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ABSTRACT

While African Americans, Hispanics, and American Indians constitute 30 percent of the U.S. K-12 school population, only about 11 percent of science and mathematics teachers come from these groups. This feasibility study examines the Alliance for Minority Participation (AMP) program as a mechanism for increasing the number of minorities in the science and mathematics teaching work force. The initiative would be articulated with teaching and research capabilities of colleges and universities and coordinated with K-12 schools, business and industry, and other government and nongovernmental entities. Partnerships and collaboration are central to the AMP design, and new teacher preparation elements would be based upon expanded alliances that are highly feasible, advisable, and cost-effective. Several AMP alliances are participating in promising teacher preparation activities. Most share common elements that are consistent with: (1) strong disciplinary foundation for teacher preparation; (2) collaborative initiatives that build upon the established infrastructure of institutional partnerships; and (3) coordination with other National Science Foundation-funded initiatives to achieve systemic impact and efficiency. The chapters are: chapter 1, "Introduction: Diversifying the Science and Mathematics Teaching Work Force"; chapter 2, "The Need for Additional Qualified Minority Teachers in Science and Mathematics"; chapter 3, "Overview of the Alliances for Minority Participation"; chapter 4, "Teacher Preparation Through the Alliances for Minority Participation: A New Paradigm"; chapter 5: "Utilizing Programs of the Directorate for Education and Human Resources That Relate to Teacher Preparation"; and chapter 6, "Opportunities for Significant Coordination and Efficiency." Appendices include: "Indicators of Mathematics and Science Teacher Qualifications and Shortages" (six figures and four tables) and "Minority Participation in the Mathematics and Science Teaching Work Force" (seven tables). (Contains 31 references.) (ND)

Science and Mathematics Teacher Preparation within the Alliances for Minority Participation Program:

A Feasibility Study

January, 1995

Division of Human Resource Development

Directorate for Education and Human Resources

NATIONAL SCIENCE FOUNDATION

Letter of Transmittal

January 30, 1995

Dear

I am pleased to submit to Congress this report, *Science and Mathematics Teacher Preparation within the Alliances for Minority Participation Program: A Feasibility Study.* The request for the Study, contained in the Conference Report from the Committee of Conference, U.S. House of Representatives (1994), was as follows:

> "The Committee recommends that the Alliances for Minority Participation program, a highly successful undergraduate science, engineering and mathematics degree program, be expanded in scope to include a mathematics and science teacher education component, under the same terms as that serving theAMP students. Through this expansion, theAMP program, which includes teacher education and is a very cost-effective mechanism, could be used to address the critically important shortage of K-12 mathematics and science teachers of color A feasibility study of this recommendation should be conducted by the Foundation and submitted to the Committee by February 1, 1995."

The Alliances for Minority Participation (AMP) program has established a strong track record of working with higher education institutions, business and industry, national laboratories, and other government agencies to increase the number of baccalaureate degrees awarded to underrepresented minorities in science, mathematics, engineering and technology fields. It is, as suggested in the Congressional request for the study, an ideal mechanism for addressing the nation's need for minority science and mathematics teachers. The AMP program is already being coordinated with other National Science Foundation programs in elementary, secondary and undergraduate education. It represents a singularly cost-effective vehicle for integrating into a comprehensive and efficient whole the resources and capabilities of the NSF and other government agencies, the nation's colleges and universities, K-12 schools, and business and industry.

As the Study shows, this initiative would address the nation's marked shortage of qualified science and mathematics teachers and increase significantly returns on related investments in systemic science and mathematics educational reform.

Sincerely,

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Chapter 1

Introduction: Diversifying the Science and Mathematics Teaching Work Force

It is widely understood that as the nation's economy becomes increasingly technology-based, it is critical that science and mathematics education in America's schools be strengthened. It is also well-recognized that while the U.S. and world economies are changing, the nation's and its schools' demographics are also changing: it is projected that by the middle of the 21st century, minorities will comprise close to one-half of all U.S. school children (1).

This Feasibility Study addresses an issue that is fundamental to better preparing the nation's minority students in the fields of science, mathematics engineering and technology (SMET) — increasing the numbers of minorities in the science and mathematics teaching work force. While African Americans, Hispanics and American Indians constitute 30 percent of the nation's K-12 school population, only approximately 11 percent of the nation's science and mathematics teaching work force is from these groups (2, 3). If current practices continue, by the year 2010 minorities will represent close to half of the nation's K-12 public school enrollment (4), but will continue to represent an unacceptably low fraction of the science and mathematics teaching work force (5).

Teachers at high-minority enrollment schools report that limited background and preparation pose major difficulties for them as science and mathematics instructors. Fewer hold degrees in science or mathematics education than do their counterparts in other schools. They are less confident about their teaching and about the ability of their students to learn than are other groups of teachers. Within schools of mixed ethnicity, the least qualified science and mathematics teachers typically teach minority students. Principals in racially mixed and high-minority schools often complain that inadequate preparation and lack of interest on the part of their science and mathematics faculty in teaching these subjects is a serious problem. Overall, schools whose students are predominantly minority employ teachers who are typically not minority and who are, on the average, less qualified to teach science and mathematics than are teachers in other schools (6).

Minority students have often been hindered from pursuing careers in science and mathematics because they have had poor quality K-12 instruction in these fields. Other obstacles include: exposure to few minority role models; being taught in ways that diminish confidence and interest; and taking few science and mathematics courses during high school (7).

This Feasibility Study examines the Alliances for Minority Participation (AMP)

program as a mechanism for expanding the minority science and mathematics teaching work force. The AMP program already has a proven trackrecord of increasing the quality and quantity of minority baccalaureate degree preparation among underrepresented minorities in the fields of science, mathematics, engineering, and technology.

The Alliances for Minority Participation is, as suggested in the Congressional request for this Study, an established mechanism that can be drawn upon and is well-suited for increasing the nation's cadre of minority science and mathematics teachers. It has the unique potential to create a new pool of talented minority individuals entering teaching and prepared by colleges and universities that have strong institutional capabilities in science and related fields.

In the AMP teacher preparation design, other National Science Foundation programs in K-12 and undergraduate education would be utilized to create each of the components needed for high-quality teacher preparation. The initiative would thereby represent a teacher preparation strategy that integrates into a comprehensive and efficient whole the resources and capabilities of several divisions and programs of the National Science Foundation. Consistent with the AMP partnership structure, the initiative would be articulated with the teaching and research capabilities of colleges and universities and coordinated with K-12 schools, business and industry, and other government and non-governmental entities.

As the Study shows, the AMP initiative would be an important asset in addressing the nation's overall shortage of qualified science and mathematics teachers. It would, in addition, contribute to increased quality and quantity of preparation of minority students in K-12 science and mathematics. In accomplishing these objectives, the AMP teacher preparation design would build upon NSF's significant current systemic reform activities. It would be uniquely capable of leveraging the returns on the nation's prior investments in science and mathematics education reform toward the goals of increasing and better preparing minority science and mathematics teachers.

Chapter 2

The Need for Additional Qualified Minority Teachers in Science and Mathematics

During the next two decades, the demand for elementary and secondary teachers in the U.S. will increase. Population growth will result in the number of teaching positions growing from approximately 2.8 million in 1991 to approximately 3.3 million by the year 2004 (1). Because the teaching work force includes a sizable number of individuals who will retire during the next decade, the number of new teachers needed will be even more substantial (2, 3).

Currently, among the most dramatic shortages of qualified teachers nationally are in the fields of physics, chemistry, mathematics, and computer science (4). Although shortages of qualified science and mathematics teachers reflect to a certain extent trends in the teaching work force as a whole, they are a more constant problem and have existed, during the past two decades, even when there were surpluses of teachers in other fields (5).

If long-standing patterns continue, shortages of qualified teachers will persist in the several science and mathematics teaching fields in which they already exist. A factor that will exacerbate this pattern is that the current teaching pool in some of these fields (e.g., chemistry and physics) represents an older than average population, meaning that replacement demand will be especially large (6, 7).

At the present time, approximately 380,000 K-12 teachers have their main or secondary teaching assignment in science, mathematics or computer science (8). In addition, many teachers who instruct in these fields have them as minor teaching assignments. Teachers with secondary assignments in science or mathematics are less well-prepared than teachers whose main assignment is in one of these fields. Teachers who teach science or mathematics and for whom the subject is neither their primary nor secondary assignment are even less prepared (9). Moreover, standards-based science instruction will seriously challenge the minimal preparation of middle and elementary level teachers.

Minority Science and Mathematics Teachers

Underrepresentation of African Americans, Hispanics and American Indians in the science and mathematics teaching work force contributes both to the insufficient supply of teachers in these fields and to the poor quality of instruction received by minority students. It results in an absence of role models for minority students in the elementary and secondary grades and limited aspirations to pursue careers in these fields.

There is a critical need nationally to increase the numbers of minority teachers in science and mathematics. This is neces-

sary in order to (a) meet the demand for science and mathematics teachers over the next decade, (b) improve the quality of science and mathematics instruction received by minority students, and (c) increase the participation of underrepresented groups in the science, mathematics, engineering, and technology work force.

Underrepresentation of minorities in science and mathematics teaching reflects the disproportionately low representation of minorities in the overall teaching work force. In 1990-91, there were more than 2.5 million public elementary and secondary school teachers in the U.S. (10). Of this total, 8.3 percent were African American and 3.4 percent were Hispanic (11).

Even these statistics mask the magnitude of imbalances in large inner city school districts and in regions where student populations have changed rapidly. In some districts, the minority student population may be as high as 100 percent, yet the minority teacher population seldom is higher than 30 percent to 40 percent and in most is substantially less.

Of the teachers having biology as a primary assignment in 1990-91, 87.4 percent were White, 6.3 percent African American, 4.7 percent Hispanic, and approximately 1 percent American Indian (12). Of the teachers who had chemistry as their primary teaching assignment, 92.3 percent were White (13). Of those who had physics as their primary assignment, 96 percent were White (14).

Of the nation's teachers who had mathematics as primary teaching assignments in 1990-91, 86 percent were White; only 9.1 percent of these teachers were African American, 2.8 percent Hispanic, and less than 1 percent American Indian (15). Detailed data on the racial-ethnic distribution of the mathematics and science teaching work forces are contained in Appendices A and B.

Of the twenty states with more than a 20 percent minority student population, only five have even half as many minority teachers in mathematics, biology, or chemistry as the proportion of minority students. State data show that, except for Hawaii, no state has a representation of minority teachers which is similar to the racial/ethnic background of its students (16).

Enrollments in undergraduate science and mathematics education fields continue to show the same general pattern of underrepresentation. Minority enrollments are disproportionately low in these and other education fields, and minorities drop out of the undergraduate teacher preparation pipeline in disproportionately large numbers (17, 18).

Limited numbers of minority teachers are paralleled by low participation rates in secondary science and mathematics courses among minority students. Combined, African American, Hispanic and American Indian students represent 30 percent of the nation's school population. However, their combined enrollments represent only 20

percent of high school biology, 11 percent of high school chemistry, and 10 percent of high school physics classes. Their enrollment in beginning algebra and in geometry represents 15 percent, and in high school advanced mathematics 8 percent of total participants (19).

The importance of increasing minority representation in the science and mathematics teaching work force is underscored by evidence indicating that current teachers do not feel well-prepared to work with the diversity of students in their classrooms. Only 70 percent of science and mathematics teachers report feeling well-prepared to teach students from a variety of cultural backgrounds. Only 29 percent feel well-prepared to teach students who are limited in their English proficiency (20).

Minority students currently have limited opportunities to learn challenging science and mathematics content. Among classrooms having more than 40 percent minority enrollment, 42 percent emphasize preparing students for taking standardized tests — activities which tend to focus primarily on low-level skills. Among classrooms having less than 10 percent minority enrollment, 78 percent emphasize higher level skills and preparing students for further study in these fields (21).

The Broader Context: Indicators of Shortages in the Numbers of Qualified Science and Mathematics Teachers

The insufficient supply of qualified science and mathematics teachers in the U.S. is evident in a wide range of indicators. Of the nation's high school science teachers, 22 percent do not hold a degree in science or science education. Similarly, 32 percent of high school mathematics teachers are individuals who do not hold a degree in mathematics or mathematics education (22). These patterns are more pronounced among middle grade teachers.

Not all states require a degree in science or mathematics or science or mathematics education to teach in these fields. Another measure of shortages of qualified teachers in science and mathematics is the number of teachers who are teaching in these fields without state certification.

The state percentages of noncertified teachers in science and mathematics vary widely. However, all but two states for which data are available report substantial numbers of science or mathematics teachers in the state who are not certified in these fields (24).

While varying in magnitude among states, shortages of qualified teachers in science and mathematics are distributed throughout the nation. The majority of states indicate continuing shortages, particularly in the physical sciences and mathematics (25).

Available data for 32 states indicate that, overall, approximately 12 percent of high school mathematics teachers do not have state certification as a mathematics teacher. Approximately 9 percent of high school biology teachers, 8 percent of chemistry teachers, and 13 percent of physics teachers do not have certification in these fields (23).

Over 1.5 million professionals (two-thirds elementary teachers) teach some science and mathematics in grades K-12 without this being their primary assignment (26). Large numbers of teachers instruct in science or mathematics without having this as their primary or secondary teaching field. Almost all elementary teachers have responsibilities for science or mathematics instruction, but only 1.5 percent of these teachers have a baccalaureate degree in science or mathematics — or in science or mathematics education.

The national shortage of qualified K-12 science and mathematics teachers compromises the quality of instruction in these fields. School districts have had to deal with the situation in several unfortunate ways: by hiring uncertified teachers; assigning teachers outside their fields of preparation; cancelling course offerings; and expanding class sizes (27, 28).

Direct consequences have been (a) poor quality science and mathematics instruction, (b) limited offerings of science and mathematics, (c) restricted opportunities for students to take courses required as a basis for college and university study in these fields, and (d) failure of many students to develop a basic appreciation and understanding of science and mathematics during the elementary and secondary grades. Thus, while relatively few teaching vacancies have remained unfilled, impacts of shortages are evident in the qualifications of teachers in these fields and on access to and quality of science and mathematics instruction.

It is important to note that schools and classrooms with large proportions of minority students are less likely to have well-qualified teachers than their counterparts (29). Schools in economically advantaged and suburban neighborhoods employ science and mathematics teachers who are, on average, the most qualified. Students attending these schools have greater access to science and mathematics teachers who are certified to teach their subjects, who hold bachelor's or master's degrees in those subjects, or who meet the standards set by professional associations (30).

Current shortages of certified science and mathematics teachers are a result of a number of interacting factors. One is the decline in the number of education majors during the 1970's and early 1980's (31, 32). Since 1990, there has been a modest but steady increase in majors in education (33, 34). However, the percentage of freshmen from minority groups interested in teaching careers continues to be lower than the percentage of White students. The pattern is most marked for prospective secondary teachers (35, 36).

The declines in the number of college students majoring in the sciences and mathematics during the 1970's and early 1980's affected the numbers of new teachers in these fields (37). This pattern in science and mathematics majors has also begun to change; it is particularly noteworthy that increases are occurring among minority students (38). The increases suggest that we are beginning to see the results of the nation's investment during the early 1990's aimed at increasing the participation and achievement of minorities in science, mathematics, engineering, and technology.

The increasing demand for mathematically and scientifically trained individuals in many sectors of the U.S. economy means that teaching is engaged in stiff competition with other occupations for the supply of college graduates trained in mathematics and science. The wage and status differentials between teaching and these other fields make recruitment of science and mathematics teachers particularly difficult.

Summary

Minorities are severely underrepresented in the nation's science and mathematics teaching work force. Without efforts to intervene, they will continue to be underrepresented, and the number of qualified science and mathematics teachers will continue to be insufficient to meet the nation's needs. The shortage of qualified teachers in these fields has direct impacts on the quality of science and mathematics instruction in the nation's schools.

Chapter 3

Overview of the Alliances for Minority Participation

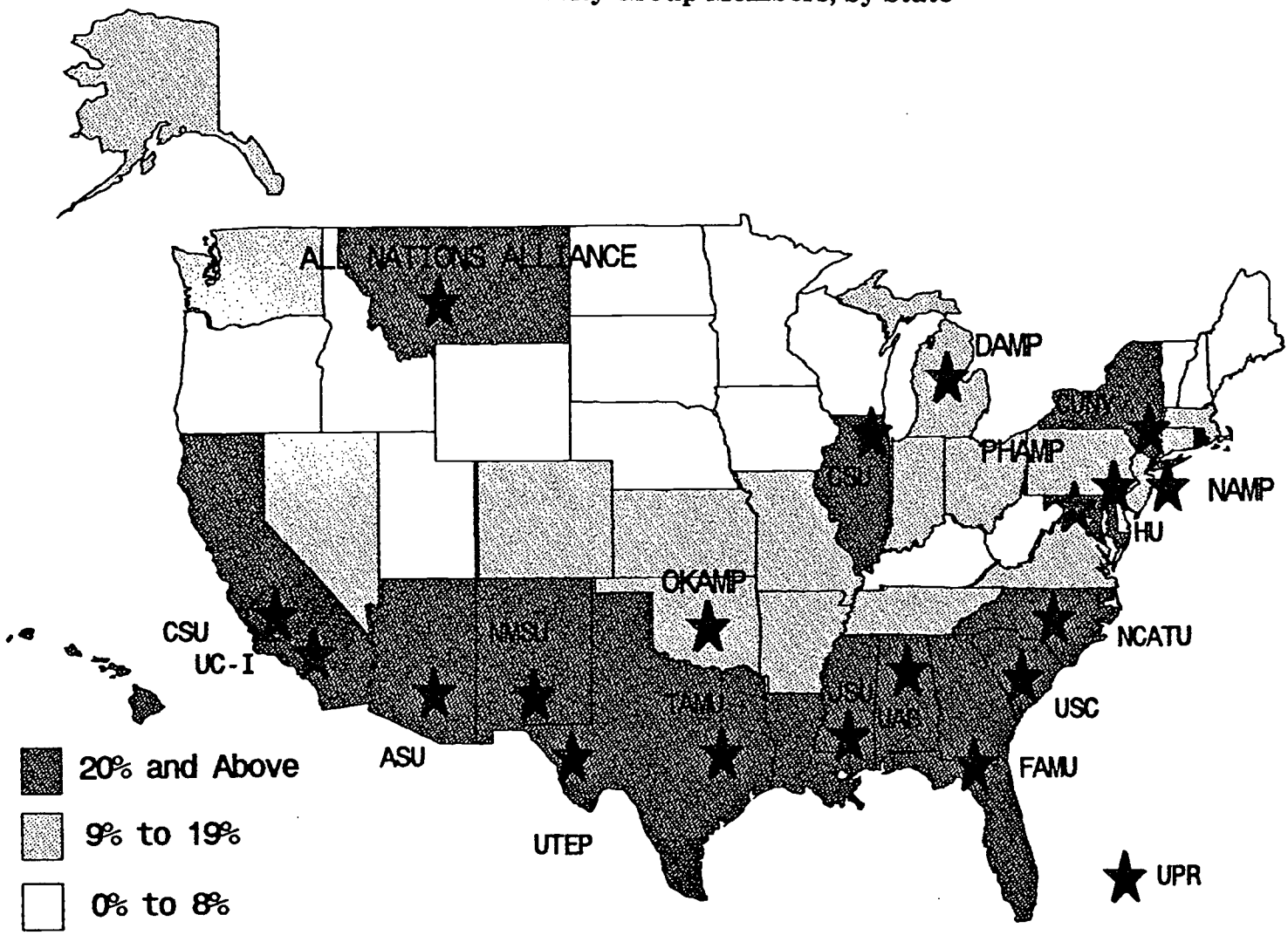
The Alliances for Minority Participation (AMP) program is the National Science Foundation's flagship initiative for increasing the participation and success of individuals from minority groups underrepresented in the science, mathematics, engineering, and technology (SMET) work force. For three years, the program has successfully engaged the resources of the scientific community in a national initiative aimed at increasing the numbers of minority individuals receiving baccalaureate degrees in SMET fields. African Americans, for example, represent 12.1 percent of the general population, yet in 1991, they earned only 4.8 percent of the bachelor's degrees in engineering, life sciences, mathematics, and the physical sciences. They earned only 2 percent of the master's degrees and 1 percent of the doctorate degrees in these fields. Similar patterns exist for Hispanics and American Indians (1).

The resources lost to America — human, financial, and societal — as a result of continuing low rates of minority participation in science-related fields are substantial. The AMP Alliances implement innovative and effective strategies to harvest these resources and to ensure that our nation has both a well-trained and a diverse science, mathematics, engineering, and technology work force.

The AMP program supports Alliances among institutions of higher education and other public agencies and private organizations. It does so through agreements that contain (a) each Alliance's goal (the current numbers of minority students obtaining B.S. degrees in SMET fields and the Alliance's five-year goal) and (b) specific work statements that describe how the Alliance will achieve its goal.

The National Science Foundation has provided support to twenty AMP Alliances. Six were initiated in 1991 (Group 1 — Alabama, Arizona, California, Mississippi, Texas, and Puerto Rico). Five were begun in 1992 (Group 2 — Florida, New York city, North Carolina, South Carolina, University of Texas System). Four were established in 1993 (Group 3 — Chicago, California State University System, Washington, D.C. area, and New Mexico). An additional five were initiated in 1994 (Group 4 — Oklahoma, Montana, Detroit, Philadelphia, and Newark). Figure 1 shows the locations of the AMP Alliances.

Figure 1.
Alliance for Minority Participation Program and Proportion of College Students Who Are Minority Group Members, by State



1991 Alliances
The University of Alabama at Birmingham (UAB)
Arizona State University (ASU)
Jackson State University (JSU)
Texas A&M University (TAMU)
The University of California at Irvine (UC-I)
The University of Puerto Rico (UPR)

1992 Alliances
City University of New York (CUNY)
Florida A&M University (FAMU)
North Carolina A&T University (NCATU)
The University of South Carolina (USC)
The University of Texas at El Paso (UTEP)

1993 Alliances
California State University (CSU)
Chicago State University (CSU)
Howard University (HU)
New Mexico State University (NMSU)

1994 Alliances
Montana State University (All Nation's)
New Jersey Institute of Technology (NAMP)
Oklahoma State University (OKAMP)
Temple University (PHAMP)
Wayne State University (DAMP)

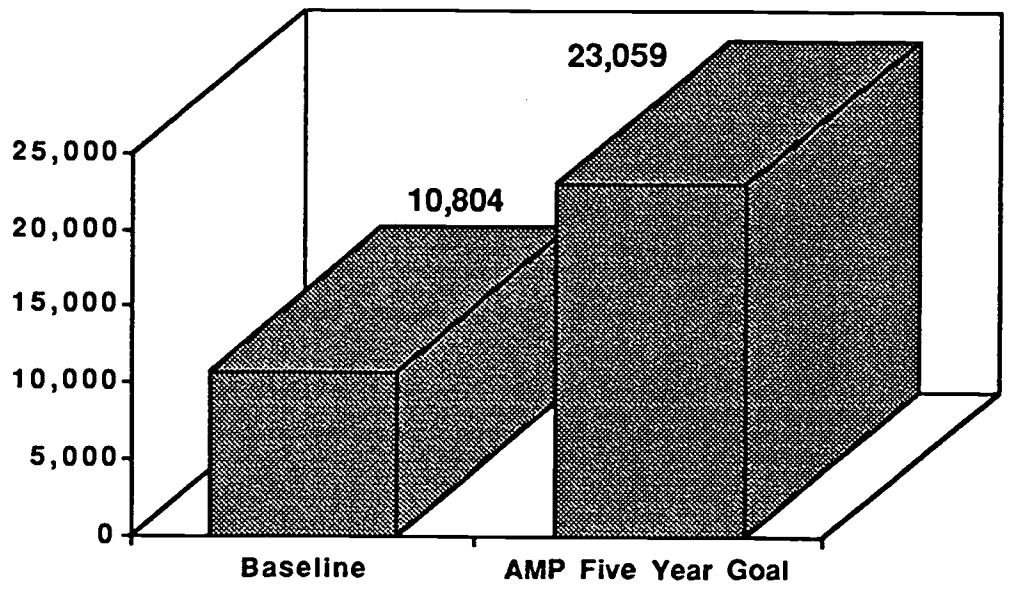
The collective goal of these Alliances is to increase the bachelor degree production in SMET fields of underrepresented groups from 10,804 in the baseline years of the Alliances to over 23,000 in year five. Significant gains have been made by the participating AMP institutions during the past three years.

The enrollments of African American, Hispanic and American Indian undergraduates in science, mathematics, engineering, and technology fields among the Group 1 and Group 2 Alliances have increased 17.5 percent since the establishment of the programs, from 73,210 in 1991-92 to 86,025 in 1993-94. The increase in degrees granted to minorities approaches 40 percent, rising from 6,473 in the first year of the Alliances to 8,904 in 1993-94, showing a consistent pattern of substantial growth.

Group 1 Alliances Production Data

- The Alabama Alliance had a 22 percent increase in minority SMET enrollments, from 4,075 in 1991-92 to 4,983 in 1993-94; B.S. degree production in SMET fields increased from 541 in 1990-91 to 917 in 1993-94, a 69.5 percent increase.

Figure 2.
The Alliances for Minority Participation Program
Baccalaureate Degree Production and Projections
Five Year Goals



- The University of California Alliance demonstrated a 10 percent enrollment increase from 3,806 in 1991-92 to 4,192 in 1993-94; B.S. degree production increased from 577 in 1990-91 to 843 in 1993-94, a 46 percent increase.

- The Mississippi Alliance achieved a 20 percent enrollment increase from 2,864 in 1991-92 to 3,434 in 1993-94; B.S. degree production increased from 288 in 1990-91 to 456 in 1993-94, a 58 percent increase.

- The Puerto Rico Alliance had a 9 percent enrollment increase from 12,624 in 1991-92 to 13,823 in 1993-94; B.S. degree production increased from 1,709 in 1990-91 to 2,064 in 1993-94, an 21 percent increase.

- The Southern Rocky Mountain Alliance achieved a 39 percent enrollment increase from 7,064 in 1991-92 to 9,803 in 1993-94; B.S. degree production increased from 484 in 1990-91 to 824 in 1993-94, a 70 percent increase.

- The Texas A & M Alliance demonstrated a 10 percent enrollment increase from 1,331 in 1991-92 to 1,470 in 1993-94; B.S. degree production increased from 345 in 1990-91 to 534 in 1993-94, a 55 percent increase.

Group 2 Alliances Production Data

- The Florida-Georgia Alliance experienced a 31 percent SMET enrollment increase from 9,842 in 1992-93 to 12,902 in 1993-94; B.S. degree production in SMET fields increased from 537 in 1991-92 to 751 in 1993-94, a 40 percent increase.

- The City University of New York Alliance had a 13 percent enrollment increase from 4,360 in 1992-93 to 4,942 in 1993-94; B.S. degree production increased from 321 in 1991-92 to 393 in 1993-94, a 22 percent increase.

- The North Carolina Alliance demonstrated a 15 percent enrollment increase from 8,378 in 1992-93 to 9,635 in 1993-94; B.S. degree production increased from 875 in 1990-91 to 1,124 in 1993-94, a 28 percent increase.

- The University of South Carolina Alliance had a 2 percent enrollment increase from 2,637 in 1992-93 to 2,704 in 1993-94; B.S. degree production increased from 232 in 1991-92 to 332 in 1993-94, a 43 percent increase.

- The University of Texas Alliance achieved a 5.7 percent enrollment increase from 9,645 in 1992-93 to 10,192 in 1993-94; B.S. degree production increased from 564 in 1991-92 to 666 in 1993-94, an 18 percent increase.

Table 1 summarizes the enrollment and degree granted data for the first two groups of AMP Alliances and demonstrates the significant outcomes they achieved. The pattern of dramatic increases has continued and is projected to be sustained. The strong accountability provisions of the program require that each Alliance continuously focus on achieving the measurable outcomes the program is intended to produce.

Effective Partnerships Involving Higher Education, Government, Business and Industry

The contributions of the AMP institutions have been well-recognized by government and private sector entities. Most Alliances have received significant support from other federal programs as well as state and local governments. Alabama, California, Florida, Mississippi, New York and South Carolina provide examples of states that are providing funds to augment the NSF investment in the programs. Business and industry, local governments, and national research laboratories are also contributing to the success of the program.

Table 1.

AMP Projects: Enrollment and B.S. Degree Data*

Alliances	Enrollment			B.S. Production		
Group 1	1991-92	1993-94	%Increase	1990-91	1993-94	%Increase
Alabama	4,075	4,983	22	541	917	69.5
Univ. of California System	3,806	4,192	10	577	843	46
Mississippi	2,864	3,434	20	288	456	58
Puerto Rico	12,624	13,823	9	1,709	2,064	21
Southern Rocky Mtn.	7,064	9,802	39	484	824	70
Texas A & M	1,331	1,470	10	345	534	55
Group 2	1992-93	1993-94	%Increase	1991-92	1993-94	%Increase
Florida-Georgia	9,842	12,902	31	537	751	40
New York City	4,360	4,942	13	321	393	22
North Carolina	8,378	9,635	15	875	1,124	28
South Carolina	2,637	2,704	2.5	232	332	43
Univ. of Texas System	9,645	10,192	5.7	564	666	18

**National Alliances for Minority Participation.* Vol. 2, No. 1. Fall 1994. Page 11, with data updated.

An example of state recognition of AMP achievements is found in California, where the Regents of the University of California have pledged $500,000 to the California Alliance for Minority Participation program over a two-year period. In South Carolina, the state is providing $600,000 in state funds for the AMP.

To utilize the knowledge, resources, and capabilities of a broad range of organizations within the scientific community, the AMP program requires the formation of coalitions among leaders throughout academia, government, industry, and other organizations. The Alliances also typically involve several four-year colleges and universities, as well as two-year colleges. From its inception, the program recognized that most minority students start their higher education in two-year colleges. There is a need nationally to increase the transfer of these students to four-year colleges and universities in science-related disciplines, and AMP Alliances are providing leadership in articulating two-year and four-year college study.

The AMP program also provides bridges for students from high schools to four-year colleges and universities. One component of the Alliances is their attention to the early career development of minority students in higher education. Historically, 65 percent of minority freshmen dropped-out or "stopped-out" of degree programs before reaching their junior year in college. The AMP program focuses and coordinates resources to assist student retention. Many students state that without the support of the program, earning a degree in higher education would not be possible for them.

A characteristic of the Alliances has been the significant involvement of leaders in higher education. Three of the Alliances — those located at the University of California at Irvine, Chicago State University, and the University of Texas at El Paso — are directed by the Chancellors or Presidents of these institutions.

This reflects the overall pattern in which colleges and universities have committed their resources and leadership to ensure the Alliances are successful. The program's focus on measurable institutional outcomes ensures that top level administrators are involved throughout its implementation.

Alliances must demonstrate to the NSF that when funding ends, changes associated with increased participation and success of minority students will be institutionalized. This requires approaches to systemic change which are both effective and efficient, as well as meaningful involvement of state and local government and the private sector.

Operational Features of Alliances

Each Alliance was selected on a competitive basis and has demonstrated the following strengths:

- Effective collaborative approaches for recruiting and graduating individuals from groups underrepresented in SMET fields;

- Strong institutional leadership at all levels, exhibited by success in implementing comprehensive new activities in these fields;

- Clear goals and objectives and a commitment to cost-effective strategies for increasing production of minority SMET graduates;

- High expectations for performance of students, faculty, and administrators; and

- Well-developed plans for evaluation, dissemination, and institutionalization.

The AMP program has been successful in helping institutions develop initiatives that work in a coordinated manner with other programs to maximize cost-effectiveness. AMP institutions are receiving support from non-NSF sources for (a) developing and improving retention programs, (b) implementing bridge programs (both precollege to undergraduate and community college to four-year college programs), (c) establishing research internships and stipends, and (d) enhancing undergraduate education.

Summary

The AMP program provides an exceptionally solid foundation for increasing the number of minority science and mathematics teachers. The AMP Alliances are producing new groups of talented minority individuals with high quality undergraduate training in science, mathematics, engineering, and technology. The strong preparation that the AMP Alliances provide in these disciplines can be built upon to prepare a new cadre of talented minority undergraduates for K-12 teaching in science and mathematics.

Chapter 4

Teacher Preparation Through the Alliances for Minority Participation: A New Paradigm

A general paradigm for the teacher preparation component of the AMP program has been developed which reflects the most promising practices nationally in the preparation of science and mathematics teachers. While individual projects may vary, each would have a number of important common characteristics.

AMP Paradigm for Teacher Preparation

The AMP teacher preparation paradigm will include elements aimed at achieving the following objectives:

- Increasing the numbers of minorities recruited into pre-service teacher preparation, including beginning career planning during the secondary grades and recruitment within two-year colleges;
- Creating articulated programs between two-year colleges and four-year colleges and universities preparing science and mathematics teachers;
- Ensuring rigorous disciplinary foundations among minority teacher candidates;
- Enhancing future teachers' understanding of scientific investigation and mathematical inquiry through direct participation in research;
- Preparing new teachers in instructional methods that are based upon current knowledge in cognitive psychology and learning theory;
- Ensuring new teachers' understanding of effective strategies for implementing science and mathematics reforms, including uses of new technologies to strengthen science and mathematics education;
- Preparing teachers to use new assessment approaches in science and mathematics education;
- Fostering knowledge of approaches for addressing cultural and linguistic differences in the teaching of science and mathematics; and
- Increasing the retention of minority science and mathematics teacher candidates both in teacher preparation programs and as beginning teachers.

The teacher preparation component will build upon the current AMP structure and emphasize:

(1) Strong collaboration of science faculty with education faculty in the teacher preparation program;

(2) Reforms in science and mathematics education, such as curriculum, teaching and evaluation standards and benchmarks developed by the National Council of Teachers of Mathematics (NCTM), the National Science Teachers Association (NSTA), the American Association for the Advancement of Sciences (AAAS), and the National Academy of Sciences (NAS);

(3) Computer applications, multimedia technologies, and telecommunications as strategies within science and mathematics instruction; and

(4) Differences among diverse student groups and the implications for teaching and learning in mathematics and science.

Undergraduate Curriculum Reforms that Involve Collaboration Among Science, Mathematics and Education Faculty

The AMP teacher preparation component will require collaboration between science, mathematics, engineering and technology faculty and education faculty in undergraduate curriculum reforms for new teachers. Teacher preparation designs will include improvement of undergraduate curricula and actively involve science and mathematics faculty and their departments in the preparation of new teachers. AMP Alliances will be encouraged to create opportunities for teacher candidates to participate in faculty research in order for them to develop a full appreciation of scientific and mathematical investigation.

Articulation with Elementary and Secondary Schools

Consistent with effective teacher preparation models, AMP colleges and universities will work with surrounding school districts in identifying exemplary sites for student teachers. Projects will be encouraged to include the participation of elementary and secondary schools serving minority students as training sites for new teachers.

At training sites, teacher candidates will serve as "apprentice" teachers and will work with outstanding teacher mentors who will

provide supervision and mentoring for them. Local schools and teachers will work with college and university faculty as partners in the preparation of new teachers.

The program will be coordinated with the NSF Collaboratives for Excellence in Teacher Preparation Programs. New strategies for training science and mathematics teachers are being piloted through this program. Its initiatives include sites for school-based training of new teachers at inner city schools serving African American and Hispanic students, and on Indian reservations.

The AMP paradigm will also encourage coordination with schools participating in other NSF comprehensive elementary and secondary reform efforts. These include the Statewide, Urban and Rural Systemic Initiatives and the Comprehensive Partnerships for Minority Student Achievement. Participation of mentor teachers trained through NSF Teacher Enhancement activities will also be encouraged. These related programs are described in Chapter 5.

Strategies for Financing of Teacher Preparation

An additional critical aspect of the program will address the financing of science and mathematics teacher preparation for low-income students. A primary barrier to minority participation in pre-service teacher preparation overall and particularly in the many states which require a year beyond the baccalaureate degree for certification has been program costs.

A number of solutions for providing financial support will be implemented by the AMP Alliances. One will be an internship model in which teacher candidates will receive a stipend for serving as student teachers. A second will involve current mechanisms such as College Work Study and Cooperative Education to provide financial assistance to students. A third will involve articulation of AMP teacher preparation activities with existing financial aid programs for new teachers such as the federal Congressional Paul Douglas Teacher Scholarship Program. Designs for financial aid will connect stipends for students with school site teaching, tutoring, and research in the fields of science, mathematics, engineering, technology and education.

Support for Beginning Science and Mathematics Teachers

The first three years in the teaching profession are the time during which the largest numbers of new teachers drop out of the field. Nationally, approximately 40 percent of new teachers are lost to the profession during the first three years: approximately 15 percent leave after their first year of teaching; another 15 percent leave after their second year; and an additional 10 percent leave after their third year (1). Teachers in the highest shortage fields (e.g., physical sciences) tend to leave more quickly and at higher rates (2-5).

New teachers typically have little support during their critical induction period. The AMP teacher preparation component will include attention to this dimension. One strategy for providing new teacher support will be pairing of new teachers with mentors at the university, including both disciplinary faculty and education faculty. Another will be the use of telecommunications for electronic mentoring, for establishing networks of new teachers, and for online conferences involving new teachers during their initial three years of practice.

Articulation Between Two-Year and Four-Year Colleges

The AMP program requires collaboration between two-year and four-year colleges. This infrastructure of the AMP Alliances will be built upon to create approaches for recruiting minority students who are interested in science and mathematics teaching from two-year colleges. In addition, current articulation agreements will facilitate the establishment of lower division courses at community colleges that prepare students for completion of a teacher preparation program at cooperating four-year colleges or universities.

Examples of Current Alliance for Minority Participation Teacher Preparation Activities

A few AMP Alliances have begun to include teacher preparation activities. However, the AMP program was not designed for these to be basic parts of the Alliances, and they currently represent limited aspects of the program.

An example of a particularly substantial teacher preparation project is the California Alliance for Minority Participation's *Project SMART — Science and Mathematics Articulated Roads Toward Teaching,* supported through funding from the Pew Charitable Trusts. The project is centered at the University of California at Irvine, and is focused on developing, implementing, evaluating and disseminating to other sites new strategies for recruiting, preparing and retaining minority science and mathematics teachers.

The Alabama AMP Alliance includes Schools of Education in all of its thirteen Alliance institutions. The fact that eight of the thirteen institutions are Historically Black Colleges and Universities presents a unique opportunity for the program to have an impact on minority participation in K-12 science and mathematics teaching.

In the Spring of 1995, the Alabama AMP will host a Conference on minority science and mathematics teacher recruitment and preparation. It will involve AMP site directors and representatives from schools of education, from neighboring states, and

from other AMP Alliances. The Conference will (a) identify the needs of institutions related to attracting and training minority students for teaching science and mathematics and (b) develop strategies for undertaking such activities.

The Southern Rocky Mountain Alliance is working with faculty at Arizona State University, Navajo Community College, and ten Maricopa Community Colleges in planning a teacher preparation initiative. Its goal will be to improve the science and mathematics curricula offered to elementary and middle school teacher candidates in Arizona.

The Greater Newark AMP encourages students it works with at the pre-college level to consider science or mathematics teaching as a rewarding and attainable career choice. In its career workshops, K-12 teaching is an option that is explored with minority teacher role models. As undergraduates, AMP students have the opportunity to serve as tutors and are invited to participate in activities of K-12 Teaching Excellence Centers.

The University of Texas at El Paso and El Paso Community College are jointly addressing the need to increase the number of individuals from minority groups preparing to teach K-12 science and mathematics. The effort is coordinated with the AMP Alliance and is part of the El Paso Urban Systemic Initiative, funded by NSF. It is part of a fundamental effort to transform teacher preparation that is grounded in and contributes to systemic reform of K-12 education in El Paso. The project includes: recruitment of minority teacher candidates; enhancement of the teacher preparation curriculum; improvement of the instructional skills of science, mathematics, and teacher preparation faculty; and support for new science and mathematics teachers as they enter the profession.

Summary

Several AMP Alliances are participating in promising teacher preparation activities. Most share common elements that are consistent with (a) a strong disciplinary foundation for teacher preparation, (b) collaborative initiatives that build upon the established infrastructure of institutional partnerships, and (c) coordination with other NSF-funded initiatives to achieve systemic impacts and efficiency.

Chapter 5

Utilizing Programs of the Directorate for Education and Human Resources that Relate to Teacher Preparation

The National Science Foundation's Directorate for Education and Human Resources (EHR) is responsible for the overall health of the nation's science, mathematics, engineering, and technology (SMET) education and for providing leadership in the effort to improve education in these areas. The Directorate has several current activities which, while not focused specifically on the preparation of minority science and mathematics teachers, can be drawn upon to establish a high-quality and efficient AMP teacher preparation component.

A number of features common to these programs make them valuable assets for the AMP teacher preparation initiative. Each emphasizes the development of the networks and partnerships needed to improve science and mathematics instruction. Participants include state and local education and government agencies, business and industry, and other Federal agencies. The programs use new technologies for improving program delivery. They can be interfaced locally and regionally with Alliances for Minority Participation teacher preparation activities.

The Division of Human Resource Development

The Division of Human Resource Development (HRD) has primary responsibility for broadening participation of groups underrepresented in science, mathematics, engineering, and technology. The Alliances for Minority Participation program is within this Division. While each of the other divisions in the Directorate for Education and Human Resources can contribute generalized expertise to the AMP teacher preparation component, HRD has experience, knowledge and a developed infrastructure focused on underrepresented minorities that can be of singular value in the initiative. Relevant programs can be drawn upon to establish a highly efficient AMP teacher preparation initiative.

- Research Careers for Minority Scholars — This program provides support to colleges and universities to implement enrichment programs in science and engineering that are typically departmentally-oriented and small-scale. It also enables institutions to improve minority student retention and advancement in SMET fields through research participation and related activities. Successful enrichment and retention activities piloted by RCMS sites will serve as components within AMP teacher preparation strategies.

- Career Access Opportunities in Science and Technology — The Career Access programs include pre-college efforts that enhance career opportunities and interest in SMET fields among underrepresented groups. The Comprehensive Regional Centers for Minorities program has historically supported the establishment of regional public-private coalitions to substantively improve the pre-college experiences of minority students in science and mathematics. The Comprehensive Partnerships for Minority Student Achievement program supports school systems with significant minority populations in initiating systemic reforms that involve partnerships with colleges and universities and other public and private entities. Summer Science Camps support summer enrichment for minority students in grades seven to nine. Projects involve school districts, museums, colleges and universities, and nonprofit, youth-centered and/or community-based organizations. Projects include academic year follow-up experiences and coordination with local schools.

  The Career Access programs will be used to begin recruitment of minority science and mathematics teachers in the intermediate, middle and secondary grades. These are the times at which students begin to form career interests. Schools participating in the programs will also provide sites for practicum experiences of teacher candidates. These sites (a) serve large numbers of minority students, (b) reflect innovative educational practices, and (c) provide a focus on encouraging and preparing minority students to pursue SMET careers.

Office of Systemic Reform

The programs of this office feature systemic strategies that, taken together, result in a coordinated approach to the improvement of mathematics and science education and teaching. Programs include:

- Statewide Systemic Initiatives — This is a major effort by the NSF to encourage improvements in science, mathematics, engineering, and technology education through comprehensive systemic changes in the education systems of the states. Reforms in requirements and strategies for the preparation, certification, and continuing education of teachers will provide a vehicle for statewide support of AMP Alliances' teacher preparation initiatives.

- Urban Systemic Initiatives — This program is aimed at effecting sustained reform in elementary and secondary science and mathematics in the nation's urban centers. Through the initiative, NSF works with the nation's 25 cities with the largest number of school-age children in poverty to achieve system-

wide improvement in student learning and teaching in grades K-12 science and mathematics. Schools in this program will also serve as training sites for new minority teachers, resulting in valuable practicum experiences as well as the potential for these schools to work with teacher candidates as an added instructional resource.

- Rural Systemic Initiatives — This program is directed toward the improvement of science, mathematics and technology education in rural, economically disadvantaged regions of the nation. It includes innovative uses of interactive distance learning, the concomitant training of current teachers to meet the demands of new instructional paradigms, and the strengthening of regional colleges and universities. Activities of this program will be coordinated directly with AMP teacher preparation activities in rural areas.

Elementary, Secondary and Informal Education

The programs in this division are designed to improve the educational experiences of all students in school settings — pre-kindergarten through the 12th grade — and to increase and improve the opportunities for all individuals to explore science, mathematics, and technology beyond the school setting.

- Instructional Materials Development — This program supports the development of instructional materials that enable students to acquire sophisticated content knowledge, higher-order thinking abilities, and problem-solving skills consistent with new standards for mathematics and science instruction. These materials are designed to promote the success of all students and will be a valuable resource for teachers preparing to teach in diverse classrooms. These materials, as well as those developed independently by commercial and non-profit publishers, will be used within the AMP teacher preparation component to prepare new teachers with the best of instructional resources, including new technology-based learning materials.

Undergraduate Education

The Division of Undergraduate Education's programs aim to strengthen and ensure the quality of education in science, mathematics, engineering, and technology in the nation's colleges and universities, both two-year and four-year.

- The NSF Collaboratives for Excellence in Teacher Preparation — This program provides support for improvements in the undergraduate education of future science and mathematics teachers through new collaboratives established among colleges, universities and K-12

schools. The program focuses on the creative design of undergraduate courses and curricula, including a focus on gateway courses. The new instructional designs address both content and method of science and mathematics teaching. They also address such issues as integration of science and mathematics, use of advanced technologies, and methods of student assessment consistent with innovative teaching methodologies. The Collaboratives program will provide models and technical assistance and coordination of resources with AMP teacher preparation activities.

- Undergraduate Course and Curriculum Development— This program fosters improvements in undergraduate science and mathematics education. It encourages and supports the efforts necessary to restructure courses and curricula in light of current needs, new technologies, and new knowledge within and across disciplines. Its activities include efforts aimed at improving undergraduate courses for pre-college teachers which can be incorporated directly within AMP teacher preparation strategies.

Research, Evaluation, and Dissemination

- Research in Teaching and Learning — This program supports basic and applied research expanding the knowledge base necessary to strengthen science, mathematics, engineering, and technology education at all levels, from pre-kindergarten through college. Research in such areas as the development of children's scientific and mathematical thinking has direct relevance to the design of effective new teacher preparation approaches and will be made available to AMP Alliances as a foundation for their teacher preparation strategies.

- Applications of Advanced Technologies — This is a research and development program that supports the development of innovative applications of advanced technologies in science, mathematics, engineering and technology education. Projects supported through it include cutting-edge uses of advanced technologies in science and mathematics education that will be incorporated into AMP teacher preparation designs.

- Networking Infrastructure for Education — This program is undertaken in collaboration with NSF's Directorate for Computer and Information Science and Engineering. It is in response to the national need to accelerate the adoption of advanced networking technologies in support of science and mathematics education at the elementary, secondary and college/university levels. It promotes the application of networking technologies to improve science, math-

ematics, and technology education. Networking applications will be used to (a) connect colleges and universities with school-based training sites and (b) support new teachers during their first three years of practice.

Summary

The Directorate for Education and Human Resources has within it the expertise needed to establish an effective AMP teacher preparation initiative. By drawing upon the Directorate's existing programs in developing an integrated teacher preparation initiative, the AMP Alliances will efficiently implement new paradigms for producing well-qualified science and mathematics teachers.

Chapter 6

Opportunities for Significant Coordination and Efficiency

A teacher preparation component within the Alliances for Minority Participation provides a number of opportunities for significant coordination and efficiency. These include the opportunities for coordination (1) between AMP teacher preparation and the existing NSF activities described in Chapter 5; (2) between AMP sites and K-12 school districts, state and local educational agencies, and business and industry; (3) between NSF and other federal education programs; and (4) between AMP teacher preparation and non-federal initiatives aimed at increasing minority participation in the teaching work force.

Coordination Between AMP Teacher Preparation and Existing National Science Foundation Activities

As indicated in Chapter 5, the programs of NSF's Directorate for Education and Human Resources provide the set of supporting elements necessary for the Alliances for Minority Participation to undertake teacher preparation projects reflecting the best of current practice. The Directorate views the AMP teacher preparation initiative as an opportunity to fully integrate these activities in support of the critical national need to increase minority science and mathematics teachers.

Coordination Between AMP Sites, K-12 Schools, and Other Public and Private Entities

The Alliances for Minority Participation program has stressed collaboration and partnership among higher education, K-12 educational institutions, and public and private entities since its inception. This tradition and the infrastructure that supports it can be used to implement a teacher preparation initiative which guarantees efficient utilization of new resources. The activities related to teacher preparation with which the AMP Alliances are already associated reflect the commitment to partnerships that is essential to maximizing the benefits of federal resources.

Coordination Between NSF and Other Federal Agencies

The National Science Foundation and the U.S. Department of Education have established formal mechanisms for cooperating in fostering systemic improvement of mathematics and science education in the nation. Department of Education programs with which AMP teacher education activities will be coordinated include those of the Elementary and Secondary Education Act, the Eisenhower Mathematics and Science professional development program, and the National Education Goals initiative.

A number of federal student financial aid programs can also be coordinated with the AMP teacher preparation component. These include the federal Work Study Program, the Cooperative Education Program, and the Congressional Paul Douglas Scholarship Program for new teachers. Financial assistance in each of these programs is directly tied to the student's work — a characteristic that will be central to the AMP teacher preparation component.

NSF and the AMP Alliances also work closely with other federal programs in SMET fields. These include, for example, programs administered by the National Institutes of Health, the Department of Energy, and the National Aeronautics and Space Administration. The relationships between NSF and the AMP Alliances and these other entities provide rich opportunities for students to have first-hand research experiences that can significantly strengthen their preparation for teaching.

Coordination Between AMP Teacher Preparation and Non-Federal Initiatives Aimed at Increasing Minority Participation in the Teaching Work Force

Several initiatives supported by Foundations and by non-federal educational organizations have related to increasing minority participation in the teaching work force. They will be drawn upon in the AMP teacher preparation component.

This area has been of concern to the Council of Chief State School Officers (CCSSO). It has also been of concern to the Education Commission of the States (ECS). A set of programs relevant to the AMP teacher preparation component was identified through the 18-month initiative of the Education Commission of the States and its report, *New Strategies for Producing Minority Teachers* (1-3). Significant efforts for recruiting and training additional minority teachers have also been undertaken by the American Association of Colleges for Teacher Education.

Another notable initiative is the Pathways to Teaching Careers program of the DeWitt Wallace-Reader's Digest Fund. This program is designed to support the recruitment and training of new teachers from especially promising pools — including minority students at the pre-collegiate level. The program includes a national campaign to recruit and train new teachers which gives special attention to new teachers from minority groups.

Other foundations have also supported programs relevant to the recruitment and preparation of minority science and mathematics teachers. The Carnegie Corporation of New York, the Rockefeller Foundation, and the Pew Charitable Trusts, have, for example, undertaken initiatives related to minority teacher recruitment and preparation that will be relevant to the AMP teacher preparation component.

Summary

Clearly there are opportunities for significant cooperation in the establishment of a teacher preparation component within the Alliances for Minority Participation program. Partnerships and collaboration are central to the AMP design, and new teacher preparation elements will be based upon expanded alliances that are highly feasible, advisable, and cost-effective.

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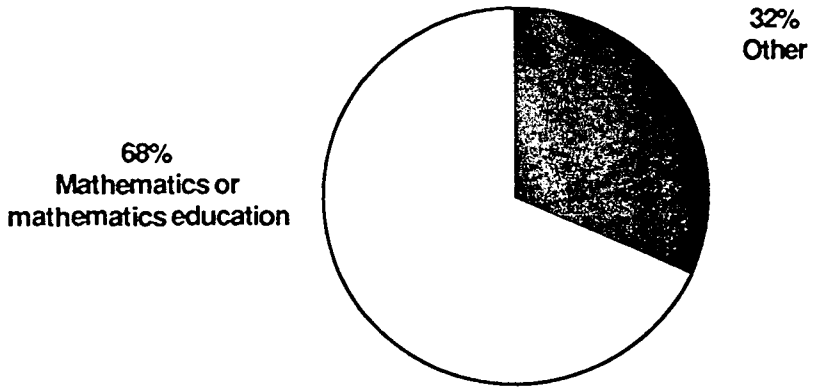
Appendix A

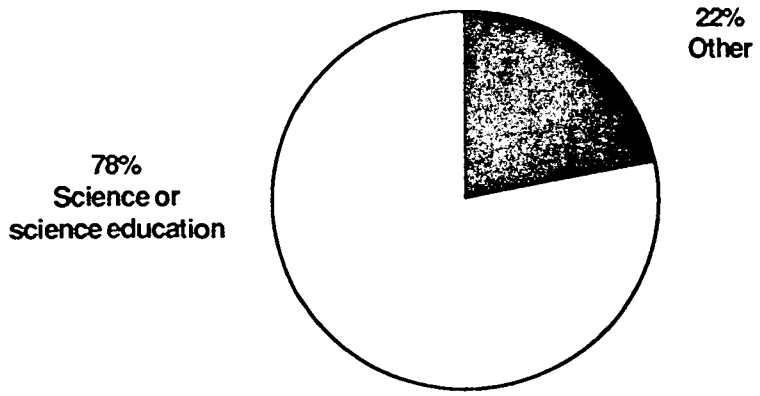
Indicators of Mathematics and Science Teacher Qualifications And Shortages

FIGURE A-1.
Percentage of Mathematics and Science Teachers[1], Grades 9-12, with Degrees[2] in Teaching Field, 1991*

All high school mathematics teachers



All high school science teachers



[1] Primary teaching assignment is science or mathematics

[2] Academic or education majors. Does not include minors or second majors in science, science education, mathematics or mathematics education

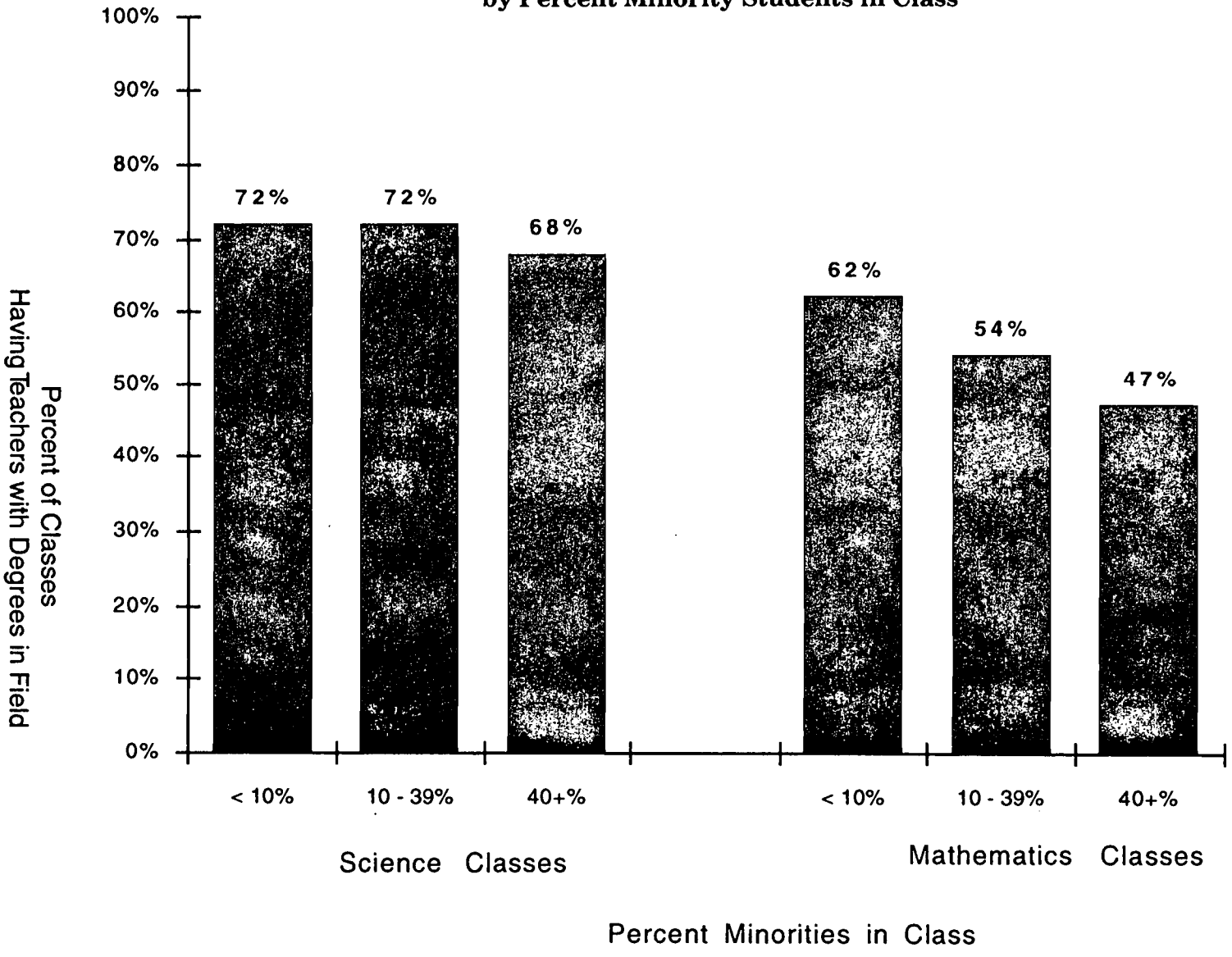
* National Education Goals Panel 1994. *Building a Nation of Learners, Data Volume for the National Education Goals Report, Volume One: National Data.* Washington, DC: US Government Printing Office. Page 89. (Source: National Center for Education Statistics, 1990-91, Schools and Staffing Survey.)

TABLE A-1.
Percentage of Mathematics and Science Teachers, Grades 9-12, with Degrees in Teaching Field, by State*

STATE	MATHEMATICS		SCIENCE	
	Main Assignment % with Major in Math	All Teachers: % with Major in Math	Main Assignment % with Major in Science	All Teachers; % with Major in Science
Alabama	89	87	79	63
Alaska	42	25	79	68
Arizona	68	64	76	69
Arkansas	69	67	58	48
California	44	33	76	62
Colorado	58	49	87	75
Connecticut	80	73	88	85
Delaware	--	--	--	--
Dist. of Columbia	--	--	--	--
Florida	56	52	71	67
Georgia	84	75	87	77
Hawaii	--	--	--	--
Idaho	55	45	77	63
Illinois	69	63	83	77
Indiana	79	68	82	79
Iowa	69	57	82	79
Kansas	82	78	72	66
Kentucky	86	77	85	72
Louisiana	60	55	66	50
Maine	69	62	83	73
Maryland	74	68	91	82
Massachusetts	68	58	86	84
Michigan	76	60	82	70
Minnesota	90	79	87	80
Mississippi	84	80	77	71
Missouri	73	70	79	65
Montana	73	72	75	71
Nebraska	87	76	83	72
Nevada	--	67	--	--
New Hampshire	--	--	--	--
New Jersey	84	75	76	73
New Mexico	55	54	48	41
New York	70	60	89	84
North Carolina	77	73	89	84
North Dakota	79	69	83	63
Ohio	78	71	73	66
Oklahoma	68	65	66	58
Oregon	59	48	90	78
Pennsylvania	84	82	83	78
Rhode Island	--	--	--	--
South Carolina	80	71	79	64
South Dakota	84	67	68	57
Tennessee	56	51	59	52
Texas	59	54	64	56
Utah	65	47	76	66
Vermont	--	--	--	--
Virginia	67	62	78	69
Washington	60	43	76	64
West Virginia	78	74	75	70
Wisconsin	87	75	83	74
Wyoming	85	73	82	77
NATION	**69 %**	**61 %**	**79 %**	**70 %**

* Blank, R. and Gruebel, D. 1993. *State Indicators of Science and Mathematics Education 1993.* Washington, DC: Council of Chief State Schools Officers, State Education Assessment Center. Page 49. (Source: National Center for Education Statistics, 1990-91 Schools and Staffing Survey , Public School Teachers, Washington, DC, US Department of Education, Spring 1991.)

FIGURE A-2.
Percentage of Grade 7-12 Mathematics and Science Classes Taught by Teachers with Degrees in Teaching Field, by Percent Minority Students in Class*



* Weiss, I. 1994. "A Profile of Science and Mathematics Education in the United States, 1993." Chapel Hill, NC: Horizon Research, Inc. Page 22.

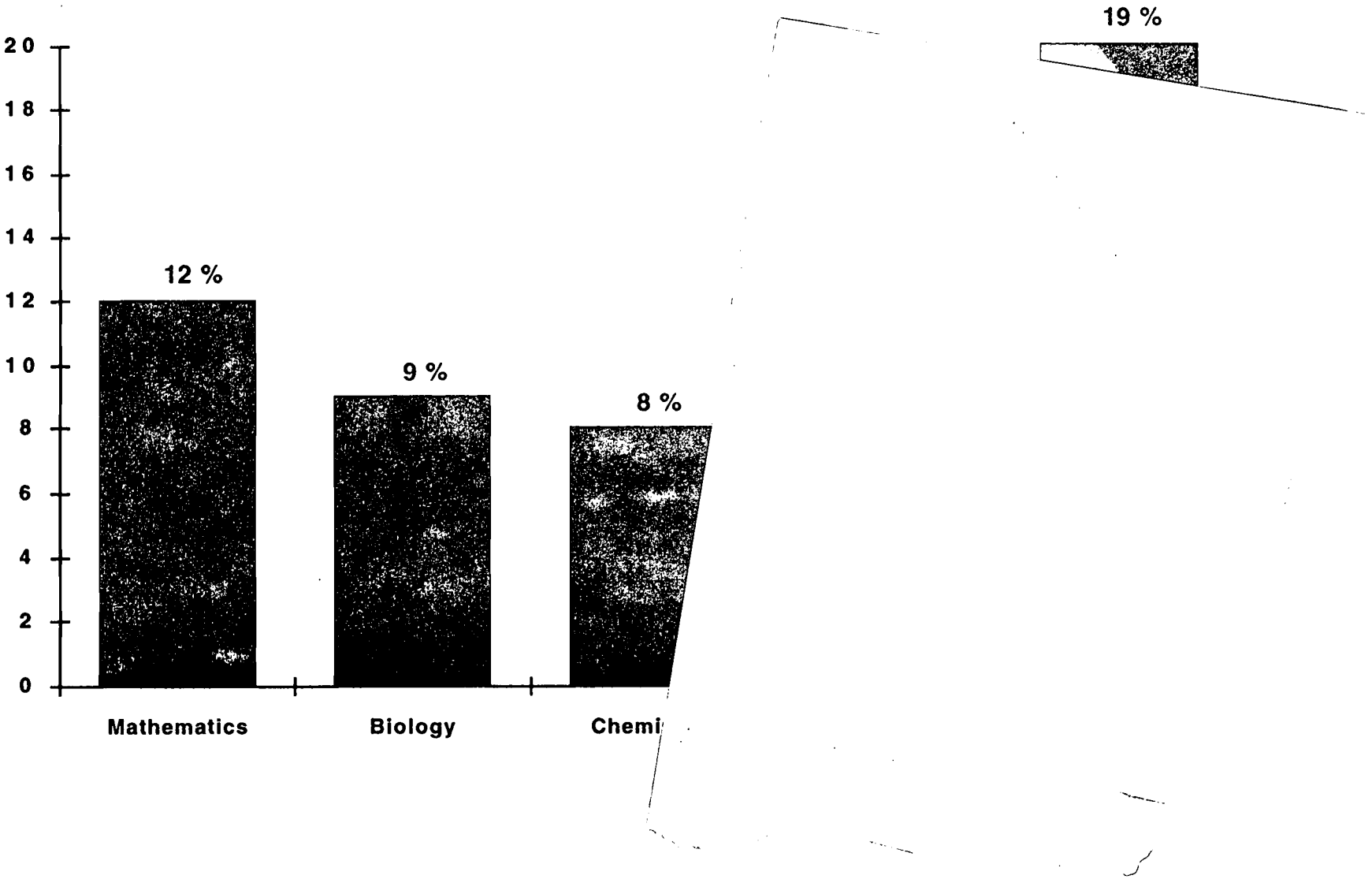
TABLE A-2.
Percentage of Mathematics and Science Teachers, Grades 9-12, Not Certified in Subject Areas, by State*

STATE	Mathematics: % Not Certified	Biology: % Not Certified	Chemistry: % Not Certified	Physics: % Not Certified	Earth Science: % Not Certified
Alabama	4	2	6	19	10
Arkansas	1	2	7	11	9
California	20	18	17	17	9
Colorado	25	7	--	--	--
Connecticut	2	3	2	12	24
Delaware	6	6	0	7	0
Florida	29	19	3	3	28
Idaho	4	4	14	40	11
Illinois	21	22	17	17	8
Indiana	4	4	6	15	35
Kentucky	1	2	2	16	55
Minnesota	2	2	12	11	23
Mississippi	10	20	25	50	14
Missouri	1	4	7	26	35
Montana	1	.4	1	4	5
Nebraska	5	1	0	4	8
New Mexico	.4	.3	0	1	2
New York	8	8	7	16	23
North Carolina	7	3	.2	8	8
North Dakota	0	0	0	0	0
Ohio	10	4	2	3	5
Oklahoma	5	3	4	10	29
Oregon	14	4	--	--	--
Pennsylvania	13	9	9	11	8
Puerto Rico	10	1	1	6	5
Rhode Island	0	0	0	0	0
South Carolina	8	8	6	8	50
South Dakota	1	1	2	7	0
Utah	12	13	13	18	36
Vermont	3	--	--	--	--
West Virginia	5	6	10	12	3
Wyoming	8	4	6	7	3
SUM (32 States)	**12 %**	**9 %**	**8 %**	**13 %**	**19 %**

Note: % Not Certified = Teachers assigned one or more period/class to subject with no state certification in subject.
Colorado: Biology = All science.

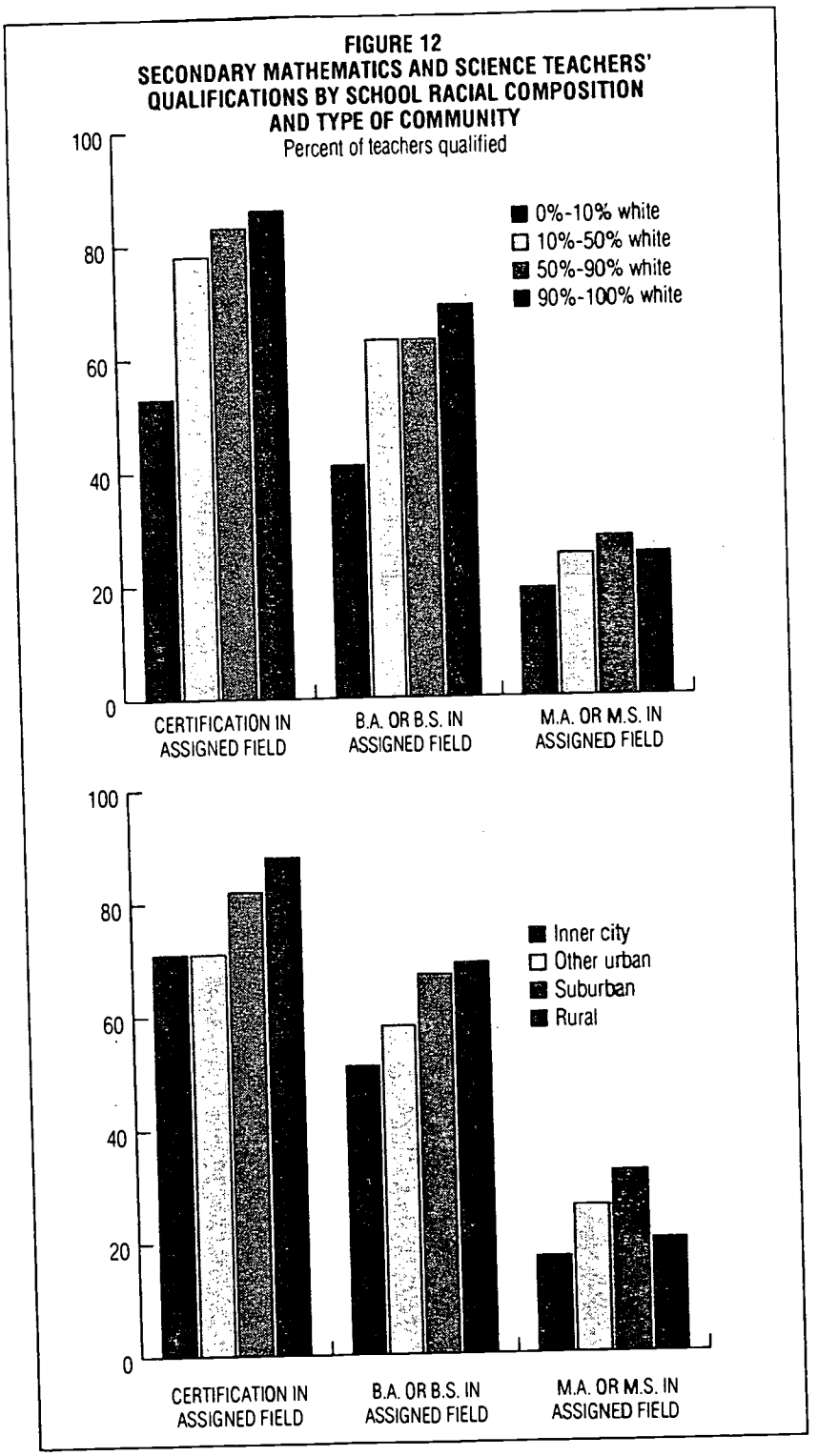
* Blank, R. and Gruebel, D. 1993. *State Indicators of Science and Mathematics Education 1993.* Washington, DC: Council of Chief State Schools Officers, State Education Assessment Center. Page 46. (Source: State Departments of Education, Data on Public Schools, Fall 1991; California, Fall 1990.)

FIGURE A-3.
Percentage of Mathematics and Science Teachers Not Certified (32 States)*



* Blank, R. and Gruebel, D. 1993. *State Indicators of Science and Mathematics Education 1993.* Washington, DC: Council of Chief State Schools Officers, State Education Assessment Center. Page 45. (Source: State Departments of Education, Data on Public Schools, Fall 1991; California, Fall 1990.)

FIGURE A-4.
Secondary Mathematics and Science Teachers' Qualifications, by School Racial Composition and Type of Community*



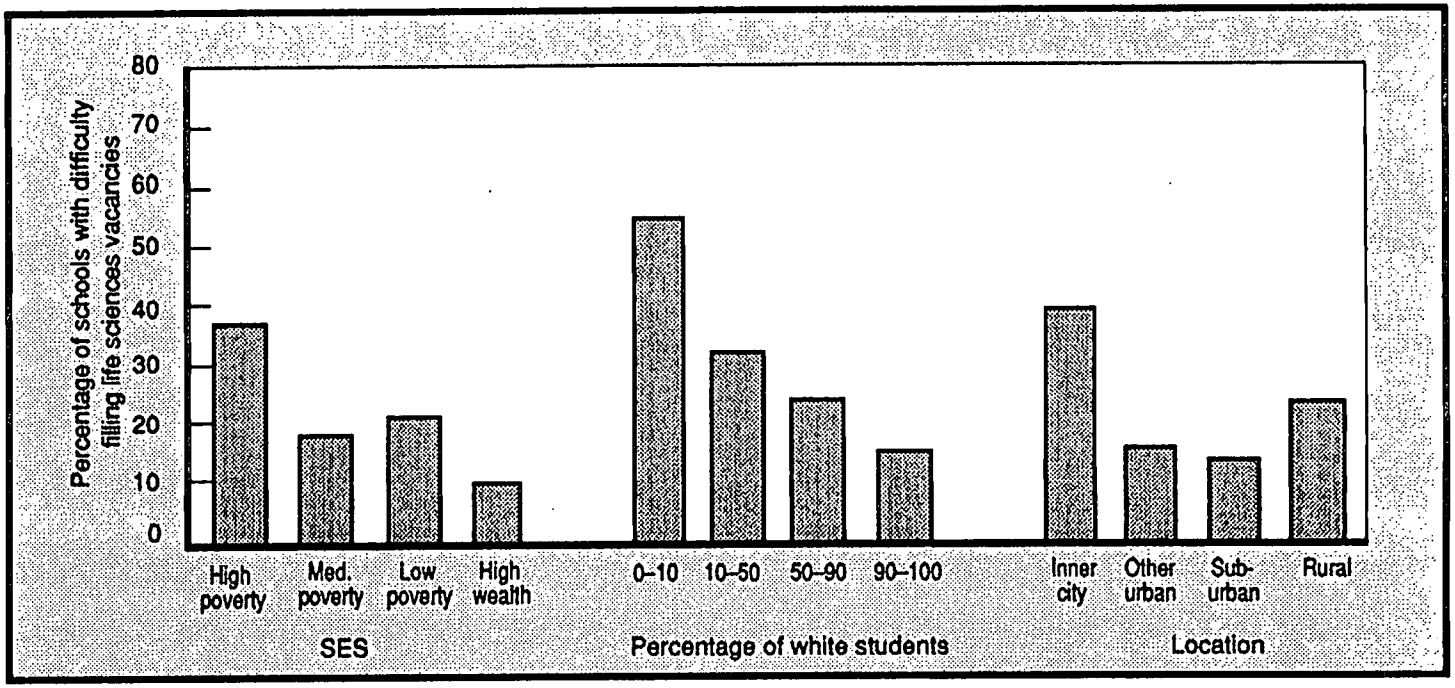
* Oakes, J. 1990. *Multiplying Inequalities, The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science.* Santa Monica, CA: The RAND Corporation. Page 61. Contained in: Blank, R. and Gruebel, D. 1993. *State Indicators of Science and Mathematics Education 1993.* Washington, DC: Council of Chief State Schools Officers, State Education Assessment Center. Page 48.

TABLE A-3.
Certification of High School Mathematics and Science Teachers in Large City Districts*

STATE/City	Mathematics: % Not Certified	Biology: % Not Certified	Chemistry: % Not Certified	Physics: % Not Certified	Earth Science: % Not Certified
California	20	18	17	17	12
10 Large City Districts	29	27	26	27	11
High	34	32	28	28	33
Low	8	0	7	0	0
New York	8	8	7	16	23
3 Large City Districts	11	15	9	12	17
High	11	16	8	13	17
Low	3	1	4	0	3
Ohio	10	4	2	3	5
5 Large City Districts	9	4	3	5	5
High	16	7	9	13	8
Low	5	0	0	0	0

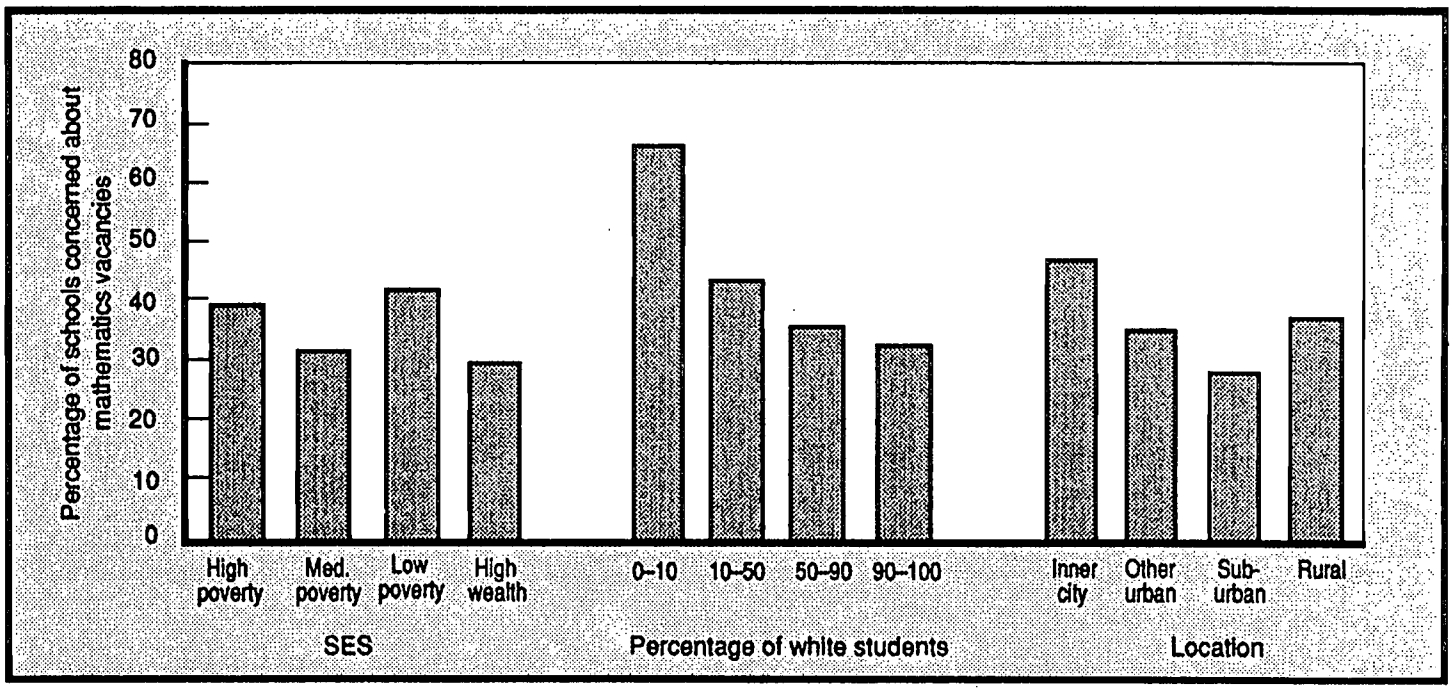
* Blank, R. and Gruebel, D. 1993. *State Indicators of Science and Mathematics Education 1993.* Washington, DC: Council of Chief State Schools Officers, State Education Assessment Center. Page 101. (Source: State Departments of Education, Data on Public Schools, Fall 1991; California, Fall 1990.)

FIGURE A-5.
Percentages of Secondary Schools Where Principals Reported Difficulties Filling Life Science/Biology Teacher Vacancies, by School Racial Composition and Location*



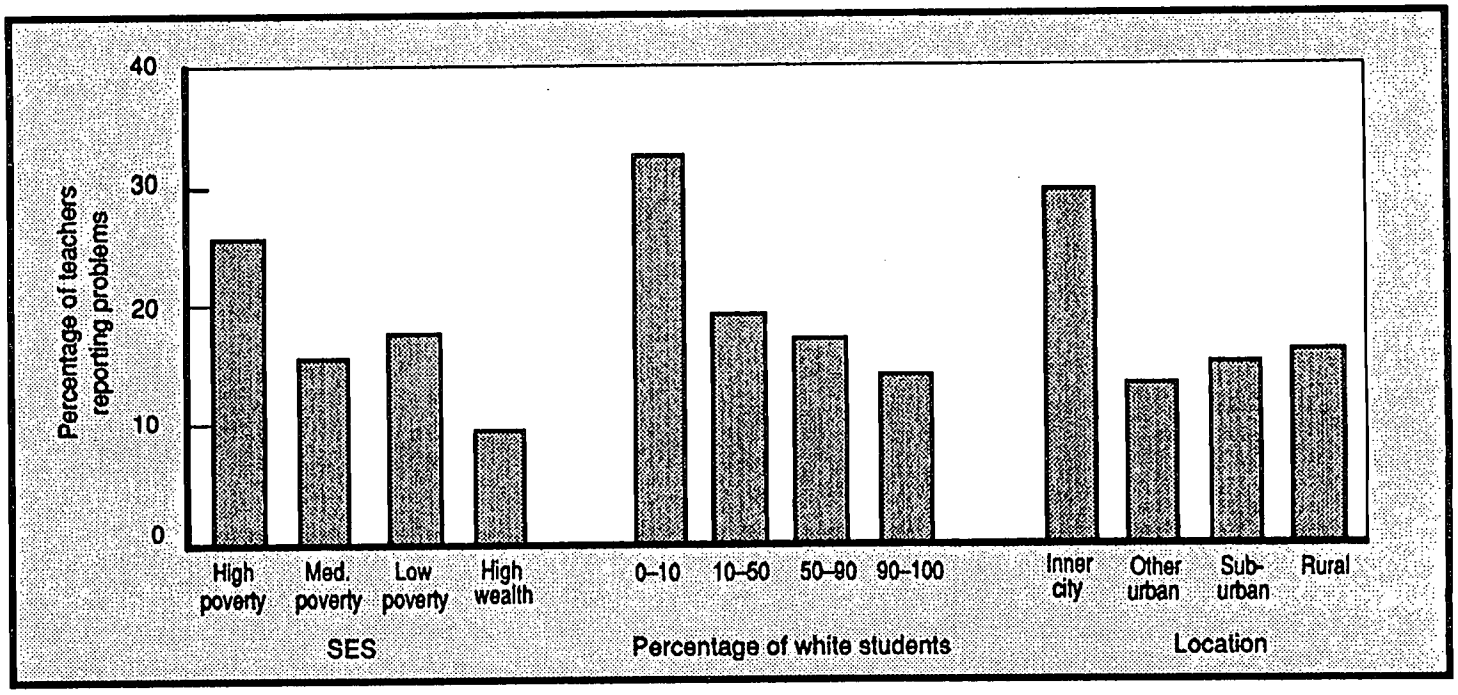
* Oakes, J. 1990. *Multiplying Inequalities, The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science.* Santa Monica, CA: The RAND Corporation. Page 52.

FIGURE A-6.
Percentages of Secondary Schools Where Principals Reported Difficulties Filling Mathematics Teacher Vacancies, by School Racial Composition and Location*



* Oakes, J. 1990. *Multiplying Inequalities, The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science.* Santa Monica, CA: The RAND Corporation. Page 51.

FIGURE A-7.
Percentages of Secondary School Teachers Who Reported Serious Problems Resulting From Lack of Teacher Interest or Preparation in Science and Mathematics, by School Racial Composition and Location*



* Oakes, J. 1990. *Multiplying Inequalities, The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science.* Santa Monica, CA: The RAND Corporation. Page 58.

Appendix B

Minority Participation in the Mathematics and Science Teaching Work Force

TABLE B-1.
Teachers Having Primary Assignments in Mathematics in U.S. Public Schools, 1987-88*

Ethnicity	*Mathematics* Percent	*Computer Science* Percent
African American	8.4	7.5
American Indian	1.0	0.6
Asian/Pacific Islander	1.3	2.1
Hispanic	2.0	1.3
White	86.4	87.4
Other/Missing**	0.9	1.1
Total	100%	100%
	N = 155,452	*N = 14,515*

** These represent cases in which teachers did not respond to the race/ethnicity question in the 1987-88 survey.

* U.S. Department of Education, National Center for Education Statistics. Data are from the 1987-88 Schools and Staffing Survey (SASS).

TABLE B-2.
Teachers Having Primary Assignments in Science in U.S. Public Schools, 1987-88*

Ethnicity	*Biology*	*Chemistry*	*Physics*
	Percent	Percent	Percent
African American	4.8	3.6	2.4
American Indian	1.2	0.5	0.5
Asian/Pacific Islander	1.3	1.8	1.0
Hispanic	1.9	1.7	1.4
White	89.1	90.6	93.4
Other/Missing**	1.7	1.8	1.3
Total	100%	100%	100%
	N = 44,156	*N = 15,458*	*N = 6,800*

Ethnicity	*Geology/Earth Science*	*General Science*
	Percent	Percent
African-American	9.6	8.5
American Indian	0.5	1.1
Asian/Pacific Islander	0.6	.2
Hispanic	2.7	1.4
White	85.6	88.0
Other/Missing**	1.0	.8
Total	100%	100%
	N = 18,116	*N = 47,663*

** These represent cases in which teachers did not respond to the race/ethnicity question in the 1987-88 survey.

* U.S. Department of Education, National Center for Education Statistics. Data are from the 1987-88 Schools and Staffing Survey (SASS).

TABLE B-3.
Teachers Having Primary Assignments in Mathematics in U.S. Public Schools, 1990-91*

Ethnicity	*Mathematics* Percent	*Computer Science* Percent
African American	9.1	6.7
American Indian	.9	.3
Asian/Pacific Islander	1.1	1.4
Hispanic	2.8	2.2
White	86.1	89.4
Total	100%	100%
	N = 162,724	*N = 13,630*

* U.S. Department of Education, National Center for Education Statistics. Data are from the 1990-91 Schools and Staffing Survey (SASS).

TABLE B-4.
Teachers Having Primary Assignments in Science in U.S. Public Schools, 1990-91*

Ethnicity	*Biology*	*Chemistry*	*Physics*
	Percent	Percent	Percent
African American	6.3	4.7	1.4
American Indian	1.0	0.4	0.5
Asian/Pacific Islander	0.6	0.5	1.9
Hispanic	4.7	2.1	0.3
White	87.4	92.3	95.9
Total	100%	100%	100%
	N = 50,992	*N = 18,181*	*N = 7,506*

Ethnicity	*Geology/Earth Science*	*General Science*
	Percent	Percent
African-American	5.1	7.5
American Indian	0.2	0.6
Asian/Pacific Islander	0.4	0.9
Hispanic	2.0	1.7
White	92.3	89.3
Total	100%	100%
	N = 15,182	*N = 50,104*

* U.S. Department of Education, National Center for Education Statistics. Data are from the 1990-91 Schools and Staffing Survey (SASS).

TABLE B-5.
Minority Teachers in Mathematics and Science, by Minority Students in State*

STATE	% Minority Students (K-12)	% Minority Teachers (9 - 12) Mathematics	Biology	Chemistry	Physics	All High School
Maine	3	.2	0	0	0	.3
Idaho	8	2	1	0	1	2
Iowa	8	.4	0	1	1	1
Utah	8	2	2	1	1	3
North Dakota	9	.2	1	1	0	2
Kentucky	10	2	3	1	1	4
Montana	12	1	1	0	0	2
Kansas	14	3	2	4	3	4
Indiana	14	3	3	2	.3	4
Wisconsin	15	2	2	1	1	2
Ohio	16	3	5	2	1	6
Pennsylvania	17	3	5	2	1	6
Rhode Island	17	2	2	5	0	6
Michigan	22	7	3	1	1	8
Connecticut	23	3	3	2	2	5
Colorado	25	5	6	--	--	7
Nevada	26	9	7	3	0	10
Arkansas	27	10	10	6	4	10
Oklahoma	28	5	5	4	1	6
Delaware	30	8	4	0	10	11
North Carolina	32	14	16	11	6	16
Virginia	32	13	14	10	10	15
New Jersey	32	10	7	5	3	10
Illinios	35	11	12	7	4	12
Maryland	38	17	16	--	--	--
Arizona	39	6	5	--	--	10
Alabama	41	18	19	17	15	21
South Carolina	43	22	21	17	15	20
Texas	48	18	17	11	8	19
Mississippi	48	26	30	27	24	31
California	53	18	16	12	9	18
New Mexico	58	20	19	19	15	25
Hawaii	76	71	61	67	59	78
SUM (33 states)	**31%**	**11%**	**10%**	**7%**	**4%**	**11%**

Note: Percent minority teachers = Asian/Pacific Islander, African American, Hispanic, and American Indian. Minority teachers reported under Biology for Colorado, Arizona, Maryland = All science fields

* Blank, R. and Gruebel, D. 1993. *State Indicators of Science and Mathematics Education 1993.* Washington, DC: Council of Chief State Schools Officers, State Education Assessment Center. Page 44. (Sources: (Teachers) State Departments of Education, Fall 1989; (Students) National Center for Education Statistics, 1990-91, Schools and Staffing Survey.)

TABLE B-6.
Percentage of Students with Mathematics Teachers of Different Races and Ethnicities, by Student Characteristics, Grades 4 and 8, 1990*

Grade and student characteristic	Percent of Total	Percent with Teachers who are: White	African American	Hispanic	Teacher's race not reported
Grade 4	100	85	11	2	2
Male	100	85	11	2	2
Female	100	85	11	2	2
White	100	93	5	1	1
African American	100	57	40	2	1
Hispanic	100	75	13	8	4
Grade 8	100	91	5	3	1
Male	100	91	5	3	1
Female	100	91	6	2	1
White	100	95	3	2	0
African American	100	77	21	2	0
Hispanic	100	80	5	13	2

* National Science Foundation, Division of Research, Evaluation and Dissemination, Directorate for Education and Human Resources. 1993. *Indicators of Science and Mathematics Education, 1992.* ed. by Larry E. Suter, Washington, DC. Page 92.

TABLE B-7.
New Minority Teachers in Mathematics and Science, Grades 9-12, by State*

STATE	No. of New 1st Year Math	% Minority of New Math	No. of New 1st Year Science	% Minority of New Science
Alabama	62	6	44	4
Alaska	--	--	--	--
Arizona	--	--	--	--
Arkansas	119	5	39	0
California	537	19	258	18
Colorado	55	5	54	2
Connecticut	12	8	17	9
Delaware	15	7	12	20
Dist. of Columbia	--	--	--	--
Florida	484	21	159	20
Georgia	--	--	--	--
Hawaii	34	47	9	50
Idaho	76	0	28	0
Illinois	111	6	89	4
Indiana	42	0	45	2
Iowa	43	0	28	3
Kansas	45	0	47	2
Kentucky	87	1	38	6
Louisiana	--	--	--	--
Maine	19	--	5	--
Maryland	--	--	--	--
Massachusetts	--	--	--	--
Michigan	192	8	49	2
Minnesota	49	--	45	--
Mississippi	419	15	469	16
Missouri	102	1	82	4
Montana	45	0	26	0
Nebraska	--	--	--	--
Nevada	26	0	17	9
New Hampshire	--	--	--	--
New Jersey	66	12	36	11
New Mexico	53	13	25	28
New York	98	--	118	--
North Carolina	171	10	105	12
North Dakota	24	4	19	0
Ohio	125	2	82	0
Oklahoma	88	2	69	2
Oregon	46	--	9	--
Pennsylvania	101	10	55	11
Puerto Rico	70	100	27	100
Rhode Island	13	8	4	20
South Carolina	76	16	39	2
South Dakota	21	0	20	0
Tennessee	--	--	--	--
Texas	664	24	329	21
Utah	14	7	6	13
Vermont	3	0	5	0
Virginia	--	--	--	--
Washington	--	--	--	--
West Virginia	--	--	--	--
Wisconsin	--	--	--	--
Wyoming	22	0	8	0
SUM (38 states)	**4,229**	**14 %**	**2,519**	**12 %**

* Blank, R. and Gruebel, D. 1993. *State Indicators of Science and Mathematics Education 1993.* Washington, DC: Council of Chief State Schools Officers, State Education Assessment Center. Page 100. (Source: State Departments of Education, Data on Public Schools, Fall 1991; California, Fall 1990.)

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