A Systemic Analysis of Affirmative Action in American Law Schools*, 57 STAN. L. REV. 367 (2004).
[104] *See, e.g.*, Ian Ayers & Richard Brooks, *Does Affirmative Action Reduce the Number of Black Lawyers?*, 57 STAN. L. REV. 1807 (2005); David B. Wilkins, *A Systemic Response to Systemic Disadvantage: A Response to Sander*, 57 Stan. L. Rev. 1915 (2005); Daniel E. Ho, Scholarship Comment, *Why Affirmative Action Does Not Cause Black Students To Fail the Bar*, 114 YALE L.J. 1997 (2005).
[105] Richard H. Sander, *A Reply to Critics*, 57 STAN. L. REV. 1964 (2005); Richard H. Sander, *Mismeasuring the Mismatch: A Response to Ho*, 114 YALE L. REV. 2005 (2005).
[106] *See, e.g.*, David L. Chambers, Timothy T. Clydesdale, William Kidder & Richard Lempert, *The Real Impact of Eliminating Affirmative Action in American Law Schools: An Empirical Critique of Richard Sander's Study*, MICH. L & ECON WORKING PAPER NO. 05-007 (2005), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=730506##; David L. Chambers, Timothy T. Clydesdale, William Kidder & Richard Lempert, *Affirmative Action in American Law Schools: A Critical Response to Richard Sander's "A Reply to Critics"*, MICH. L & ECON WORKING PAPER NO. 06-001, *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=886382; Katherine Y. Barnes, *Is Affirmative Action Responsible for the Achievement Gap Between Black and White Law Students?*, 101 NW U. L.REV. 1759 (2007).
[107] Richard H. Sander & Jane Yakowitz, *The Secret of My Success: How Status, Prestige and School Performance Shape Legal Careers*, (2010), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1640058.
[108] Admittedly, the exact nature and extent of this "mismatch" effect has been obscured by resort to vague language in the recommendations, such as "large deficit." It should be noted that initial approval of this report's recommendations was scuttled when a majority of Commissioners were unwilling to endorse this imprecise language. *See* USCCR Business Meeting Transcript June 11, 2010, pp. 27-34.

Additionally, we object to the non-deliberative manner by which the Findings and Recommendations were drafted and adopted. As has been become the norm with the Commission, Commissioner-drafted alternatives to staff-issued findings and recommendations are only being provided to all Commissioners less than a day before votes are scheduled on the findings and recommendations. In some cases, alternate findings and recommendations have been issued the night before a Commission meeting, only to be superseded by even newer drafts issued the morning of a meeting or during the meeting itself.

Joint Rebuttal of Commissioners Gail Heriot, Peter Kirsanow and Todd Gaziano

Commissioners Yaki and Melendez take the position that the 1996 article by Dartmouth College psychology professor Rogers Elliott and his co-authors is "over a decade old" and hence in their view too old to be valuable.[109] Perhaps they regard the 2009 article by UCLA law professor Richard Sander and UCLA Medical School senior statistician Roger Bolus as tainted because it is somehow too new.[110] But, if so, that would still leave the 2004 article by University of Virginia psychology professors Frederick L. Smyth and John J. McArdle.[111] Not all these empirical studies can be dismissed so casually.

All three reach the same conclusion: Mismatch likely puts affirmative action beneficiaries who plan to major in science or engineering at special disadvantage. More specifically, all three agree that a student whose entering credentials put him towards the bottom of his college class is less likely to follow through with plans to major in science or engineering than a student *with the same entering credentials* attending a less elite school where those credentials put him in the middle or towards the top of the class.[112]

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[109] Rogers Elliott, A. Christopher Strenta, Russell Adair, Michael Matier & Jannah Scott, The Role of Ethnicity in Choosing and Leaving Science in Highly Selective Institutions, 37 Res. Higher Ed. 681 (1996).

[110] Richard Sander & Roger Bolus, Do Credentials Gaps in College Reduce the Number of Minority Science Graduates?, Working Paper (Draft July 2009).

[111] Frederick L. Smyth & John McArdle, Ethnic and Gender Differences in Science Graduation at Selective Colleges with Implications for Admission Policy and College Choice, 45 Res. Higher Ed. 353 (2004).

[112] It should be noted that the work of these three investigative teams does not come out of nowhere. It is consistent with a long history of research that dates back to the 1960s. That literature includes the work of Elinor Barber and Stephen Cole, which found that affirmative action beneficiaries at elite schools are less likely than similarly-credentialed minority students attending less elite schools to desire to become college professors. See Elinor Barber & Stephen Cole, Increasing Faculty Diversity: The Occupational Choices of High Achieving Minority Students (2003). It also includes a wealth of literature like James A. Davis's The Campus as A Frog Pond: An Application of the Theory of Relative Deprivation to Career Decisions of College Men, which does not deal with race-conscious admissions practices directly, but which nevertheless sheds light on the processes at work at schools where those practices are employed. Davis found that, for better or worse, among the college students he studied, students who get good grades at less competitive schools will think more highly of their own academic skills than otherwise identical students who attend more competitive schools and thus earn lower grades. He further found that good self-opinion influences career choices. James A. Davis, The Campus as a Frog Pond: An Application of the Theory of Relative Deprivation to Career Decisions of College Men, 72 Am. J. Socio. 17, 30-31 (1966)("[T]hese ideas … challenge the notion that getting into the 'best possible' school is the most efficient route to occupational mobility. Counselors and parents might well consider the drawbacks as

Is it possible that Drs. Elliott, Strenta, Adair, Matier, Scott, Smyth, McArdle, Sander, and Bolus are nevertheless incorrect? Of course it's possible. That is why more research would be useful. At this point, however, the evidence is going strongly in favor of their conclusions. And that is important to recognize.

The Commission has nevertheless taken a cautious approach. It is not calling upon Congress or state legislatures to prohibit racially-preferential admissions policies for students who intend to major in science or engineering. Nor is it calling on colleges and universities to abandon racial preferences altogether, at least not in this report. The Commission's recommendation is modest. What we are asking is that college applicants be made aware of the potential for a mismatch effect. Students should be given the facts, so that they, in consultation with their parents, teachers and other advisors, can decide for themselves how to proceed.[113]

It is difficult to understand why Commissioners Yaki and Melendez object to disclosure. Next to homeownership, a college education is typically the largest investment an American makes during his or her lifetime. The law requires that manufacturers of breakfast cereals inform consumers of the ingredients and nutritional content of their products as well as warn of any known health hazards associated with them. Here we are simply calling for disclosures by the institutions themselves. Is the value of a college degree less important than corn flakes?

The dissenters could argue that the Commission should wait until all the evidence is in before they make any recommendation, even a recommendation of disclosure.[114] But in issues of

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well as the advantages of sending a boy to a 'fine' college, if, when doing so, it is fairly certain he will end up in the bottom ranks of his graduating class."). See also Marjorie Seaton, Herbert W. Marsh & Rhona G. Craven, Big-Fish-Little-Pond Effect: Generalizability and Moderation: Two Sides of the Same Coin, 47 Am. Educ. Res. J. 390 (2010); Herbert W. Marsh, Ulrich Trautwein, Oliver Ludke, Jurgen Baumert & Olaf Koller, The Big-Fish-Little-Pond Effect: Persistent Negative Effects of Selective High Schools on Self-Concept After Graduation, 44 Am. Educ. Res. J. 631 (2007); Herbert W. Marsh, Chit-Kwong Kong & Kit-Tai Hau, Longitudinal Multilevel Models of the Big Fish Little Pond Effect on Academic Self-Concept: Counterbalancing Contrast and Reflected Glory Effects in Hong Kong Schools, 78 J. Personality & Soc. Psych. 337 (2000).

[113] Commissioners Yaki and Melendez are less cautious. Three years ago, in connection with the Commission's Report on Affirmative Action in Law Schools, they were utterly disdainful of the mismatch theory and quite certain that the issue was the invention of sinister forces. They asserted "[t]he proof that affirmative action works in law schools is overwhelming" and that "the success of the policy" is "unmistakable." See U.S. Commission on Civil Rights, Briefing Report: Affirmative Action in Law Schools, Joint Dissent of Commissioner Arlan D. Melendez and Commissioner Michael Yaki at 188 (2007). So certain were they that mismatch was not an issue in law school or anywhere else that they dissented even from the Commission's recommendation that more research be conducted—hardly the cautious course of action. Now they argue with equal certainty that "[t]his effect has been exaggerated" in the science and engineering context. This statement is curious given that the current evidence in the science and engineering context points in only one direction. In the future, it could always turn out that researchers were mistaken about the mismatch effect. Or it could turn out that the effect was larger or smaller than they now believe it to be. But at present there is no basis upon which to conclude that it "has been exaggerated." To baldly assert otherwise is to substitute swaggering certitude for rational analysis.

[114] As far as I know, no one has ever made such an argument in the context of products liability. In that area, for example, a manufacturer can be held liable if it fails to warn of a "foreseeable" risk. See Restatement (Third) of

public policy, the evidence is never all in. Decisions must be made based on the available evidence, not the evidence that would exist in a perfect world. At present, the evidence that students intending to major in science and engineering can be worse off if they are mismatched is fairly strong—much stronger than the evidence that underlies most public policy decisions. Indeed, it is considerably stronger than the evidence that racially-preferential admissions policies benefit minority students in any context, science-related or not. [115]

Torts: Products Liability section 2. To exempt manufacturers from liability in cases in which the evidence of risk was not yet utterly conclusive would be an extraordinary (and in my view inappropriate) change of policy. A large proportion of the warnings on pharmaceutical products are for risks that have not yet been conclusively proven to exist. Science, like life, is full of uncertainties. In this case, the risk is not only foreseeable, it has actually been foreseen by a number of commentators of which Drs. Elliott, Strenta, Adair, Matier, Scott, Smyth, McArdle, Sander, and Bolus are just a few. Moreover, it is not simply foreseen, it has been tested empirically and strong evidence of its existence has been found in three independent studies.

[115] Interestingly, rather than discuss that evidence or indeed anything directly related to the current report, the dissenting commissioners prefer to discuss an earlier Commission report—one in which the issue was the effect of affirmative action in law schools rather than its effect on science and engineering students at the undergraduate level. See United States Commission on Civil Rights, Report on Affirmative Action in Law Schools (2007). In that report, the Commission examined research by Dr. Richard Sander that appears to show that mismatched law students are less likely to complete law school and pass the bar than are identically-credentialed students who attend law schools at which they are not mismatched. See Richard Sander, A Systemic Analysis of Affirmative Action in American Law Schools, 57 Stan. L. Rev. 367 (2004). Commissioners Yaki and Melendez take the position that this research has been "soundly debunked in a sustained manner." I can only imagine that they have not read the articles they cite. For the most part, I will rely on my analysis in my Commissioner's Statement to the Report on Affirmative Action in Law Schools Report, since I have already dealt with most of the criticisms they cite. See also Gail Heriot, Affirmative Action in Law Schools, 17 J. Contemp. Legal Issues 237 (2008)(another version of same essay).

A few points should nevertheless be made here either because they are new or in need of repetition to give the reader of this report a taste of the evidence examined in the earlier report:

1. The evidence behind Sander's conclusions in his law school study is not yet conclusive. Nor does the Commission report claim that it is. More research needs to be done and that is a significant part of what the Commission recommended. Some of the dissenting commissioners' citations, however, are quite misplaced. For example, the article by David Wilkins does not dispute Sander's conclusion that there are today fewer, rather than more, African-American attorneys as a result of racially preferential admissions policies. Instead, Wilkins argues that even assuming mismatched African-Americans leave law school or never pass the bar at higher rates than they would under race-neutral admissions policies, those who do make it get the benefit of having the opportunity to network with more elite law students. David B. Wilkins, A Systemic Response to Systemic Disadvantage: A Response to Sander, 57 Stan. L. Rev. 1915 (2005).

2. The dissenting commissioners cite Katherine Y. Barnes, Is Affirmative Action Responsible for the Achievement Gap Between Black and White Students?, 101 Nw. U. L. Rev. 1759 (2007), as part of a second wave of criticism of the Sander study. Scholars, however, have been unable to replicate Dr. Barnes' results. See Doug Williams, Does Affirmative Action Create Educational Mismatches in Law School, Draft at 9 (January, 2010)(presented at the 20th Annual Conference of the American Law and Economics Association). Efforts to do so by Williams "produce[d] results generally consistent with the mismatch hypothesis." Id. Indeed, Dr. Barnes' own efforts to replicate her original findings have produced very different results from those in the original article—results that provide some support for Sander. For example, in her original article she reported that students in the 5th percentile nationally for entering academic credentials passed the bar after attending a historically black law school at a rate of only 12.9%. Her revised is 77.9%. In a correction and update that has

Commissioners Yaki and Melendez argue that the panel at the briefing was "stacked in favor of 'mismatch' proponents."[116] Since no researcher has taken a position contrary to that of our witnesses, Dr. Elliott and Dr. Sander, on the issue of mismatch in science and engineering, it is difficult to understand who Commissioner Yaki believes should have been called as a witness. The Commission cannot call witnesses that do not exist.

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been submitted to the Northwestern University Law Review, she reports that her new results do indeed indicate that HBCUs "boost graduation and bar passage rates for students with low credentials"—although she is not yet willing to concede that the total pattern of results supports mismatch. Katherine Y. Barnes, Correction and Update to Is Affirmative Action Responsible For The Achievement Gap Between Black And White Law Students?, forthcoming in the Northwestern University Law Review. Dr. Barnes agrees with the Commission that more research is necessary and that the Bar Passage Study database is not adequate for that research.

3. The Williams article provides general support for Sander. "Although the results here are not conclusive," he writes, "I find much more evidence for mismatch effects than previous research, which has been dismissive of the mismatch hypothesis." Significantly, Williams goes on to explain that the Bar Passage Study, from which the data for Sander's and his studies were obtained, does not categorize law schools by academic tier. Consequently, Williams points out, it is difficult to find evidence of mismatch even if a serious mismatch problem really is there. Williams urges that further studies be conducted on bar passage data from large states like California, Florida or Texas so that the mismatch theory in law schools can be confirmed or refuted Williams at 34. Williams' recommendation is thus in accord with the Commission's.

4. Surely all fair-minded scholars would agree that obtaining data with which to confirm or refute Sander's conclusions concerning law schools is worthwhile and important. But if one were to expect those who critiqued the original study uniformly to be fair-minded scholars, one would be disappointed. William Kidder, one of the team of David Chambers, Timothy Clydesdale, William Kidder & Richard Lempert, whose critique of the Sander study is cited by Commissioners Yaki and Melendez in their Footnote 6, wrote to the State Bar of California's Committee of Bar Examiners urging that the committee deny Sander and his co-authors access to the California Bar Examination data—probably the richest and best source available upon which to test the hypothesis further. Among other things, Kidder argue that disclosure of the data "risks stigmatizing African-American attorneys regardless of how successful they may be in legal practice." Sander, of course, had not requested names or any information that would allow him to identify particular persons. At the time he co-authored the article cited by the dissenters, Kidder was employed as a researcher with the Equal Justice Society, an organization that describes its mission as to "marshal our forces to defeat the right wing assault on social and racial justice." More recently, he has been employed as an administrative staff member at the University of California. See United States Commission on Civil Rights, Report on Affirmative Action in Law Schools, Statement of Commissioner Gail Heriot at 148 (2007). Similarly, David Chambers was the former president of the Society of American Law Teachers, which also wrote a letter to the State Bar of California opposing scholarly access to the data. That letter raised the specter of litigation if the data is disclosed. Id.

5. Commissioners Yaki and Melendez seem to suggest that there is something strange about the fact that the word "mismatch" does not appear in Dr. Sander's most recent article. Richard H. Sander & Jane Yakowitz, The Secret of My Success: How Status, Prestige and School Performance Shape Legal Careers, Draft (August 9, 2010), available athttp://papers.ssrn.com/sol3/papers.cfm?abstract_id=1640058. The reason for this choice of words is easy to explain: The paper isn't about mismatch, but rather about how law school grades have more impact on future success in the legal profession than the prestige of the law school a lawyer attended (controlling for other factors like LSAT). The study did not make a distinction between students who were mismatched and those who were not. The fact that the word "mismatch" was not used is thus no more significant than the absence of the word "elephant" from the article.

[116] Dissent Statement of Yaki and Melendez at 1; Transcript at 146.

Nonetheless, extraordinary efforts were made to call either (1) any witness who had expressed doubts about the problem of mismatch in any context or (2) any witness who had expressed strong support for race-based admissions as a means of increasing the number of minority members in science & engineering.[117] Among those contacted were: Gibor Basri, Vice Chancellor for Equity and Inclusion at the University of California at Berkeley; Ted Greenwood, Program Director at the Alfred P. Sloan Foundation; Freeman A. Hrabowski III, President of the University of Maryland (Baltimore County); Christopher Jencks, Professor of Social Policy at Harvard University; Paul Joskow, President of the Alfred P. Sloan Foundation; Thomas Kane, Professor of Education at Harvard University; William Kidder, Special Assistant to the Vice President for Student Affairs, University of California; Tom Loveless, Senior Fellow in Governance Studies at the Brookings Institute, Tom Luce, CEO of the National Science and Math Initiative; and Kenneth Maton, Professor of Psychology at the University of Maryland (Baltimore County).

Commission staff members also invited Ann Mullen, Associate Professor of Sociology at the University of Toronto; Meredith Phillips, Associate Professor of Public Policy & Sociology at UCLA, Jesse Rothstein, Associate Professor of Public Policy at Princeton University; Marta Tienda, Professor of Sociology & Public Affairs at Princeton University; Philip Uri Treisman, Professor of Mathematics & Public Affairs at the University of Texas; and Sarah Turner, Professor of Economics & Education at the University of Virginia.[118]

All declined to testify. Of course, if Commissioners Yaki and Melendez could have suggested additional potential witnesses. Indeed, they were asked to by the staff--in writing

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[117] My own view is that it is naïve to expect the Commission staff to please all Commissioners as to "balance" when they invite experts to testify at a briefing. No matter how well-balanced the panel is or is not, someone will complain. Any procedure that places the responsibility for balance on the Commission staff's shoulders is thus begging for controversy. Instead, that responsibility should be on the Commissioners, each one having the right to call an expert witness to a briefing (if he or she feels the panel is unbalanced). That way if a panel does indeed fail to reflect the spectrum of responsible opinion on an issue, the Commissioners have no one to blame but themselves.

Sadly, it has been observed by the Commission staff that when witnesses generally congenial to Commission Yaki's point of view agree to testify, they sometimes mysteriously withdraw shortly after their identities are made available to the members of the Commission. Commissioner Yaki can then berate the staff for failing to properly balance the panel and complain that the Commission's report is somehow illegitimate. Again, the solution is to alter the Commission's procedures. If the Commissioners were responsible for identifying and securing witnesses, there would be no occasion for concerns of this type.

It is well worth noting that Congress does not charge some "neutral" staff with the responsibility for balancing opinion at Congressional hearings. Instead, the majority chooses a number of witnesses and the minority is permitted to choose a somewhat smaller number. Under the circumstances, neither party can complain about whether the full spectrum of opinion was reflected in the panel. Instead, disagreements are limited to the more mundane question of whether the minority has been accorded the right to call an adequate number of witnesses. I would amend our procedures to conform to Congressional practice. I believe this would eliminate some of the controversy over panel balance that periodically rears its head at our briefings.

[118] Also contacted for advice on speakers was Peter Henderson, Director on the Board of Higher Education and Workforce of the National Academy of Sciences and Sigal Alon, Senior Lecturer in the Department of Sociology at Tel Aviv University.

and more than once. But they did not respond with recommendations—even though there is no question that any such recommendations would have been followed.

The peculiar thing about the complaint of the dissenting commissioners is that ultimately the panel was fairly well-balanced. Commission staff members were able to identify and secure the testimony of a qualified witness, Rice University Professor of Mathematics Richard Tapia, a long-time forceful advocate of increasing the number of minority students in science and engineering at highly competitive institutions.[119] Still, Commissioner Yaki at least appeared disappointed rather than pleased and complained of lack of balance anyway. His reaction when Fisk University President Hazel O'Leary (former Clinton Administration Secretary of Energy) abruptly cancelled her testimony on the eve of the briefing (not long after the identities of the witnesses were announced to the Commissioners) was equally if not more telling: Commissioner Yaki declared that he was "kind of glad she did" and implied that the Commission's calling of President O'Leary to testify on the successes of HBCUs in graduating African-American science and engineering majors was somehow inappropriate.[120]

Finally, the objections of Commissioners Yaki & Melendez to what they regard as the "non-deliberative manner by which Findings and Recommendations were drafted" are surprising. In fact, what they are objecting to is the deliberative character of our negotiations rather than their non-deliberative character. The Commission members who make up the majority that adopted these findings and recommendations take them seriously. We are not potted plants. We do not show up once a month to sign on the dotted line where staff members tell us to, and then collect a stipend and a free lunch. We sometimes have been negotiating with each other over the language of the findings and recommendations in a report long prior to their adoption. But given that all of us have full-time jobs and most of us must travel distances to get to our meetings, these negotiations take a while. Sometimes changes are still being suggested both shortly before a meeting and during the meeting. If Commissioners Yaki and Melendez would like to take part in those negotiations, they would certainly be welcome to, but thus far they have shown no desire to do so. To the contrary, Commissioner Yaki has declared the opposite intention in an open meeting, "I will not be a party," he said to Chairman Reynolds, "to contributing to your ability to get things done."[121] In any event, the Chairman has always been willing to postpone consideration of findings and recommendations when Commissioners Yaki or Melendez have requested such a delay, so it is difficult to understand what motivates their argument.

Part of the reason Commission members must spend a good deal of time hammering out findings and recommendations lies in the Commission's ill-considered procedures. The staff

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[119] According to the magazine Science, Dr. Tapia's graduate program in mathematics at Rice University has graduated far greater than the average number of underrepresented minorities than is the national average, causing the National Research Council to cite his program's success in one of its reports. Paul Selvin, Math Education: Multiplying the Meager Numbers, 258 Science 1200, 1201 (November 13, 1992).
[120] STEM Testimony at 146.
[121] Meeting of November 20, 2009, Transcript at 8-9. See Rebuttal Statement of Commissioner Gail Heriot to Report on Historically Black Colleges and Universities (issued in conjunction with this report) at n.1 (cataloguing occasions upon which Commissioner Yaki has walked out of ordinary business meetings to defeat a quorum or joined a meeting only when a quorum is already established.)

members who are assigned to write the first draft of them seldom get as much time as I would like to confer with Commission members about the kinds of recommendations those Commission members want to make. In part this is a result of poorly-designed internal procedures, which deliberately isolate them from the Commission. Sometimes staff members end up making guesses about what the Commission's majority wants, and sometimes those guesses turn out to be incorrect. They learn. Ultimately, however, it is for the Commissioners and not for the staff members to issue the reports. That is what it means to be the Commissioners instead of the staff. As the statute that chartered the Commission makes clear, the Commission is made up of the eight Commissioners; it is not made up of the staff.[122] The findings and recommendations of Commission reports must reflect that.

[122] *See* 42 U.S.C. 1975(b): "The Commission shall be composed of eight members." The subsection then goes on to describe how members of the Commission will be appointed by the President and Congress. But it is silent on the subject of staff.

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