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ABSTRACT

This study was designed to address two related issues: (1) Why are Blacks, Hispanics, and American Indians underrepresented in science and mathematics-related fields, and (2) Why do students of these minority groups have lower achievement test scores in science and mathematics than other students? Data on a number of home, school, and student variables were collected from the 1988 eighth-grade cohort of the National Education Longitudinal Study. Major findings include: (1) At early ages, all students have equally positive attitudes toward science and mathematics learning in school and have similar aspirations for science and mathematics-related careers, but as they get older, more minority students become unprepared to enter these fields as they fall behind in mathematics and science learning; (2) a larger percentage of minority students come from families in poverty which have fewer learning materials at home such as books and computers, and their parents are more likely than others to have low educational levels and to be unemployed and are less likely to provide adequate mentoring or role models for mathematics and science learning; and (3) these minority students are more likely to attend disadvantaged schools where the overall academic and supporting environments are less conducive to learning, suffer from the lack of persistent effort and active involvement in school, and are in low-track achievement groups. Appendices include data tables; National Center for Education Statistics (NCES) Databases for Studies of Science and Mathematics in Education; Specification of Variables Used in the Study; and a table of Correlation Coefficients for Contextual and Process Variables. (Contains 44 references.) (MKR)

NATIONAL CENTER FOR EDUCATION STATISTICS

Research and Development Report February 1995

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U.S. Department of Education
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February 1995

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# FOREWORD

The purpose of this study is to increase understanding of the lower achievement of black, Hispanic, and American Indian secondary school students in science and mathematics, as compared to white and Asian students. The study is important because the numbers of these minority students are growing and their talents need to be fully developed to keep our country technologically competitive in the modern world.

The study used primarily the base-year and the first follow-up survey data of the National Education Longitudinal Study of 1988 (NELS:88). The study has produced rich information about family resources, school practices, and individual characteristics. The information helps us understand the differences in achievement in science and mathematics between minority students (black, Hispanic, and America Indian) and white students.

This report is a result of a collaborative effort between the National Center for Education Statistics, U.S. Department of Education, and the Division of Science Resources Studies, National Science Foundation. It focuses on eighth and 10th grade students; the next report will focus on 12th graders using their survey responses and school transcript data.

For further information about this study and the databases available for studies in science and mathematics education, readers should contact the Statistical Standards and Methodology Division, National Center for Education Statistics, 555 New Jersey Avenue, NW, Washington, DC 20208.

Susan Ahmed
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Statistical Standards and Methodology Division

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# Executive Summary

This study was designed to address two related issues: Why are blacks, Hispanics, and American Indians underrepresented in science and mathematics-related fields, and why do students of these minority groups have lower achievement test scores in science and mathematics than other students?

This study examined a number of home, school, and student variables selected from a national database on the 1988 eighth grade cohort provided by the National Center for Education Statistics, U.S. Department of Education. The selected variables such as educational activities at home, course work in school, teacher qualification, school environment, and student learning behavior were analyzed separately and jointly. The analysis has produced a number of findings. Some major ones are highlighted below.

1. Underrepresentation of blacks, Hispanics, and American Indians in science and mathematics-related fields reflects in large part the outcomes of their education at all levels. This study found that at early ages all students have equally positive attitudes toward science and mathematics learning in school, and they have similar aspirations for science and mathematics-related careers. As they get older, however, more of these minority students become unprepared to enter or become disinterested in these fields as they fall behind in mathematics and science learning.

2. Black, Hispanic, and American Indian students exhibit lower average achievement test scores in science and mathematics than white and Asian students. A number of phenomena are found to be associated with their lower achievement:

a. A larger percentage of these minority students come from families in poverty, and their parents are more likely to have low educational levels and to be unemployed. Thus, they are less likely to have learning materials and educational activities at home and to participate in educational activities outside of school. Their parents are less likely to provide adequate mentoring or role models for science and mathematics learning and also are less likely to have high educational expectations for them.

b. A larger percentage of these minority students attend disadvantaged schools where the overall academic and supporting environments are less conducive to learning. Their schools have lower achievement scores and more discipline and safety problems. Their schools also do not or cannot place as much emphasis on learning and grade competition as other schools. Students in these environments are less likely to have a strong peer group or community support to encourage them to work hard in school.

c. A larger percentage of these minority students suffer from the lack of persistent effort and active involvement in school. They are perceived more often by teachers as being inattentive and frequently disruptive in class. They are also more likely to fail to complete homework and to perform below their ability.

d. A larger percentage of these minority students reported that they were in a low-track achievement group and non-college preparatory high school program. Consequently, they have received less rigorous academic training and have failed to obtain enough preparation, competence, or motivation to take more higher level courses that prepare them for science and mathematics-related fields.

e. Each of the home, school, and individual factors separately accounts for a small proportion of the achievement differences between these minority students and white and Asian students, based on the results of regression analyses. However, when these variables are considered jointly, their relationship with achievement differences is higher, i.e., the achievement differences are 45 percent less if the students have the same value on all selected variables in the study.

For the purpose of encouraging discussion and exchange of ideas among educators, several ways for reducing the achievement gaps in science and mathematics are suggested below for further research since the current study provides only partial answers to many related questions:

1. The use of holistic approaches for improving learning. Since student learning is associated with multiple factors of family, school, and individual, and each factor accounts for only a small proportion of the differences in science and mathematics achievement among racial/ethnic groups, is it sensible to conclude that any education improvement program will require a systemic approach involving these factors jointly? How likely is it that student achievement can increase significantly simply by improving classroom instructional techniques, for example, without improving the supporting systems outside the classroom?

2. Start improvement programs early. The result of this study shows that regardless of race/ethnicity all students exhibit similar interests in and positive attitudes toward science and mathematics-related careers and aspire equally to higher education at early ages. They begin to withdraw and become less interested in science and mathematics probably in the later stages of their education when they become aware of their lack of adequate preparation. Would programs that work to reduce the achievement gaps at early ages be most helpful? What should be done to reduce the gaps?

3. Improvement programs begin at home. Parents play an important role in student learning in science and mathematics. Many of the activities related to student learning require the commitment of parents to support their child. What can be done to help parents become their child's first teacher, as many educational improvement programs emphasize? How can parents help improve the quality of school education?

4. Focus on disadvantaged schools. Since a larger percentage of black, Hispanic, and American Indian students attend disadvantaged schools, and since the quality of these schools is lower than advantaged schools, should improvement efforts be emphasized or concentrated on the improvement of the overall quality of these schools? Would such an approach significantly narrow the achievement differences among racial/ethnic groups? For example, if schools work with parents and other authorities to place higher emphases on safety, discipline, and learning, if schools improve course offerings and the quality of instruction in science and mathematics, and if schools establish programs that can help students improve their engagement in learning, would students' motivation to learn further be increased and the achievement gaps among racial/ethnic groups be narrowed?

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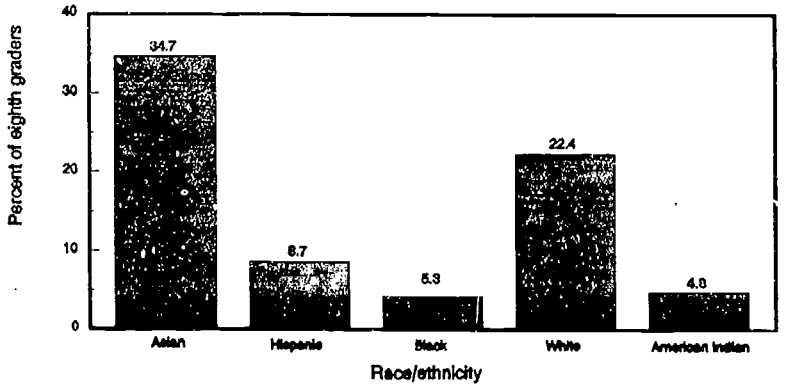
# Chapter 1. Introduction

## A. Background

Ever since the former Soviet Union launched Sputnik almost four decades ago, advancing the education of students in science and mathematics has been a top education priority in the United States. In 1989, President Bush and the State Governors renewed this priority at a historic education summit. They established six National Education Goals, two of which specifically focus on aims for science and mathematics achievement of American students by the year 2000. Two additional goals were later added in the Goals 2000: Educate America Act. Goal 3 states that American students will leave grades four, eight, and 12 with demonstrated competency in core subjects such as science and mathematics. Goal 4 states that U.S. students will become first in the world in science and mathematics (The Goals 2000: Educate America Act).

To reach these national goals, *all U.S. students will require substantial improvement* in their understanding of science and mathematics. Three racial-ethnic groups -- black, Hispanic, and American Indian -- in particular will require greater support because they have a greater distance to travel to meet high performance standards. One indicator of academic success is the percentage of students who are proficient at an advanced mathematics level (i.e., simple problem-solving, including geometry and simple equations). Figure 1.1 shows that 8.7 percent of Hispanic, 5.3 percent of black, and 4.8 percent of American Indian eighth graders in 1988 were proficient at this level, compared to 22.4 percent of white students and 34.7 percent of Asian students (Hafner, Ingels, Schneider, & Stevenson, 1990). A similar pattern was also found in science achievement. Approximately 11.0 percent of Hispanic, 6.3 percent of black, and 9.3 percent of American Indian eighth graders in 1988 had their science test scores in the fourth quartile (highest), compared to 29.7 percent of white and 31.1 percent of Asian counterparts. More information showing these differences in science and mathematics achievement is presented in Appendices A.1 through A.4.

Figure 1.1--Percent of 1988 eighth graders proficient at the advanced mathematics level, by race/ethnicity

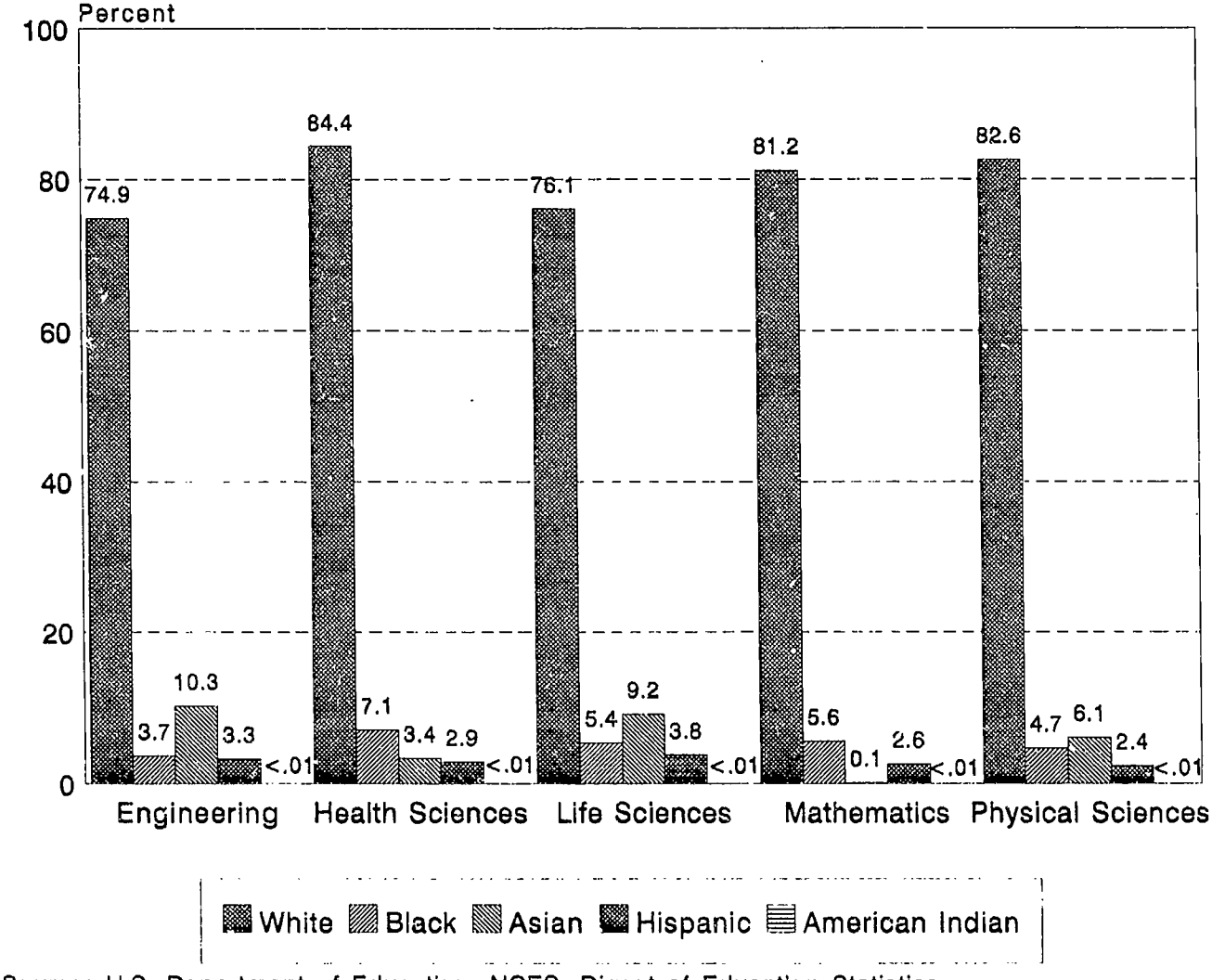



Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student Survey."

The substantial differences in science and mathematics achievement among racial-ethnic groups have raised serious concerns among educators and policy makers. From the nation's point of view, gaps in the education of any of these minority groups in science and mathematics would subsequently affect the quality and quantity of human resources in this country because their populations have been growing at a much faster rate than the white population. As reported by the Bureau of the Census, about 30 percent of the U.S. population will be racial-ethnic minorities by the year 2005, and the percentage is projected to be about 50 percent by the year 2050 (Day, 1993). Failing to improve the education of any specific minority group in science and mathematics could seriously impair the human resources and economic competitive ability of this country. Moreover, having a poor understanding of science and mathematics is disadvantageous for individuals in an increasingly technology-oriented society and labor market. For example, data based on *High School and Beyond* revealed that among the high school class of 1982 who did not go to college, the unemployment rate for students with science and mathematics test scores below the national level was higher than those with scores at or above the national average 20 months after graduation (36.9 versus 28.1 percent). Moreover, among the graduates who were employed at any point during these 20 months, 69.1 percent of those whose science and mathematics scores were below the national average worked as clerks, operative workers, laborers, or service workers -- occupations generally considered to be low-skilled, compared to 58.6 percent of the other students.

In addition, studies have found that high school graduates with low achievement in science and mathematics, who continued their education after high school, were less likely than other students to be in science and mathematics-oriented fields in college (Peng, Fetters, & Kolstad, 1981; Kaufman, 1991). This may in part explain the serious underrepresentation of Hispanics, blacks, and American Indians in science and mathematics-related fields. For example, while blacks and Hispanic each constituted more than 10 percent of this country's population, only 3.7 percent of the total Bachelor's degree recipients in engineering in 1990-91 were blacks, and only 3.3 percent were Hispanic (National Center for Education Statistics, 1993). The percentages were even lower for Master's (1.8 and 2 percent, respectively) and Doctoral degree recipients (approximately 1 percent each). Similar patterns also existed in mathematics and health, life, and physical sciences (figure 1.2). (More detailed data are presented in Appendix A.5.) In summary, it is clear that black, Hispanic, and American Indian students lag behind others in science and mathematics education achievement. Understanding why these differences exist is critical for the well-being of both individuals and society and for determining how to improve science and mathematics education in this country.

Figure 1.2 -- Percent distribution of Bachelor's degrees conferred in 1990-91 by institutions of higher education, by major field of study and race/ethnicity




Source: U.S. Department of Education, NCES, Digest of Education Statistics

## B. Purpose of the Study

The primary purpose of this study is to gain a better understanding of the differences in science and mathematics education among racial-ethnic groups. Among plausible questions, several are examined in this report:

Why are blacks, Hispanic, and American Indians underrepresented in science and mathematics-related fields?

- Is it because a higher proportion of each group chooses non-science fields?
- Is it because they have poorer preparation for science fields in high school and therefore they are less likely to be admitted into and succeed in these fields in college? Is it because they are more likely to drop out from these fields in college?

Why do black, Hispanic, and American Indian students exhibit lower average achievement in science and mathematics than other students in high school based on commonly used assessments?

- Is it because they have fewer learning materials and educational activities and lower parental support and/or lower quality of education in school?
- Is it because they have less positive attitudes toward science and mathematics?

Although these questions are not new and a number of previous studies have addressed such questions (e.g., Lockheed, Thorpe, Broods-Gunn, Caserley, & McAloon, 1985; Cole & Griffin, 1987), they have not been examined completely due to their complexity. Complexity here means that multiple factors affect student learning, and that addressing questions relating to learning fully would require large samples of students using a comprehensive array of measures. Such data have become available only in recent years, allowing simultaneous study of multiple factors and a sorting out of their complex relationships. As in any other social science research, educational research is a continuing search for truth in which tentative answers lead to a refinement of the questions to which they apply. This study builds upon findings of the previous studies by asking more detailed questions about racial-ethnic differences in science and mathematics education. Results of this study should add credence to findings of other previous studies.

More specifically, this study addresses these questions from a multiple-factor point of view. It studies students' educational and learning opportunities and experiences at home and in school, and attempts to identify instructional programs, practices, and resources in school, as well as family and community factors, that are related to the achievement gaps in science and mathematics among racial-ethnic groups.

## C. General Approach for the Study

### 1. Sources of Data

This study extracts information from national databases produced by the National Center for Education Statistics, U. S. Department of Education. The primary data source is the National Education Longitudinal Study of 1988 (NELS:88), a study of the eighth graders of 1988, plus a follow-up in 1990 as 10th graders. (As this study was finalized, data from the NELS:88 second follow-up were released, and data collection for the third

follow-up was completed.) Other data sources are the National Assessment of Educational Progress (NAEP), High School and Beyond (HS&B)--a longitudinal study of the sophomore and senior cohorts of 1980, the National Household Education Survey (NHES), and the Schools and Staffing Survey (SASS). These databases contain rich information about student achievement and educational experiences as well as individual, family, and school characteristics. Detailed descriptions of these databases are presented in Appendix B.

2. Conceptual framework

Previous research studies have provided an array of variables that are related to student learning. For example, studies have found that family resources and learning opportunities at home are highly related to student learning (Clarke-Stewart, 1988; Hess & Holloway, 1984; Scott-Jones, 1984; Wang, Haertel, & Walberg, 1994). As stated by Coleman and his colleagues (1966), what students bring to school from home greatly influences how they perform in school. Studies also have found that student achievement is related to such educational processes as:

(1) quantity of courses taken (Anick, Carpenter & Smith, 1981; Mullis, 1978);

(2) expectations of achievement (Boyd, 1981; Creative Associates, Inc., 1980; Kahle, 1982);

(3) motivation (Banks, McQuater, and Hubbard, 1978; Khoury & Voss, 1985);

(4) field dependency (Ascher, 1983; Creative Associates, Inc., 1980; Kahle, 1982; Ramirez and Castaneda, 1974; Valverde, 1983);

(5) tracking (Brown, Carter, & Harris, 1978; Creative Associates, Inc., 1980; Kahle, 1982; Oakes et al., 1990; Weinberg, 1977);

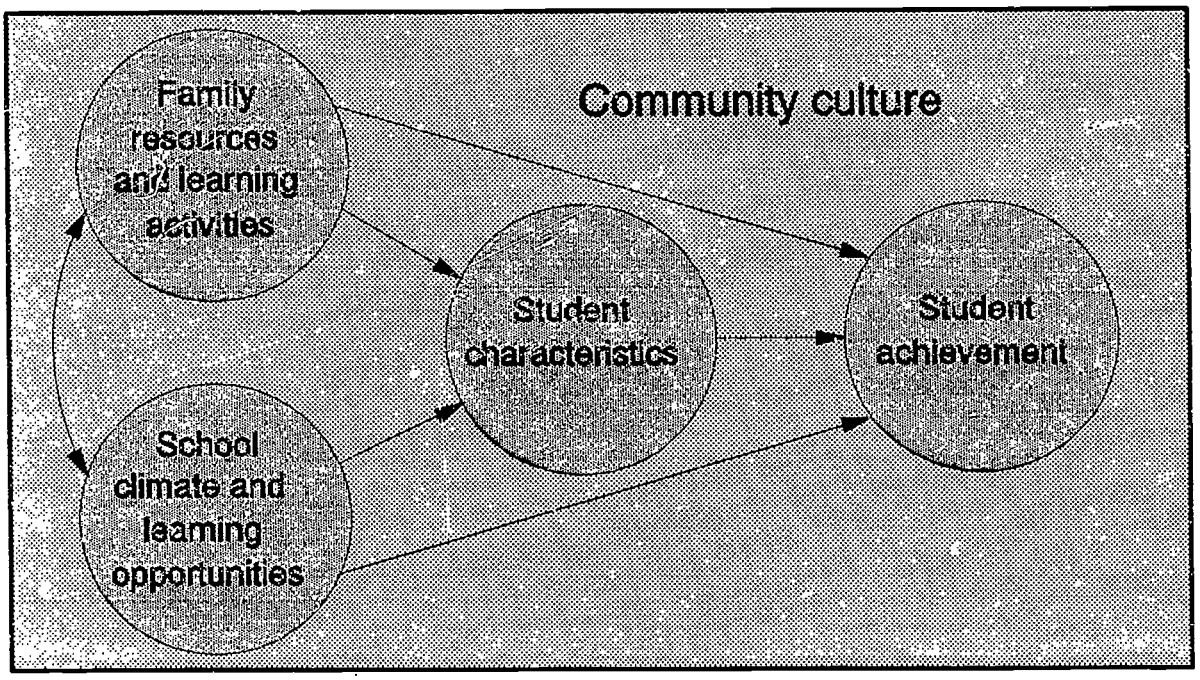
(6) science-related experiences outside of school (Kahle, 1982); and

(7) mentors and role models (Johnson, 1983).

According to Walberg (1981), the following nine categories of variables are related to learning success: (1) ability or prior achievement, (2) motivation, (3) age or developmental level, (4) quality of instruction, (5) quantity of instruction, (6) classroom climate, (7) home environment, (8) peer group, and (9) exposure to mass media. Of these variables, the quality and quantity of instruction in the classroom are of special importance to educators because they are explicit measures of the opportunity to learn.

Furthermore, research literature has revealed that multiple variables of home, school, and individual students are related to student learning. To understand the differences in achievement among racial-ethnic groups, one must consider all these variables independently and jointly. It can be hypothesized that the low achievement of black, Hispanic, and American Indian students in science and mathematics is due to the lower quality and quantity of instruction received at home and in school, the individual differences in aspirations and attitudes, and the general climate of the communities in which these students live. In summary, family resources and learning activities, school climate and learning opportunities, and a student's own characteristics constitute the major factors of student learning. This framework is presented schematically in figure 1.3.

## Figure 1.3--Conceptual framework for studying science and mathematics education




Each factor of student learning is measured by multiple variables which are listed below. The definition and coding scheme for each variable are presented in Appendix C, and the correlation coefficients among variables are shown in Appendix D. It should be noted that many desirable variables such as class size and instructional strategies in the classroom are not included because they are either not available from the database or do not differentiate among racial/ethnic groups based on the results of preliminary analyses.

Family resources and learning activities:

- Poverty level
- Father's occupation
- Mother's occupation
- Father's education
- Mother's education
- Family composition
- Parent/child communication
- Learning materials at home
- Classes outside of school
- Educational activities outside of school
- Parental assistance in homework
- Parental educational expectations for children

School climate and learning opportunities:

- School Socioeconomic Status (SES)
- School type

- School climate
  - Students face competition for grades
  - Discipline is emphasized
  - Students place a priority on learning
  - Teachers encourage students to do their best
  - Teacher morale is high
  - Teachers have positive attitudes toward students
  - Teachers do not have difficulty motivating students
  - Teachers respond to students' individual needs
- Teacher qualification and background
- Teacher attitudes and expectations
- Curriculum requirements
- Tracking system
  - High school program
  - Achievement-level grouping in mathematics classes
  - Achievement-level grouping in science classes

Student characteristics:

- Gender
- Race/ethnicity
- Early start of schooling
- Educational aspirations
- Occupational aspirations
- Attitudes toward science and mathematics education
- Degree of engagement in learning
  - Courses taken -- algebra I, algebra II, geometry, general science, biology, and chemistry
  - Learning behavior -- perform below ability, rarely complete homework, frequently absent, frequently tardy, inattentive in class, and disruptive in class

Achievement:

- Science achievement test scores
- Mathematics achievement test scores

3. Analysis strategies

In order to gain a clear understanding of their complex relationships, an array of variables included in this study were examined individually and then jointly. Two types of analyses were conducted. The first type employed descriptive techniques to show the differences among racial-ethnic groups in, for example, science and mathematics achievement, career aspirations, family characteristics, and the quality and quantity of school instruction. The second type of analysis used statistical modeling techniques to determine the relative importance of selected variables in relation to the student learning differences among racial/ethnic groups.

Because of the multi-level nature of the data (e.g., students within schools), Hierarchical Linear Modeling techniques were considered but not used (Bryk & Raudenbush, 1992). The main reason for not using the techniques was that the number of variables included in the model was too large for the program to work (e.g., the number of individual characteristics variables is larger than the number of sample students within a school). Therefore, the traditional regression analysis technique was applied, and the effect of the clustering design in the sample selection was adjusted by the design effect which was estimated to be 2.54, resulting in conservative tests (see Ingels, Abraham, Karr, Spencer, Frankel, Owings, 1990, pp. 25-28).

Furthermore, because sample students were selected with unequal probabilities,

sampling weights were used to obtain unbiased population estimates in both descriptive and regressional analyses. The sampling weights are the inverse of the sample selection probabilities adjusted for non-responses. The details of weight calculation and the proper use of weights are described in Ingels et al. (1990).

4. Significance Testing

Statistics reported in this study are based on data collected by sample surveys which are subject to sampling variability. Statistics such as means, percentages, and regression coefficients for each group of students, as well as group differences, require proper statistical testing to determine whether they are statistically significant. The process is complicated by the complex sample design of the surveys which require the use of special procedures or adjustment for the variance of a statistic produced by popular statistical analysis packages such as Statistical Program for the Social Sciences (SPSS) or Statistical Analysis System (SAS). For example, the variance of a mean produced by SPSS is smaller than it should be and needs to be adjusted by multiplying it by the design effect which is estimated to be 2.54. A detailed discussion of these procedures can be found in the *User's Manual* (Ingels et al., 1990).

The significance level used throughout this report is .05. Where group comparisons are made, Bonferroni adjusted t-tests are applied. The educational value of group differences or estimates (i.e., practical value) was also considered. This means that in reporting correlation coefficients, regression coefficients, and group differences, many small statistics are not discussed even though they are statistically significant.

Moreover, sample size is a major factor in determining the variance of a statistic and the degrees of freedom in testing statistical significance. Depending on the source of the data used in the analysis, the sample size by race-ethnicity may vary. For example, there are more students in the NELS:88 base-year survey than the first follow-up survey. A detailed breakdown of sample size by survey and race-ethnicity for NELS:88 is shown below.

**Table 1.1--NELS:88 Sample Size**

| | Base-year | First Follow-up |
|---|---|---|
| Asian | 1,527 | 1,030 |
| Hispanic | 3,171 | 2,143 |
| Black | 3,009 | 1,748 |
| White | 16,317 | 12,147 |
| American Indian | 299 | 180 |

## D. Limitations of the Study

This study is based on survey data, most of which are self-reported. While the results of this study show that many family and school characteristics as well as instructional processes are indeed related to student achievement, these variables cannot be regarded as causes for differential student achievement, even though the findings are based on rigorous statistical modeling. Readers should exercise caution in interpreting the results of relational analyses. Nevertheless, the identified variables are good candidates for field studies which might be designed to examine causal relationships. Discussions and debates on these study results should enable researchers to ask better questions in the continuing search for what is true.

# Chapter 2. Differences in Contextual and Process Variables

This chapter presents results of analyses that address two issues:

- How are the variables selected for the study related to student achievement?
- Are there any differences in these variables among racial-ethnic groups since they differ in achievement?

Results show that almost all variables selected for the study are significantly related to student achievement in science and mathematics, confirming many findings from previous studies on student achievement (Wang, Haertel, Walberg, 1994). Results also show significant differences in these variables among racial-ethnic groups, suggesting potential factors of racial-ethnic differences in achievement. Details are presented below.

## A. Relationships of Selected Variables with Student Achievement

Variables in this study (see Section 1.C.2 and Appendix C) were selected because they had been found to be related to student achievement as discussed in the previous chapter. To further verify this assumption, the correlation coefficients for these variables with student achievement test scores in science and mathematics were calculated, using NELS:88 data.

Results of analyses show that family resources and learning activities are all significantly related to both science and mathematics achievement test scores although some of the relationships are moderate (table 2.1). Eighteen of the 24 coefficients are above .23. Of these variables, parental educational expectations, learning materials at home, and father's education have the strongest relationships with achievement (r's ranging from .32 to .44). All variables except for homework assistance have a positive relationship with both science and mathematics test scores. The negative relationship between homework assistance and achievement suggests that eighth graders who need assistance from their parents are more likely to be low-achievers.

All school variables are significantly related to student achievement in science and mathematics (table 2.2). In addition to status variables such as school SES and school type, many process variables have high coefficients with student achievement. These variables are: students face competition for grades, students place a priority on learning, teachers do not have difficulty motivating students, high school program, and mathematics ability groupings. Their coefficients range from .11 to .43.

**Table 2.1--Correlation coefficients (Spearman Rho) between family variables and student science and mathematics achievement test scores**

| Family variable | Achievement test scores | |
|---|---|---|
| | Science | Mathematics |
| Not in poverty | 0.25 | 0.28 |
| Father's occupation | 0.28 | 0.32 |
| Mother's occupation | 0.19 | 0.21 |
| Father's education | 0.32 | 0.35 |
| Mother's education | 0.27 | 0.30 |
| Family composition | 0.14 | 0.14 |
| Parent/child communication | 0.24 | 0.27 |
| Learning materials | 0.32 | 0.35 |
| Classes outside of school | 0.25 | 0.29 |
| Educational activities | 0.25 | 0.27 |
| Homework assistance | -0.07 | -0.08 |
| Parents' educational expectations | 0.36 | 0.44 |

Notes: All correlation coefficients are significant at the .05 level. Definition and coding scheme for each variable are presented in Appendix C.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Parent Survey."

**Table 2.2--Correlation coefficients (Spearman Rho) between school variables and student science and mathematics achievement test scores[1]**

| School variable[2] | Achievement test scores | |
|---|---|---|
| | Science | Mathematics |
| School SES | 0.21 | 0.23 |
| School type | 0.18 | 0.22 |
| Students face competition for grades | 0.11 | 0.12 |
| Discipline is emphasized | -0.03 | -0.04 |
| Students place a priority on learning | 0.16 | 0.19 |
| Teachers encourage students to do their best | 0.07 | 0.07 |
| Teacher morale is high | 0.05 | 0.07 |
| Teachers have positive attitudes about students | 0.07 | 0.09 |
| Teachers do not have difficulty motivating students | 0.14 | 0.17 |
| Teachers respond to students' individual needs | 0.06 | 0.07 |
| High school program[3] | 0.29 | 0.33 |
| Math achievement level grouping[3] | 0.31 | 0.43 |
| Science achievement level grouping[3] | 0.21 | 0.23 |

Notes: [1]All correlation coefficients are significant at the .05 level. [2]Definition and coding scheme for each variable are presented in Appendix C. [3]Program or group in which students were enrolled.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988,"Base-year School Survey."

Table 2.3--Correlation coefficients (Spearman Rho) between student characteristics and student science and mathematics achievement test scores

| Student characteristics | Achievement test scores | |
|---|---|---|
| | Science | Mathematics |
| Sex (M=1, F=0) | 0.07 | 0.03 |
| Race/ethnicity (Asians and whites=1, others=0) | 0.32 | 0.34 |
| Educational aspirations | 0.24 | 0.27 |
| Occupational aspirations | 0.23 | 0.26 |
| Course taken (Y=1, N=0): | | |
| Algebra I | 0.12 | 0.14 |
| Algebra II | 0.31 | 0.40 |
| Geometry | 0.41 | 0.52 |
| General science | -0.18 | -0.21 |
| Biology | 0.19 | 0.22 |
| Chemistry | 0.24 | 0.27 |
| Learning behavior (Y=1, N=0): | | |
| Perform below ability | -0.23 | -0.29 |
| Rarely complete homework | -0.23 | -0.27 |
| Frequently absent | -0.13 | -0.15 |
| Frequently tardy | -0.12 | -0.13 |
| Inattentive in class | -0.22 | -0.26 |
| Disruptive in class | -0.16 | -0.17 |

Note: All correlation coefficients are significant at the .05 level. Definition and coding scheme for each variable are presented in Appendix C.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year and First Follow-Up Student and Base-Year Teacher Surveys."

All student characteristics are related to achievement, and the relationships are in the expected direction. Among these variables, educational and occupational aspirations, advanced course work (algebra II, geometry, chemistry), homework, and attentiveness in class as well as racial-ethnic background have a relatively strong relationship with achievement ($r > .20$).

It is clear from these correlations that almost all of the variables identified for this study are potentially important in overall student learning. The issue, then, is whether these variables can help to explain the differences in science and mathematics achievement among the various racial-ethnic groups. This issue raises two questions: (1) How do students differ in these variables by racial-ethnic group? and (2) how are these differences, if they exist, related to differences in achievement? Answers to the first question are presented in the following sections, and answers to the second question in Chapter 3.

## B. Differences in Home Variables

Overall, the results of our analyses are consistent with previous findings that black, Hispanic, and American Indian students are more likely than white and Asian students to have fewer learning opportunities available at home as measured by family resources and learning activities. While these findings clearly

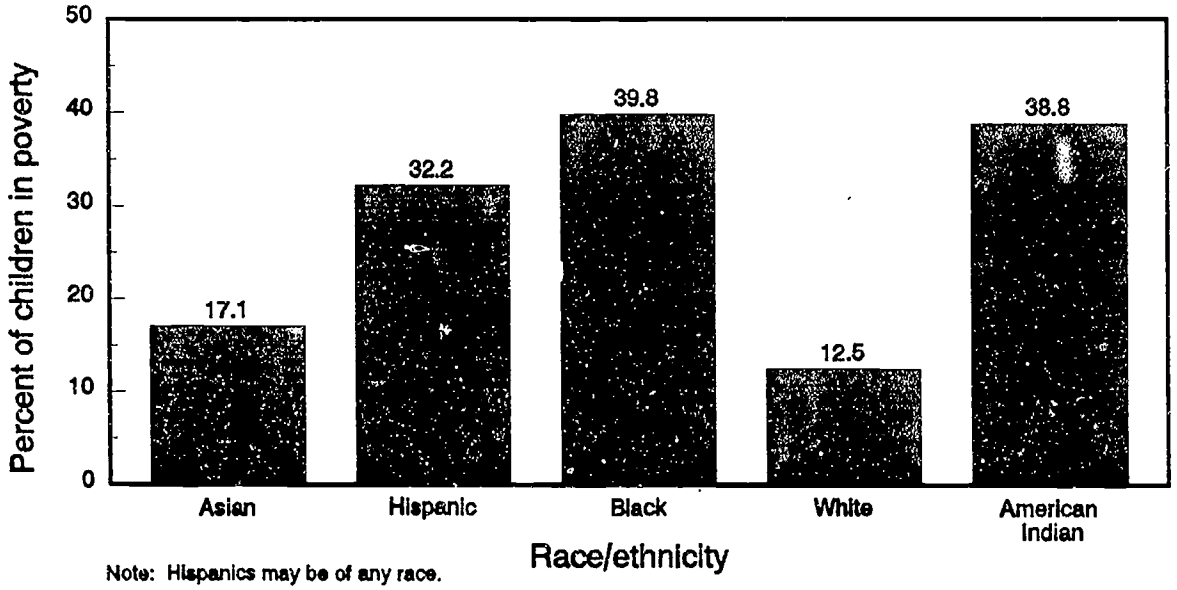
reflect the overall social and economic status of certain groups, they do point out areas where parents can improve the learning climate for their children. They also affirm the importance of programs at the preschool and elementary levels which provide additional resources to students from backgrounds where there are fewer learning opportunities. Details are presented below.

1. Family resources

Major differences among racial-ethnic groups of students are the fiscal and human resources available at home.

First, data show that white students are less likely to come from low-income families (Center for the Study of Social Policy, 1992). The 1990 Census data for children under age 18 show that 39.8 percent of black, 32.2 percent of Hispanic, and 38.8 percent of American Indian children under 18, as compared to 12.5 percent of white and 17.1 percent of Asian children, are in poverty (figure 2.1).

**Figure 2.1--Percent of U.S. children under 18 in poverty, by race/ethnicity: 1990 census**



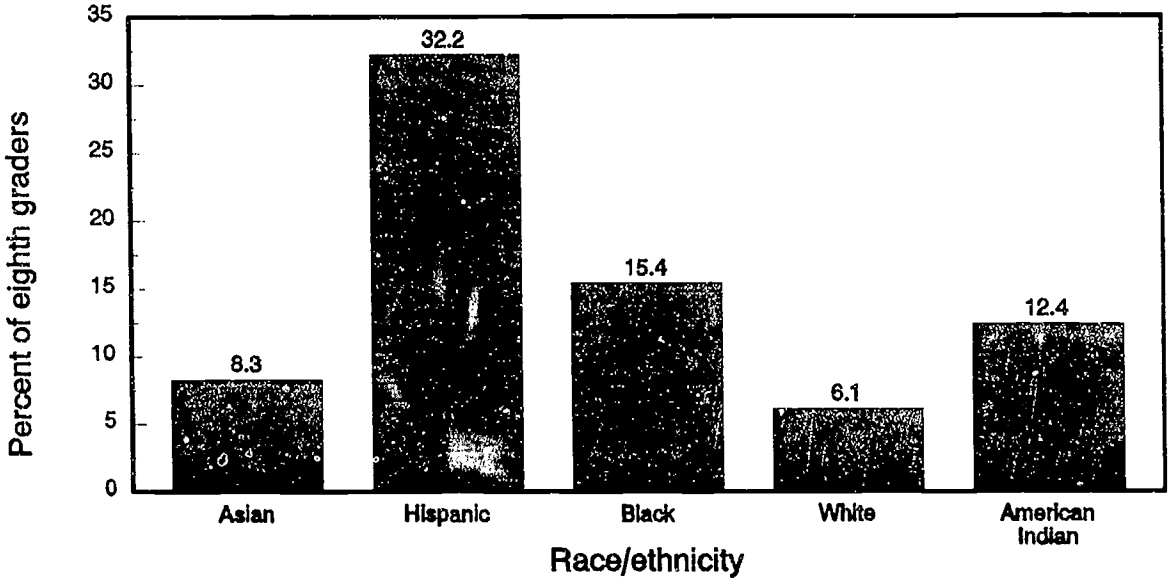

Note: Hispanics may be of any race.

Source: The Challenge of Change: What the 1990 Census Tells Us About Children (Center for the Study of Social Policy, September 1992).

Second, white and Asian students are less likely to have parents with a low educational level and a low-skilled occupation. As NELS:88 data show, 32.2 percent of Hispanic, 15.4 percent of black, and 12.4 percent of American Indian eighth graders, as compared to 6.1 percent of white and 8.3 percent of Asian eighth graders, have parents/guardians who did not finish high school (figure 2.2).

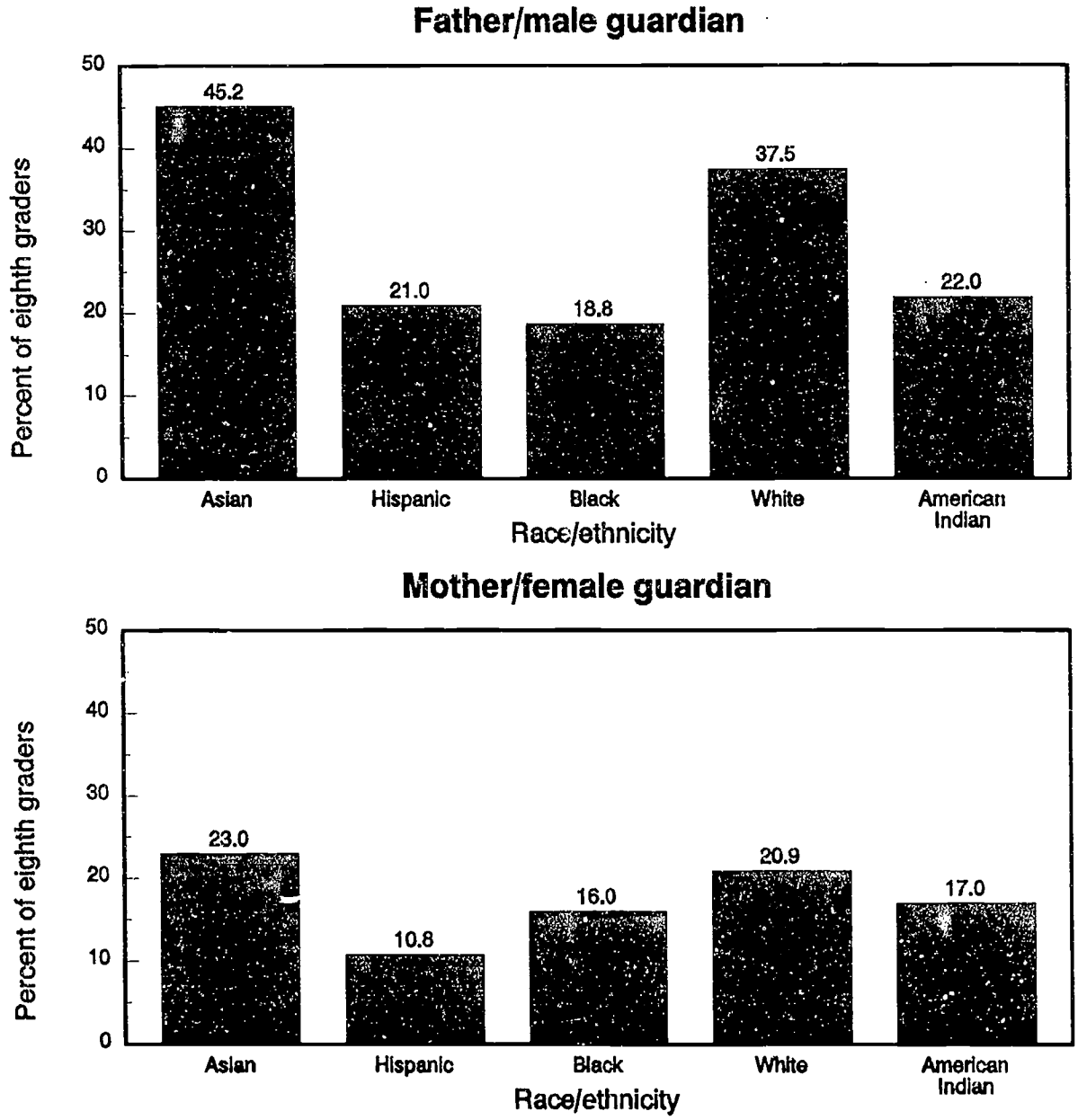
Third, fewer parents of black, Hispanic and American Indian students are in occupations that require higher-level knowledge or skills. For example, only 18.8 percent of the black and 21.0 percent of the Hispanic fathers/male guardians of 1988 eighth graders were employed in high-skill occupations such as professional, manager/administrator, and school teacher. In contrast, 37.5 percent of the fathers of white students were in these occupations. A similar pattern was also found among mothers/female guardians (figure 2.3).

**Figure 2.2--Percent of 1988 eighth graders whose parents did not finish high school, by race/ethnicity**




Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student Survey."

## Figure 2.3--Percent of 1988 eighth graders with parents holding high-skill occupations, by parent's gender and student's race/ethnicity




Note: High-Skill Occupations include the following categories: Professional, Manager/Administrator, Military, Proprietor/Owner, School Teacher, Technical, Protective Service, Farmer/Farm Manager, and Student

Source: U.S. Department of Education, National Center for Education Statistics, Longitudinal Study of 1988, "Base Year Student Survey."

Furthermore, black and American Indian students are more likely than white students to live in a single-parent household (table 2.4). Among 1988 eighth graders, 35.5 percent of blacks and 21.3 percent of American Indians lived with their mothers only, as compared to 12.8 percent of white and 8 percent of Asians. The percentage of Hispanic students living with their mothers only was 17.3 percent.

2. Learning activities at home

A lack of resources may adversely affect the kind of educational experiences students receive at home. First, since fewer black, Hispanic, and American Indian parents are in science and mathematics-related fields (National Science Foundation, 1992a&b), there are fewer role models available at home for students in these fields. As Johnson (1983) and Boyd (1981) found, mentors or role models play an important role in students' career development. The lack of strong mentors or role models at home may be affecting students' perception about the possibility of science and mathematics-related careers for themselves.

Second, black, Hispanic, and American Indian students in general have fewer learning opportunities at home because there are fewer learning materials there; they attend fewer classes outside of their regular school; and they have fewer educational activities provided by their parents (Peng & Lee, 1992). Results of the 1991 NHES reveal that Hispanic and black students are less likely than white students to visit an art gallery, museum, zoo, or aquarium, or to go to a movie, play, concert, or other live entertainment in their early childhood (table 2.5). Similarly, the NELS:88 survey shows that Hispanic, black, and American Indian students are less likely than their white and

**Table 2.4--Family composition of 1988 eighth graders, by race/ethnicity**

| Family composition | Race/ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| Mother and father | 76.0 | 62.1 | 37.7 | 67.3 | 54.8 |
| Mother and male guardian | 5.4 | 11.0 | 13.0 | 11.5 | 12.4 |
| Father and female guardian | 1.8 | 1.9 | 1.8 | 2.8 | 1.7 |
| Mother only | 8.0 | 17.3 | 35.5 | 12.8 | 21.3 |
| Father only | 2.4 | 2.2 | 2.1 | 2.7 | 3.3 |
| Other relative/non-relative | 3.4 | 3.4 | 8.2 | 2.1 | 6.4 |
| Unknown | 3.0 | 2.1 | 1.7 | 0.9 | 0.1 |

Note: Details may not add up to 100 percent due to rounding.

Source: U.S. Department of Education, National Center for Education Statistics, Longitudinal Study of 1988," Base Year Student Survey."

Asian counterparts to visit museums, attend concerts, and borrow books from public libraries under their parents' direction (table 2.6).

As a higher proportion of minority parents did not graduate from high school, they are unlikely to be able to provide adequate help to their children in completing science and mathematics homework. Thus, if other assistance is not available from peers and teachers, minority students would certainly find these subjects to be more difficult and frustrating.

**Table 2.5--Percent of three- to eight-year-old children participating in activities with family members in the last year, by activity and race/ethnicity: 1991**

| Activity | Race/ethnicity | | |
|---|---|---|---|
| | Hispanic | Black | White |
| Visited a library | 29 | 31 | 33 |
| Went to a movie | 28 * | 29 * | 39 |
| Went to a play, concert, or other live show | 31 * | 34 * | 43 |
| Visited an art gallery, museum, or historical site | 30 * | 34 * | 48 |
| Visited a zoo or aquarium | 44 * | 42 * | 59 |
| Visited a playground or park | 14 * | 20 * | 25 |

Note: * indicates that the percent is significantly different from white at the .05 level.
- Asian and American Indian children are not presented because their sample sizes are too small for reliable estimates.

Source: U.S. Department of Education, National Center for Education Statistics, 1991 National Household Education Survey, "Early Childhood Component."

**Table 2.6--Percent of 1988 eighth graders who participated in selected educational activities outside of school, by race/ethnicity**

| Race/ethnicity | Activity | |
|---|---|---|
| | Visited museums and attended concerts | Borrowed books from public library |
| Asian | 71.2 | 89.5 |
| Hispanic | 56.3 | 77.6 |
| Black | 65.5 | 77.8 |
| White | 77.2 | 82.4 |
| American Indian | 49.5 | 72.9 |

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Parent Survey."

Furthermore, fewer parents of Hispanic students have high educational expectations for their children than parents of other children (table 2.7). According to NELS:88 data, 56.7 percent of Hispanic, as compared to 63.4 percent of white and 79.6 percent of Asian parents, expect their children to complete a college education. The percentage for American Indians is 56.3 percent, and the percentage for black students is 61.7 percent, comparable to that for white students (i.e., differences are not statistically significant). The differences are generally greater for males than females. (It is interesting that expectations are higher for girls than boys regardless of race/ethnicity.) Readers should be reminded that a large percentage of Hispanic parents (32 percent) did not finish high school (figure 2.2). Many of them expect their children to have higher education.

## C. Differences in School Variables

Like families, the schools that students attend play a critical role in their science and mathematics education. Various characteristics of schools, including environment, teachers' qualifications, and curriculum programs and practices, are examined in this section.

Overall, analysis results show that black, Hispanic, and American Indian students are more likely than other students to be educated in disadvantaged schools and to be placed in "low-track" instructional programs. It follows that the lower achievement of these three groups of students in science and mathematics, as well as other areas of learning, reflects in

**Table 2.7--Percentage distribution of level of education expected by parents for 1988 eighth graders, by student's sex and race/ethnicity**

| Expected level of education | Race/ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| **All students** | | | | | |
| High school or less | 7.5 | 16.7 | 15.9 | 12.3 | 17.9 |
| Some college | 12.8 | 26.6 | 22.4 | 24.3 | 25.8 |
| College degree | 79.6 | 56.7 | 61.7 | 63.4 | 56.3 |
| **Males** | | | | | |
| High school or less | 9.9 | 18.3 | 17.7 | 13.3 | 22.0 |
| Some college | 13.6 | 26.8 | 23.7 | 24.7 | 31.0 |
| College degree | 76.4 | 55.0 | 58.6 | 62.0 | 46.9 |
| **Females** | | | | | |
| High school or less | 4.9 | 15.2 | 14.2 | 11.3 | 14.1 |
| Some college | 12.0 | 26.4 | 21.1 | 23.8 | 21.4 |
| College degree | 83.1 | 58.4 | 64.7 | 64.9 | 64.5 |

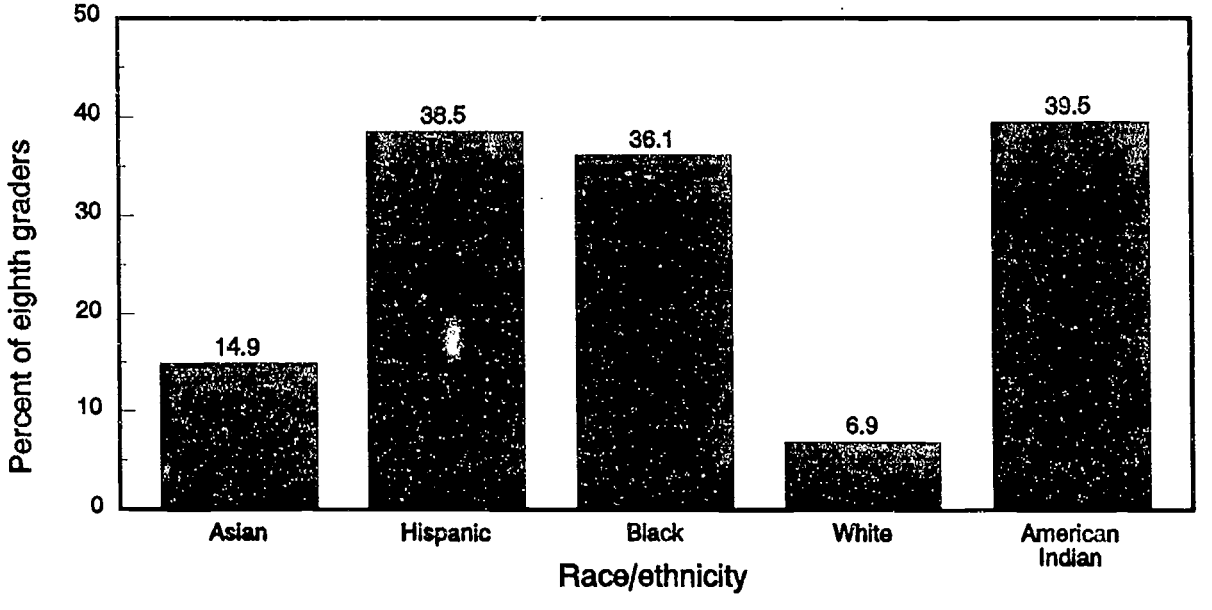
Note: Details may not add up to 100 percent due to rounding.
Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Parent Survey."

part, the poor quality of their schools and academic programs. It would be inappropriate to expect these students to make significant improvements in science and mathematics without improving the overall quality of their schools and providing equal and challenging curriculum programs to them. Details of the analysis results are presented below.

1. School Socioeconomic Status (SES)

Hispanic, black, and American Indian students are more likely than other students to attend schools located in poor communities (figure 2.4). Using NELS:88 data, schools were separated into two categories: a) "disadvantaged" if over 50 percent of the students participated in a free or reduced-price lunch program, and b) "not disadvantaged" if otherwise. A tabulation of students according to these two categories show major differences among racial-ethnic groups in attending disadvantaged schools -- i.e., 36.1 percent of black, 38.5 percent of Hispanic, and 39.5 percent of American Indian students as compared to 6.9 percent of white and 14.9 percent of Asian students. The concentration is particularly evident in urban and rural communities (table 2.8).

**Figure 2.4--Percent of 1988 eighth graders attending disadvantaged schools, by race/ethnicity**




Note: Disadvantaged schools are those schools with 50 percent or more of their students participating in a free or reduced-price lunch program.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student Survey

**Table 2.8--Percent distribution of students, by school status and race/ethnicity within each type of community**

| Type of community | School status | Race/ethnicity | | | | |
|---|---|---|---|---|---|---|
| | | Asian | Hispanic | Black | White | American Indian |
| Urban | Disadvantaged | 20.2 | 42.4 | 50.2 | 10.9 | 53.1 |
| | Advantaged | 79.8 | 57.6 | 49.8 | 89.1 | 46.9 |
| Suburban | Disadvantaged | 12.4 | 30.2 | 13.5 | 3.7 | 17.6 |
| | Advantaged | 87.6 | 69.8 | 86.5 | 96.3 | 82.4 |
| Rural | Disadvantaged | 10.9 | 47.2 | 33.0 | 9.4 | 47.6 |
| | Advantaged | 89.1 | 52.8 | 67.0 | 90.6 | 52.4 |
| Total | Disadvantaged | 14.9 | 38.5 | 36.1 | 6.9 | 39.5 |
| | Advantaged | 84.6 | 61.3 | 64.2 | 92.2 | 60.5 |

Note: Disadvantaged schools are those schools with 50 percent or more of their students participating in a free or reduced-price lunch program.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year School Survey."

In the urban community, about 50.2 percent of black and 42.4 percent of Hispanic students, as compared to 10.9 percent of white students, attend disadvantaged schools. In the rural community, 47.2 percent of Hispanic and 33.0 percent of black students, as compared with 9.4 percent of white students, attend disadvantaged schools. The quality of education in disadvantaged schools is known to be generally less than that in other schools, in part because of the many problems associated with the lack of funding for schools and the reverberating effect of the poverty on their children. This difference is reflected not only in student achievement but also in teacher attitudes, school practices, and school climate. For example, Oakes, Ormseth, and Campbell (1990) found that students in disadvantaged schools have less demanding programs available to them and have limited access to the "gatekeeping" courses (i.e., algebra in junior high school and calculus in senior high school) that prepare them for further study of science and mathematics. In these schools, students are often taught by less qualified teachers who are also less likely to promote active involvement in science and mathematics (National Science Foundation, 1992c, pp.96-98). School administrators' perceptions reported in the NELS:88 survey support this view of disadvantaged

schools (table 2.9). Teachers in such schools are less likely than teachers in advantaged schools to have high morale (68.2 versus 82.0 percent), to have positive attitudes toward students (65.5 versus 81.5 percent), and to be responsive to student needs (75.7 versus 84.6 percent). Moreover, administrators in disadvantaged schools are less likely to perceive students facing competition for grades (32.2 versus 47.2 percent) and placing a priority on learning (49.1 versus 63.5 percent).

2. Type of School

Hispanic, black, and American Indian students are less likely than white students to attend private schools (Catholic and other private schools combined) (table 2.10). Based on the NELS:88 data, 16.6 percent of Asians and 10.5 percent of white tenth graders attend private schools, as compared to 6.6 percent of Hispanic, 5.7 percent of black, and 1.6 percent of American Indian tenth graders. Many American Indian students attend Bureau of Indian Affairs schools on Indian reservations. According to the 1990-91 Schools and Staffing Survey and Common Core of Data, about 10 percent of American Indian students attend such schools. Like many rural schools, the education quality in these schools can be different from that in other non-rural schools.

**Table 2.9--Percent of school administrators reporting selected characteristics, by school socioeconomic status**

| School characteristics | School socioeconomic status | |
|---|---|---|
| | Advantaged | Disadvantaged |
| Students face competition for grades | 47.2 * | 32.2 |
| Students place a priority on learning | 63.5 * | 49.1 |
| Teachers encourage students to do their best | 93.6 | 92.2 |
| Teachers have positive attitudes about students | 81.5 * | 65.5 |
| Teachers don't have difficulty motivating students | 50.3 * | 23.4 |
| Teachers respond to students' individual needs | 84.6 * | 75.7 |
| Discipline is emphasized | 91.7 | 88.7 |
| Teacher morale is high | 82.0 * | 68.2 |

Notes: Disadvantaged schools are those schools with 50 percent or more of their students participating in a free or reduced-price lunch program.

* Indicates that the two types of schools differ significantly at the .05 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year School Survey."

**Table 2.10--Percent distribution of type of school attended by 1990 tenth graders, by race/ethnicity**

| Type of school | Race/ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| Public | 83.4 | 93.4 | 94.4 | 89.4 | 98.4 |
| Catholic | 8.1 | 5.0 | 4.9 | 6.0 | 1.6 |
| Other | 8.5 | 1.6 | 0.8 | 4.5 | -- |

Note: Details may not add up to 100 percent due to rounding. -- 0 or less than .05 percent.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "First Follow-Up Student Survey."

3. School climate

As shown in table 2.9, disadvantaged schools in general have lower measures on a number of school climate variables than advantaged schools. For example, their teachers have lower morale and less positive attitudes about students and are less responsive to student needs. These conditions combined with students' low achievement and lack of emphasis on learning can create an environment that is less conducive to learning. This is an important concern because a larger proportion of black, Hispanic, and American Indian students attend disadvantaged schools and thus are more likely than other students to be exposed to such an environment.

4. Teachers' qualifications and background

Are teachers of black, Hispanic, and American Indian students less prepared and experienced than teachers of other students? The answer to this question depends on the criteria. On the basis of general criteria (i.e., certification, education degree, and tenure of teaching), the answer is mostly negative. Minority students' teachers are not necessarily less prepared than teachers of white students in terms of certification, number of years of teaching, or educational level (tables 2.11, 2.12, and 2.13). For example, the percent of eighth-grade science teachers certified to teach science is 88.2 percent for black students and 83.8 percent for Hispanic students, as compared to 84.8 percent for white students. For eighth-grade mathematics teachers, the percent of teachers certified to teach mathematics is above 80 percent for all students except American Indian students (72.3 percent). Almost all teachers held a Bachelor's degree or higher.

**Table 2.11--Percent of teachers of 1988 eighth graders certified to teach in mathematics and science, by student race/ethnicity**

| Student Race/ethnicity | Subject | |
|---|---|---|
| | Mathematics | Science |
| Asian | 83.9 | 84.1 |
| Hispanic | 81.7 | 83.8 |
| Black | 81.3 | 88.2 |
| White | 84.7 | 84.8 |
| American Indian | 72.3 | 84.5 |

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Teacher Survey."

**Table 2.12--Percent distribution of number of years teachers of 1988 eighth graders have taught, by student race/ethnicity**

| Student Race/ethnicity | Number of years taught | | | |
|---|---|---|---|---|
| | One to three | Four to six | Seven to nine | Ten or more |
| Asian | 7.8 | 7.9 | 11.2 | 73.2 |
| Hispanic | 14.9 | 11.9 | 11.4 | 61.7 |
| Black | 12.6 | 9.4 | 9.6 | 68.4 |
| White | 11.9 | 9.2 | 10.1 | 68.8 |
| American Indian | 11.9 | 9.1 | 11.9 | 67.1 |

Note: Details may not add up to 100 percent due to rounding.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Teacher Survey."

**Table 2.13--Percent distribution of highest degree held by teachers of 1988 eighth graders, by student race/ethnicity**

| Student Race/ethnicity | Highest degree held | | |
|---|---|---|---|
| | Less than Bachelor's degree | Bachelor's degree | Master's degree, education specialist, or PhD |
| Asian | 0.2 | 52.9 | 46.9 |
| Hispanic | 0.3 | 63.2 | 36.5 |
| Black | 0.4 | 54.4 | 45.2 |
| White | 0.2 | 54.7 | 45.1 |
| American Indian | 0.3 | 58.6 | 41.1 |

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Teacher Survey."

Based on subject-matter preparation, however, it is interesting to note that the majority of eighth-grade science and mathematics teachers do not major in their respective field. The percentage is even lower for mathematics teachers of Hispanic and American Indian students. As shown in table 2.14, 33.3 percent of Hispanic students' teachers and 30.5 percent of American Indian students' teachers, as compared to 45.7 percent of white students' teachers major in mathematics or mathematics education. It is probable that many eighth grade teachers received broad training in multiple subject areas since eighth grade teachers may fall under elementary education training in many colleges. Among science teachers, no significant differences are found by subgroups of students except for American Indian students who have a lower percentage of science teachers who majored in science or science education -- 40 percent as compared to 47 percent and above for other groups (table 2.15).

Another topic of interest is whether schools provide minority students with mentors or role models in science and mathematics teachers. NELS:88 data reveal that in eighth-grade mathematics classes, 17.6 percent of Hispanic students are taught by Hispanic teachers, and 32.5 percent of black students are taught by black teachers. In contrast, 93.9 percent of white students are taught by white teachers. A similar pattern is also found in eighth-grade science classes for black and white students, but there is a lower percentage of Hispanic students taught by Hispanic teachers (7.9 percent) (table 2.16). This pattern may reflect a smaller percentage of minority teachers in general. Of the total number of mathematics teachers in secondary schools in 1990, 2.8 percent are Hispanic, 8.2 percent are black, and 0.8 percent are American Indian (Data from SASS 1990). Likewise, of the total science teachers in secondary schools in 1990, 2.8 percent are Hispanic, 5.8 percent are black, and 0.6 percent are American Indian.

**Table 2.14--Percent of the 1988 public school eighth graders, by baccalaureate majors of mathematics teachers and student race/ethnicity**

| Student Race/Ethnicity | Baccalaureate majors of mathematics teachers | | | |
|---|---|---|---|---|
| | Major in mathematics/ math education | Minor in mathematics/ math education | Major in education only | Major in other subject only |
| Asian | 44.1 | 23.5 | 15.0 | 17.5 |
| Hispanic | 33.3 | 28.5 | 17.5 | 20.8 |
| Black | 40.0 | 26.6 | 21.5 | 12.9 |
| White | 45.7 | 27.2 | 17.7 | 9.4 |
| American Indian | 30.5 | 23.5 | 23.4 | 22.6 |

Note: Details may not add up to 100 percent due to rounding. Figures in the table indicate the percent of students taught by teachers with a specific major. For example, 44.1 percent of Asian students were taught by a mathematics teacher with a major in mathematics or math education.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student and Teacher Surveys."

**Table 2.15--Percent distribution of the 1988 public school eighth graders, by baccalaureate majors of science teachers and student race/ethnicity**

| Student Race/Ethnicity | Baccalaureate majors of science teachers | | | |
|---|---|---|---|---|
| | Major in science or sci. education | Minor in science or sci. education | Major in education only | Major in other subject only |
| Asian | 53.3 | 22.6 | 11.4 | 12.6 |
| Hispanic | 46.6 | 20.5 | 16.1 | 16.8 |
| Black | 48.9 | 19.6 | 18.5 | 13.0 |
| White | 48.6 | 24.2 | 15.5 | 11.7 |
| American Indian | 39.9 | 47.7 | 7.1 | 5.3 |

Note: Details may not add up to 100 percent due to rounding. Figures in the tables indicate the percent of students taught by teachers with a specific major. For example, 53.3 percent of Asian students were taught by a science teacher with a major in science or science education.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student and Teacher Surveys."

**Table 2.16--Percent of 1988 eighth graders, by student and teacher race/ethnicity**

| Teacher race/ethnicity | Student race/ethnicity | | |
|---|---|---|---|
| | Hispanic | Black | White |
| **Mathematics teachers** | | | |
| Hispanic | 17.6 | 1.0 | 0.9 |
| Black | 9.9 | 32.5 | 3.5 |
| White | 68.1 | 63.8 | 93.9 |
| Other | 4.3 | 2.8 | 1.7 |
| **Science teachers** | | | |
| Hispanic | 7.9 | 0.5 | 1.2 |
| Black | 7.7 | 32.2 | 3.1 |
| White | 74.6 | 64.6 | 93.9 |
| Other | 9.9 | 2.7 | 1.8 |

Note: Column details for math or science teachers may not add up to 100 percent due to rounding. Figures indicate percent of students taught by teachers with certain race/ethnicity. For example, 17.6 indicates that 17.6 percent of Hispanic students were taught by Hispanic math teachers. Likewise, 32.5 percent of black students were taught by black math teachers.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student and Teacher Surveys."

5. Teacher attitudes and expectations

Teachers have different attitudes toward and expectations for their students. Previous studies have found that teachers expect less from minority students (Kahle, 1982), and that teachers' low expectations have contributed to hindering the progress of minority students in science and mathematics (Creative Associates, Inc., 1980). As mentioned earlier, NELS:88 data show that black, Hispanic, and American Indian students are more likely than other students to attend disadvantaged schools, where teachers are less likely to have positive attitudes toward their students (see table 2.9).

6. Curriculum requirements

There are no obvious differences in the minimum science and mathematics curriculum requirements for students by racial-ethnic group. As shown in table 2.17, the amount of instruction (i.e., number of years) required for science and mathematics is basically the same for all students. This is not surprising because curriculum requirements are set at the state and school district level. The differences lie more in advanced courses being available and/or taken by students. Such differences are discussed in Section C.4.

**Table 2.17--Percent distribution of instruction required for mathematics and science, by student race/ethnicity**

| Subject and amount of instruction | Student race/ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| Mathematics | | | | | |
| No specific amount | 0.2 | 0.2 | 0.3 | 0.1 | -- |
| Full year | 99.8 | 99.8 | 99.7 | 99.9 | 100.0 |
| Science | | | | | |
| No specific amount | 5.7 | 3.0 | 3.2 | 0.7 | 1.9 |
| Full year | 81.4 | 88.4 | 93.4 | 93.4 | 92.7 |
| One-half year | 12.6 | 8.6 | 2.9 | 5.7 | 5.1 |
| Less than 1/2 year | 0.4 | 0.1 | 0.5 | 0.1 | 0.3 |

Note: Details may not add up to 100 percent due to rounding. -- 0 or less than .05 percent.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student and School Surveys."

7. Tracking system

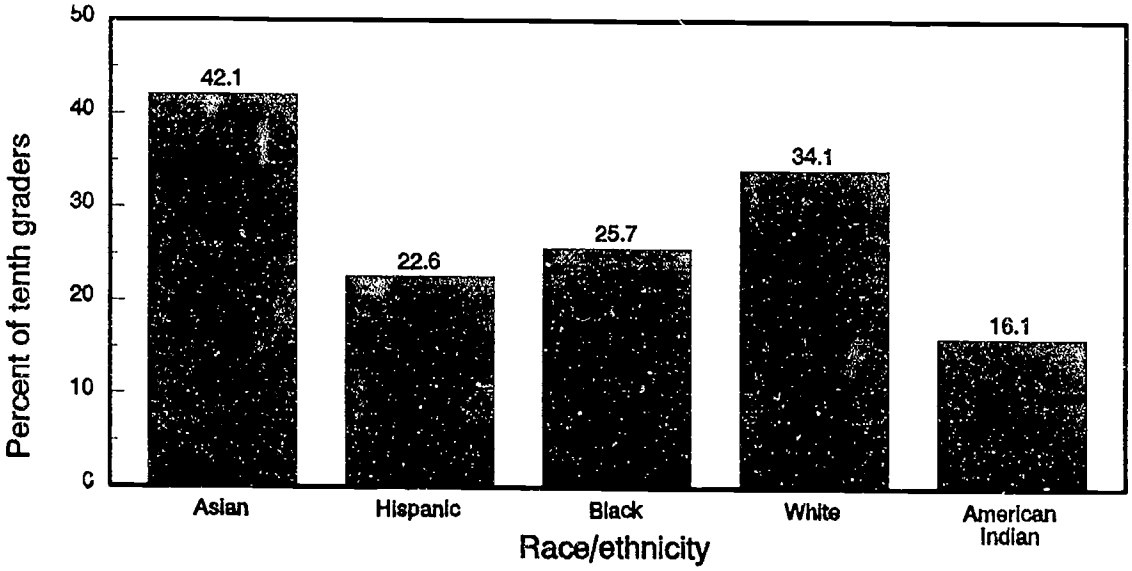
Black, Hispanic, and American Indian students are less likely than other students to be enrolled in the college preparatory, academic, or specialized academic programs where science and mathematics are emphasized. Among 1990 10th graders, 34.1 percent of white and 42.1 percent of Asian students, as compared to 22.6 percent of Hispanic, 25.7 percent of black, and 16.1 percent of American Indian students, report themselves to be in academic programs (figure 2.5 and table 2.18). The differences already existed by the eighth grade as measured by the expected high school programs reported by students (table 2.18). A similar pattern has also been found for 10th and 12th graders by High School and Beyond data collected in 1980 (Peng, Fetters, & Kolstad, 1981).

Considering that minorities had a higher dropout rate (Owings & Peng, 1993), the overall cohort differences in high school program between minority and other students were actually bigger than they are shown here.

Previous research has shown that black, Hispanic, and American Indian students are also more likely to be placed in "low-track" achievement groupings within their schools or classes, and consequently they tend to be excluded from advanced courses (Oakes, Ormseth, & Bell, 1990; Kahle, 1982; Brown, Carter & Harris, 1978). NELS:88 data support these earlier findings. As presented in table 2.19, 24.6 percent of Hispanic and 26.0 percent of black eighth graders, as compared to 32.0 percent of white and 43.3 percent of their Asian counterparts, are in the high-track

group in their mathematics classes. Similarly, 19.3 percent of Hispanic and 11.9 percent of American Indian students, as compared to 23.7 percent of white and 27.2 percent of Asian students, are in the high-track group in their science classes.

**Figure 2.5--Percent of 1990 tenth graders who were enrolled in college preparatory, academic, or specialized academic programs, by race/ethnicity**




Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "First Follow-Up Student Study."

**Table 2.18--Type of High school program expected by the 1988 Eighth Graders, and enrolled by the 1990 Tenth graders, by student race/ethnicity**

| High School Program | Student Race/Ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| **1988 Eighth graders** | | | | | |
| General | 9.8 | 10.6 | 9.7 | 16.0 | 9.2 |
| College prep, academic, or specialized academic | 37.6 | 22.5 | 24.8 | 30.9 | 17.0 |
| Vocational | 17.4 | 22.3 | 25.9 | 15.9 | 22.5 |
| Other specialized program | 4.1 | 5.2 | 5.6 | 5.5 | 7.3 |
| Other | 6.7 | 10.3 | 10.9 | 7.2 | 9.7 |
| Don't know | 24.4 | 29.1 | 23.2 | 24.6 | 34.3 |
| **1990 Tenth graders** | | | | | |
| General | 39.5 | 43.5 | 33.9 | 46.5 | 38.9 |
| College prep, academic, or specialized academic | 42.1 | 22.6 | 25.7 | 34.1 | 16.1 |
| Vocational | 3.6 | 4.5 | 5.3 | 2.2 | 5.5 |
| Other specialized program | 7.9 | 10.6 | 15.2 | 6.7 | 11.9 |
| Other | 3.8 | 7.1 | 8.2 | 4.0 | 5.8 |
| Don't know | 3.0 | 11.1 | 9.1 | 6.0 | 21.0 |
| Never attended high school | -- | 0.7 | 2.5 | 0.5 | 0.9 |

Note: Details may not add up to 100 percent due to rounding. -- 0 or less than .05 percent.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year and First Follow-Up Student Surveys."

**Table 2.19--Percent distribution of 1988 eighth graders, by race/ethnicity, course, and ability group**

| Subject and ability group | Student Race/ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| **Mathematics** | | | | | |
| High | 43.3 | 24.6 | 26.0 | 32.0 | 18.0 |
| Middle | 38.0 | 43.8 | 41.5 | 41.7 | 47.5 |
| Low | 6.0 | 8.8 | 7.3 | 7.0 | 8.0 |
| Not grouped | 9.0 | 17.1 | 20.1 | 14.2 | 20.8 |
| Don't know | 3.7 | 5.7 | 5.1 | 5.1 | 5.6 |
| **Science** | | | | | |
| High | 27.2 | 19.3 | 22.5 | 23.7 | 11.9 |
| Middle | 34.4 | 41.7 | 39.5 | 37.1 | 42.9 |
| Low | 4.6 | 7.2 | 5.9 | 4.8 | 8.7 |
| Not grouped | 27.3 | 23.9 | 25.4 | 28.5 | 28.0 |
| Don't know | 6.6 | 7.9 | 6.7 | 5.9 | 8.5 |

Note: Details may not add up to 100 percent due to rounding.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student Survey."

In general, students tracked into high-track achievement groups receive more challenging and demanding instruction. As indicated by a recent study conducted by the National Research Council, the tradition of tracking students by achievement has worsened failure rates for low-achieving students (Vobejda, 1993).

## D. Differences in Individual Characteristics

In addition to their families and schools, students' personal characteristics such as aspirations, attitudes, and degree of engagement, are associated with their desire and ability to learn. The study examined a number of individual characteristics to determine how they differ by racial-ethnic group. Results of the analysis are presented in the following pages.

Overall, the findings indicate that career aspirations and enjoyment of science and mathematics do not differ by racial-ethnic groups. However, there are group differences in classroom behavior and in the number of advanced science and mathematics courses taken. While many Hispanic, black, and American Indian students like science and mathematics and aspire at a young age to science and mathematics careers, they are reported by teachers to be less likely to exhibit the kind of classroom behavior that is conducive to learning. In addition, they are not enrolled in the kinds of courses that will prepare them for postsecondary science and mathematics studies.

1. Early start of schooling

Because proportionately fewer minority students attend pre-school and kindergarten, some minority children are less likely to be ready for school when they enter the first grade. As shown in table 2.20, Hispanic and American Indian eighth-graders are less likely than white students to have attended nursery or pre-school. Although this situation has improved in recent years, Hispanics still lag behind other groups in attending nursery/pre-school programs, based on data from the 1991 National Household Education Survey. Without additional help, these students may soon find themselves falling behind in school as their "ready for school" peers are prepared to learn more information at a quicker pace.

2. Aspirations

In the NELS:88 survey, students were asked the question: "As things stand now, how far in school do you think you will get?" The responses range from "won't finish high school" and "will go to vocational trade or business school after high school" to "will attend a higher level of school after graduating from college". The distribution of students' responses at the eighth and 10th grades are presented in table 2.21. The results show that Asian students have the highest educational aspirations at both the eighth and 10th grades. A majority of all students, however, expect to have some education beyond high school. A slightly higher percentage of whites than Hispanic, black, and American Indian students expect at least to graduate from college -- 67.1 versus 54.7, 63.8, and 50.7 percent at the eighth grade, and 57.2 versus 42.3, 51.9, and 34.7 percent reported at the 10th grade.

**Table 2.20--Percent distribution of nursery/pre-school attendance of 1988 eighth graders, by race/ethnicity**

| Student Race/ethnicity | Attended nursery/pre-school | | |
|---|---|---|---|
| | Yes | No | Don't know |
| Asian | 52.8 | 44.8 | 2.4 |
| Hispanic | 37.2 | 61.0 | 1.8 |
| Black | 52.1 | 46.6 | 1.4 |
| White | 55.2 | 44.2 | 0.6 |
| American Indian | 41.5 | 57.0 | 1.5 |

Note: Details may not add up to 100 percent due to rounding.
Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Parent Survey."

**Table 2.21--How far in school 1988 eighth graders and 1990 tenth graders expect they will get, by race/ethnicity**

| Educational level | Race/ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| **1988 Eighth graders** | | | | | |
| Not finish high school | 1.5 | 2.6 | 1.4 | 1.3 | 3.5 |
| Finish high school | 5.4 | 14.9 | 8.2 | 10.4 | 15.0 |
| Attend vocational school | 5.0 | 10.7 | 10.2 | 9.2 | 14.7 |
| Attend college | 11.9 | 17.1 | 16.4 | 11.9 | 16.2 |
| Graduate from college | 37.5 | 33.2 | 39.4 | 45.2 | 32.8 |
| Beyond Baccalaureate | 38.7 | 21.5 | 24.4 | 21.9 | 17.9 |
| **1990 Tenth graders** | | | | | |
| Not finish high school | 1.3 | 4.0 | 2.3 | 2.4 | 7.9 |
| Finish high school | 8.1 | 15.9 | 15.4 | 10.5 | 18.5 |
| Attend vocational school | 10.8 | 14.0 | 12.9 | 13.3 | 16.5 |
| Attend college | 12.5 | 23.8 | 17.4 | 16.5 | 22.5 |
| Graduate from college | 29.8 | 23.2 | 25.5 | 31.5 | 19.3 |
| Beyond Baccalaureate | 37.5 | 19.1 | 26.4 | 25.7 | 15.4 |

Note: Details may not add up to 100 percent due to rounding.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year and First Follow-Up Student Surveys."

It is interesting to note that the percentage of students expecting to graduate from college has decreased between the eighth and 10th grade for all racial/ethnic groups. The decreases range from just under 9 percent among Asian students to 16 percent for American Indian students.

Eighth graders in the NELS:88 base year survey also were asked what they expected to be doing when they were 30 years old. Responses were grouped into four broad categories: (1) professional, business, or managerial; (2) technical; (3) science or engineering professional; and (4) others. Results show that black, Hispanic,

and white students do not differ significantly in professional, business, or managerial fields -- around 30 - 32 percent, although Asian students have slightly higher percentages in these areas. As shown in table 2.22, the percentages in the category of professional, business, or managerial fields range from 39.2 for Asian students to 23.7 for American Indian students. Hispanic and American Indian eighth graders generally aspire for science, and engineering professional fields as much as white students.

3. Attitudes toward science and mathematics education

Previous studies have found that black and Hispanic students have positive attitudes toward science and mathematics (Ascher, 1983; Kahle, 1982). Data from recent surveys also confirm this finding. In the 1990 NAEP science assessment, each student was asked to respond to the question "Do you like science?" Results to this inquiry show that there are no significant differences among racial-ethnic groups (figure 2.6a and table 2.23). A similar pattern is also observed for attitudes toward mathematics (figure 2.6.b and table 2.23). One exception is that a higher percentage of Asian students, compared with other students at the fourth and the 12th grade, report that they like mathematics.

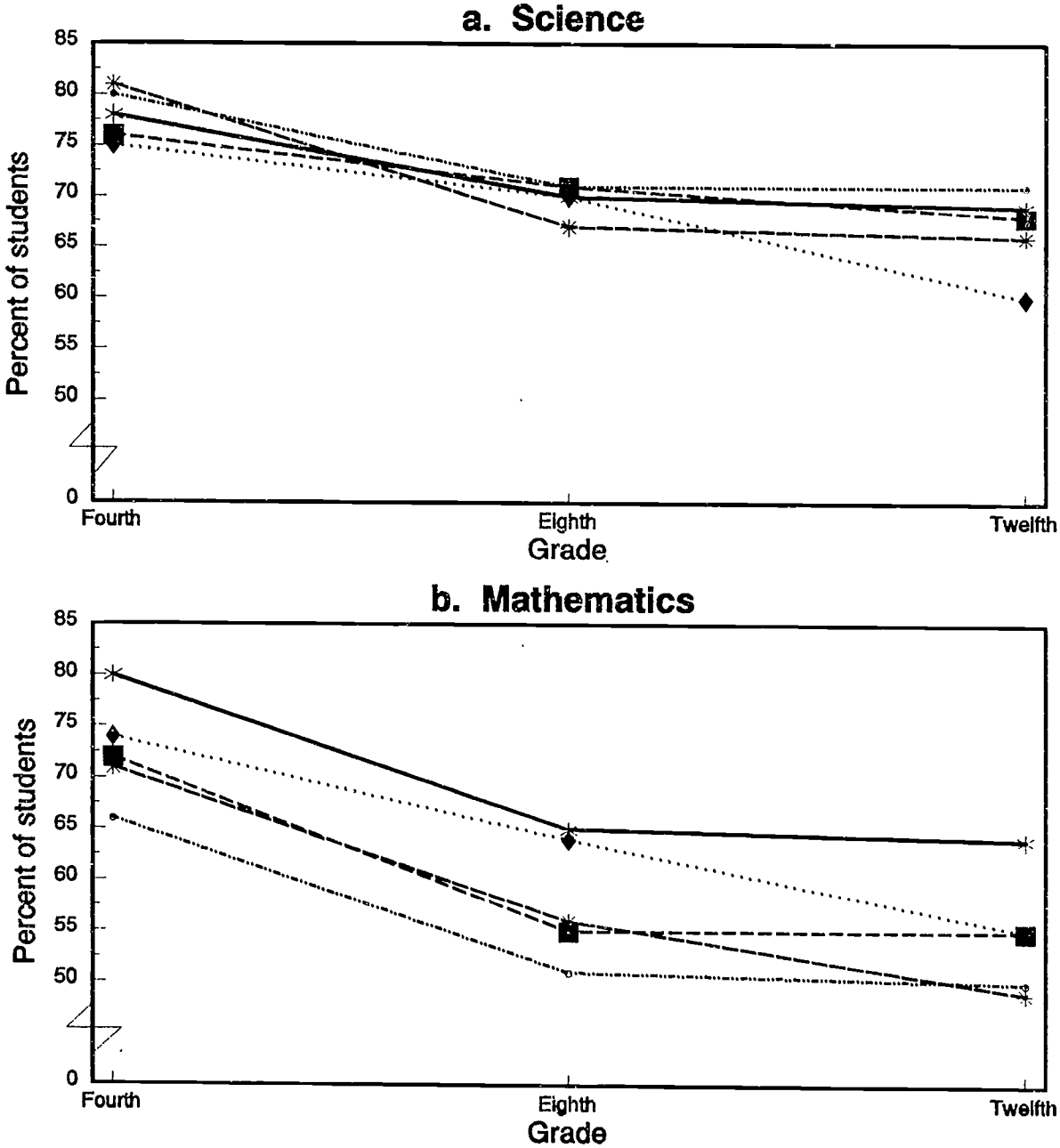
**Table 2.22--Percent distribution of what 1988 eighth graders expect to be doing when they are 30 years old, by race/ethnicity**

| Occupation | Race/ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| Professional, business, or managerial | 39.2 | 29.7 | 32.8 | 32.0 | 23.7 |
| Technical | 8.3 | 8.3 | 8.9 | 6.3 | 5.8 |
| Science or engineering professional | 10.9 | 5.5 | 4.7 | 6.8 | 8.3 |
| Other | 41.6 | 56.5 | 53.6 | 54.9 | 62.1 |

Note: Details may not add up to 100 percent due to rounding.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student Survey."

## Figure 2.6—Percent of students who like science and mathematics, by grade and race/ethnicity




Source: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress, "1990 Science Assessment and 1992 Mathematics Assessment."

**Table 2.23--Percent of students who like science and mathematics, by race/ethnicity and grade**

| Subject and Grade | Race/ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| **Science** | | | | | |
| Fourth | 78 | 76 | 75 | 81 | 80 |
| Eighth | 70 | 71 | 70 | 67 | 71 |
| Twelfth | 69 | 68 | 60 | 66 | 71 |
| **Mathematics** | | | | | |
| Fourth | 80 | 72 | 74 | 71 | 66 |
| Eighth | 65 | 55 | 64 | 56 | 51 |
| Twelfth | 64 | 55 | 55 | 49 | 50 |

Source: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress, "1990 Science Assessment and 1992 Mathematics Assessment."

It is interesting to note that attitudes toward both science and mathematics decline steadily from the fourth to the 10th grade for all racial/ethnic groups. For example, positive attitudes of white students toward mathematics change from 71 percent at the fourth grade to 49 percent at the 12th grade. Similarly, attitudes of black students change from 74 percent at the fourth grade to 55 percent at the 12th grade. Reasons for these changes are not known. It is possible that the degree of complexity of subject matter, the quality of teaching, the school facilities, the curriculum, and the cumulative experience of students in science and mathematics may all contribute in part to these changes. Further studies of this phenomenon are warranted.

In NELS:88, three questions were asked about eighth-graders' attitudes toward science and mathematics: (1) "did they look forward to class?" (2) "were they afraid to ask questions in class?" and (3) "did they think science (mathematics) was important to their future?" Results show that black and Hispanic students are not less positive toward science and mathematics courses than white students (table 2.24). In fact, minority students are more likely than white students to report that they looked forward to both science and mathematics classes. For example, 72 percent of black students as compared to 52.6 percent of white students indicated that they looked forward to mathematics classes.

However, Hispanics and American Indians are more likely than other students to be reluctant to ask questions in the classroom. This observation is consistent with other studies of American Indian students (e.g., Cole & Griffen, 1987). These minority students may, therefore, get less help from teachers, and consequently learn less in the classroom.

**Table 2.24--Percent of 1988 public school eighth graders reflecting different attitudes toward mathematics and science, by race/ethnicity**

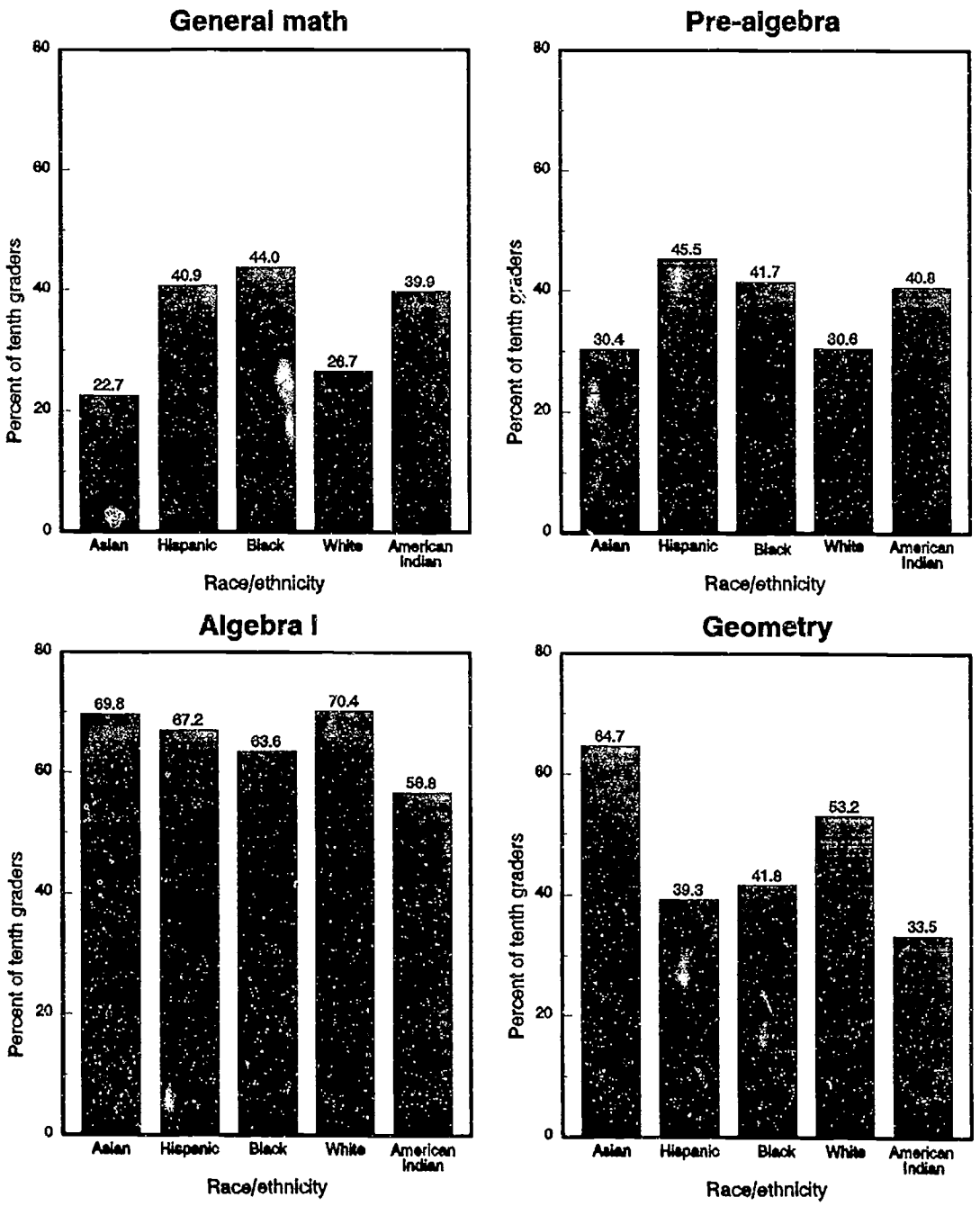
| Subject and race/ethnicity | Attitudes toward class | | |
|---|---|---|---|
| | Look forward to class | Afraid to ask questions | Important to future |
| **Mathematics** | | | |
| Asian | 66.3 | 21.4 | 90.3 |
| Hispanic | 62.7 | 27.8 | 88.7 |
| Black | 72.0 | 20.8 | 89.0 |
| White | 52.6 | 19.8 | 87.5 |
| American Indian | 54.8 | 33.4 | 82.5 |
| **Science** | | | |
| Asian | 68.6 | 14.3 | 76.5 |
| Hispanic | 67.3 | 20.5 | 70.6 |
| Black | 68.7 | 18.0 | 72.7 |
| White | 60.6 | 12.9 | 68.2 |
| American Indian | 69.7 | 31.7 | 77.0 |

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student and Teacher Surveys."

4. Degree of engagement in learning

a. Courses Taken. The number and type of courses taken at the high school level are directly related to achievement (Anick, Carpenter, & Smith, 1981; Mullis, 1978). Several nationally representative data sets have provided evidence that differences exist among racial-ethnic groups in opportunities for learning advanced mathematics. Black, Hispanic, and American Indian students are more likely than white and Asian students to take general rather than advanced science and mathematics courses. As shown in figure 2.7, about 40 percent of black, Hispanic, and American Indian 10th graders, compared to about one-fourth of white and Asians, take general mathematics. Pre-algebra also shows a similar pattern. Slightly more Asian and white students take algebra I. Approximately 70 percent of these two groups, compared to 63.6 percent of black and 67.2 percent of Hispanic students, take algebra I. The differences among students who have taken geometry, however, are substantial. Almost two-thirds of the Asian students have taken geometry by the 10th grade, whereas just over half of the white students have taken it. About 40 percent or fewer students in the other groups have taken geometry. Since algebra and geometry are prerequisites for calculus, these data suggest that fewer Hispanic, black, and American Indian students would be prepared to take calculus by the 12th grade. Thus, the difference in mathematics education for these three groups is likely to be even larger at the end of high school.

## Figure 2.7–Percent of 1990 tenth graders with current or past exposure to mathematics, by course and race/ethnicity




Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "First Follow-Up Student Survey."

Likewise, HS&B data show significant differences among racial-ethnic groups in mathematics coursework in secondary education. Based on data from the transcripts of the high school class of 1982, 72.5 percent of white students, as compared to 49.5 percent of Hispanic and 44.2 percent of black students, are classified as moderate or high mathematics concentrators (figure 2.8). High concentrators are those students who have earned four or more credits in mathematics with credits in at least one advanced course such as analytic geometry, pure mathematics, solid geometry, analysis, calculus, mathematics 3, or statistics and probability. Moderate concentrators are those students who have earned four or more credits in mathematics with credits in at least one of the following courses: algebra I, II, or III, geometry, plane geometry, trigonometry, or mathematics 1 or 2. Students are classified as general mathematics students if they have earned one or more credits in mathematics with less than two credits in college preparatory courses. Students are classified as limited/non-participants if they have earned less than one credit in mathematics (Kaufman, 1991). Similar differences are also found with data from the 1992 NAEP mathematics assessment. Results are presented in tables 2.26 and 2.27). White and Asian students take more semesters of high school mathematics than do students in the other three groups, and are more likely to take Algebra III and Calculus.

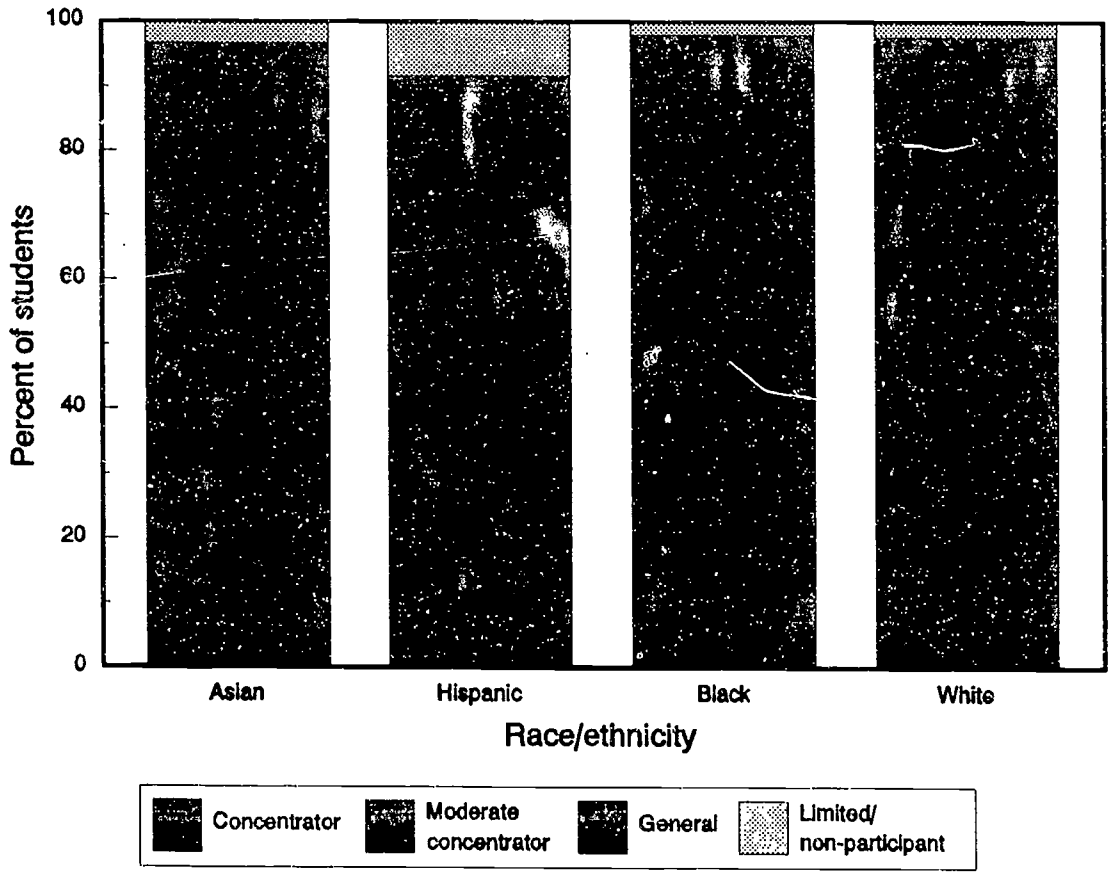
The implications of course taking are quite clear: the more advanced courses students take, the more they learn. As shown in figure 2.9, mathematics proficiency increases for all racial/ethnic groups as the number of semesters of mathematics taken increases. Moreover, figure 2.10 shows that Asian and white students not only have higher mathematics proficiency scores than minority students, they have more coursework in mathematics.

As for science, the picture is less clear in the 10th grade. In general, all racial-ethnic groups are exposed similarly to all types of science courses (figure 2.11 and table 2.28). However, the differences among groups become substantial by the time they graduate--a reflection of the course-taking pattern in the latter two years of high school. As shown by data from the transcripts of the high school class of 1982, about 60 percent of white students, compared to 35.0 percent of Hispanic and 37.9 percent of black students, are classified as moderate or high science concentrators (figure 2.12). (American Indians are not presented here because their sample size is too small.) High concentrators are those students who have earned one or more credits in biology, chemistry, and physics in addition to any credits in general science. Moderate concentrators are students who have earned one or more credits in advanced physical science or advanced life science in addition to any credits in general life or physical science (Kaufman, 1991). It is notable that almost three fourths of Asian students are classified as high or moderate concentrators.

## Figure 2.8--Percent of postsecondary students with specified high school mathematics patterns, by race/ethnicity

| Race/ethnicity | High school mathematics course pattern | | | |
|---|---|---|---|---|
| | Concentrator | Moderate concentrator | General | Limited/ non-participant |
| Asian | 29.9 | 52.7 | 14.3 | 3.1 |
| Hispanic | 10.5 | 39.0 | 42.3 | 8.3 |
| Black | 6.1 | 38.1 | 53.9 | 1.9 |
| White | 18.8 | 53.7 | 25.3 | 2.2 |

Note: Details may not add up to 100 percent due to rounding.




Source: U.S. Department of Education, National Center for Education Statistics, High School and Beyond, "Third Follow-Up Survey, Sophomore Cohort."

**Table 2.25--Percent distribution of the number of semesters of high school mathematics courses taken in grades 9 through 12, by race/ethnicity**

| Number of semesters | Race/ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| Zero to three | 4 | 20 | 21 | 12 | 24 |
| Four to five | 15 | 19 | 27 | 18 | 22 |
| Six to seven | 17 | 30 | 19 | 26 | 26 |
| Eight or more | 64 | 30 | 32 | 44 | 28 |

Note: Details may not add up to 100 percent due to rounding.

Source: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress, "1992 Twelfth Grade Mathematics Assessment."

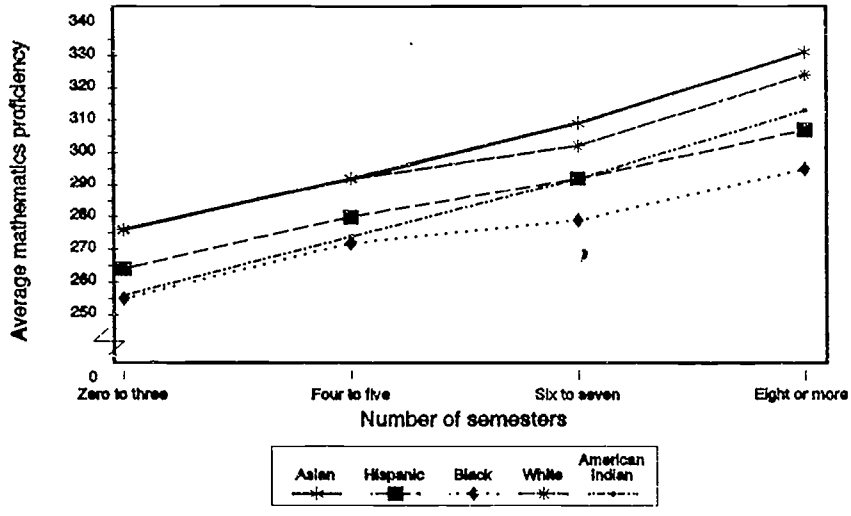
**Table 2.26--Percent distribution of algebra course taking of the 1992 12th graders, by race/ethnicity**

| Algebra course taking | Race/ethnicity | | | |
|---|---|---|---|---|
| | Asian | Hispanic | Black | White |
| Have not studied algebra | 1 | 7 | 8 | 5 |
| Only taken pre-algebra | 4 | 9 | 8 | 5 |
| Only taken algebra I | 20 | 34 | 37 | 27 |
| Taken algebra II but not beyond | 45 | 40 | 38 | 45 |
| Taken algebra III or pre-calculus | 12 | 6 | 7 | 12 |
| Taken calculus | 17 | 4 | 3 | 5 |

Note: Details may not add up to 100 percent due to rounding.

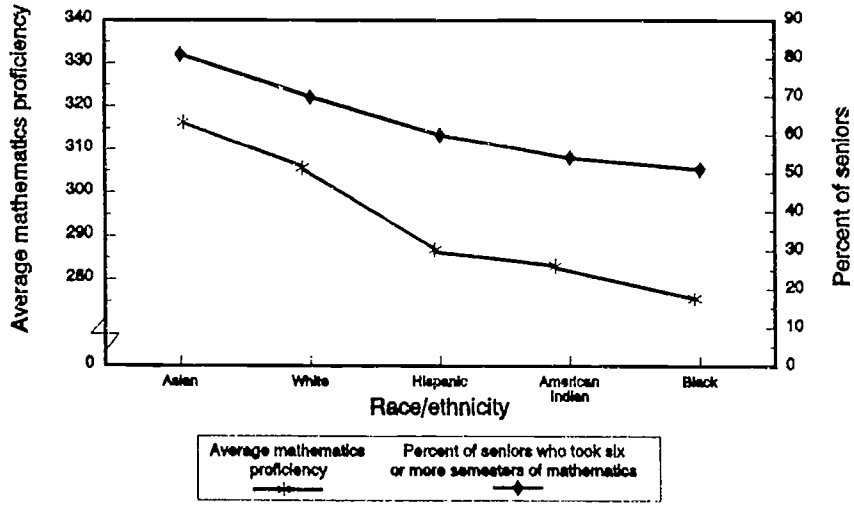
Source: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress, "1992 Twelfth Grade Mathematics Assessment."

**Figure 2.9--Average mathematics proficiency of high school seniors, by race/ethnicity and number of semesters of mathematics courses taken in grades 9 through 12**



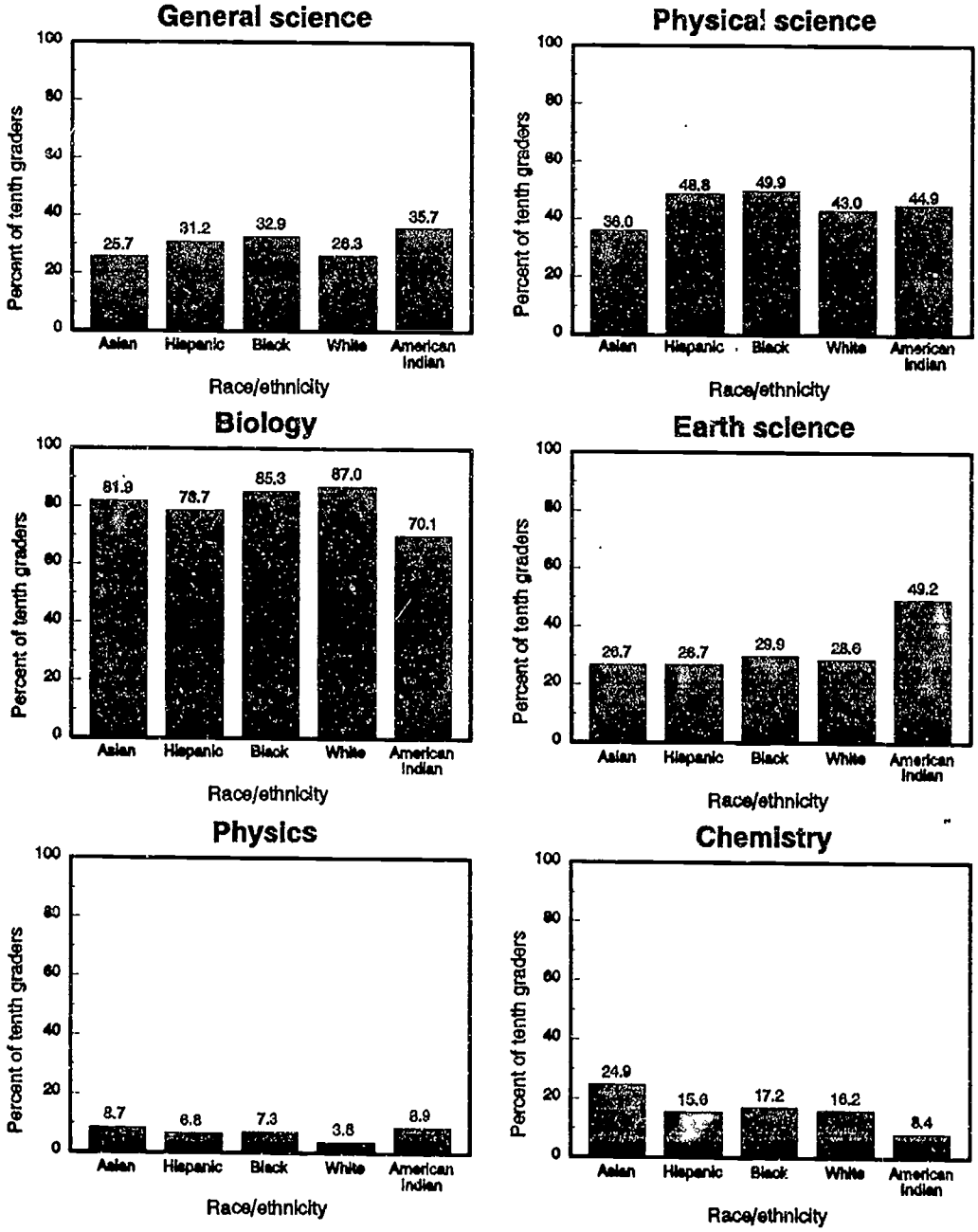

Source: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress, "1992 Twelfth Grade Mathematics Assessment."

**Figure 2.10--Average mathematics proficiency of high school seniors and percent of seniors who took six or more semesters of mathematics in grades 9 through 12, by race/ethnicity**




Source: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress, "1992 Twelfth Grade Mathematics Assessment."

## Figure 2.11--Percent of tenth-grade students with exposure to science, by course and race/ethnicity

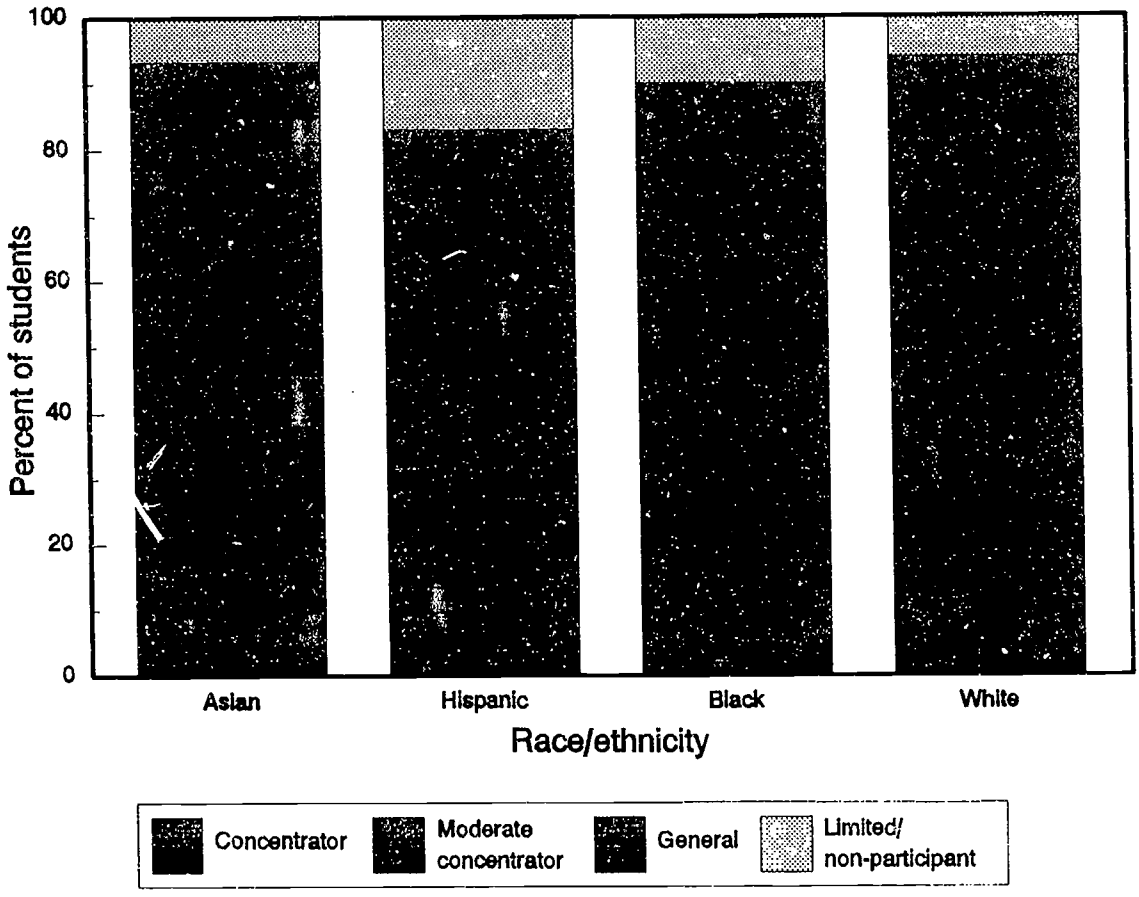



Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "First Follow-Up Student Survey."

# Figure 2.12--Percent of postsecondary students with specified high school science patterns, by race/ethnicity

| Race/ethnicity | High school science course pattern | | | |
|---|---|---|---|---|
| | Concentrator | Moderate concentrator | General | Limited/ non-participant |
| Asian | 40.2 | 33.7 | 19.6 | 6.6 |
| Hispanic | 9.7 | 25.3 | 48.2 | 16.8 |
| Black | 5.8 | 32.1 | 52.2 | 9.8 |
| White | 19.3 | 40.6 | 34.1 | 6.0 |

Note: Details may not add up to 100 percent due to rounding.




Source: U.S. Department of Education, National Center for Education Statistics, High School and Beyond, "Third Follow-Up Survey, Sophomore Cohort."

b. Time on school work

Based on 10th graders' responses to the NELS:88 first follow-up survey, it was found that black, Hispanic, and American Indian students do not spend less time on science and mathematics homework every week than white students. In fact, slightly more white students than Hispanic or black students reported spending no time on math homework (table 2.27). Among the five racial/ethnic groups, Asian students spend the most time doing homework at home.

c. Learning behavior

There are striking differences among the eighth graders in teachers' perceptions of their engagement in classroom instruction on the following scales: perform below ability, rarely complete homework, frequently absent, frequently tardy, inattentive in class, and disruptive in class. As shown in figures 2.13 and 2.14 respectively), more black, Hispanic, and American Indian students, especially males, are seen by their mathematics and science teachers as performing below their ability and rarely completing homework as well as being inattentive and disruptive in class. Absenteeism and tardiness are less frequent than other behaviors, although the disengagement of American Indian males in mathematics, relative to the other groups, is notable. The data clearly show that Asian eighth graders are the least likely to be perceived by their teachers as being disengaged from their school work. Both science and mathematics teachers gave similar reports.

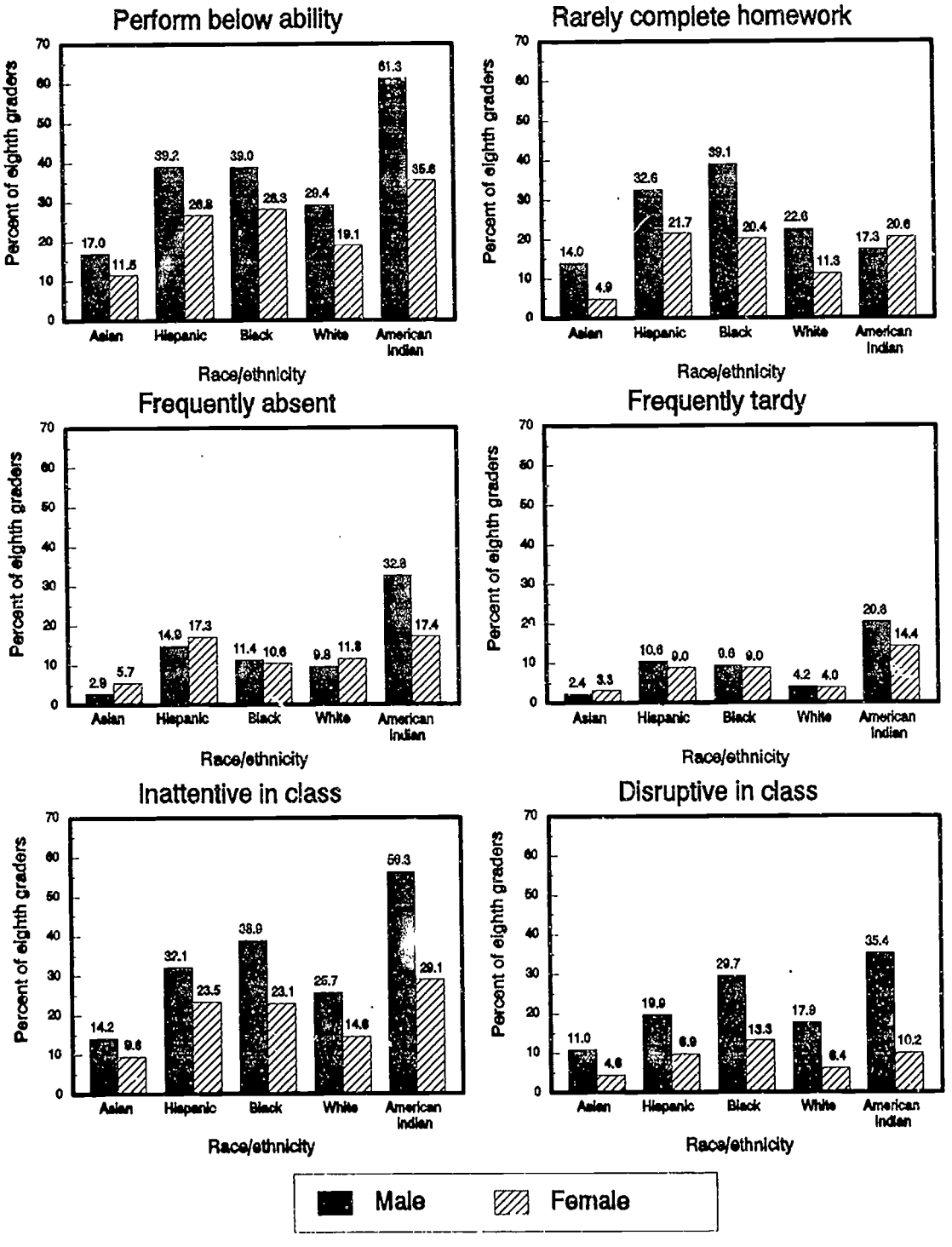
**Table 2.27--Percent distribution of weekly time spent on mathematics and science homework outside of school, by race/ethnicity**

| Subject and time spent on homework | Race/ethnicity | | | | |
|---|---|---|---|---|---|
| | Asian | Hispanic | Black | White | American Indian |
| Mathematics | | | | | |
| None | 8.1 | 17.0 | 12.5 | 19.0 | 21.2 |
| One to three hours | 72.1 | 71.9 | 75.6 | 67.8 | 68.4 |
| Four or more hours | 19.8 | 11.1 | 11.9 | 13.2 | 10.5 |
| Science | | | | | |
| None | 10.2 | 20.8 | 20.4 | 20.9 | 30.0 |
| One to three hours | 70.1 | 69.2 | 69.5 | 68.7 | 61.0 |
| Four or more hours | 19.8 | 10.1 | 10.1 | 10.5 | 8.9 |

Note: Details may not add up to 100 percent due to rounding.

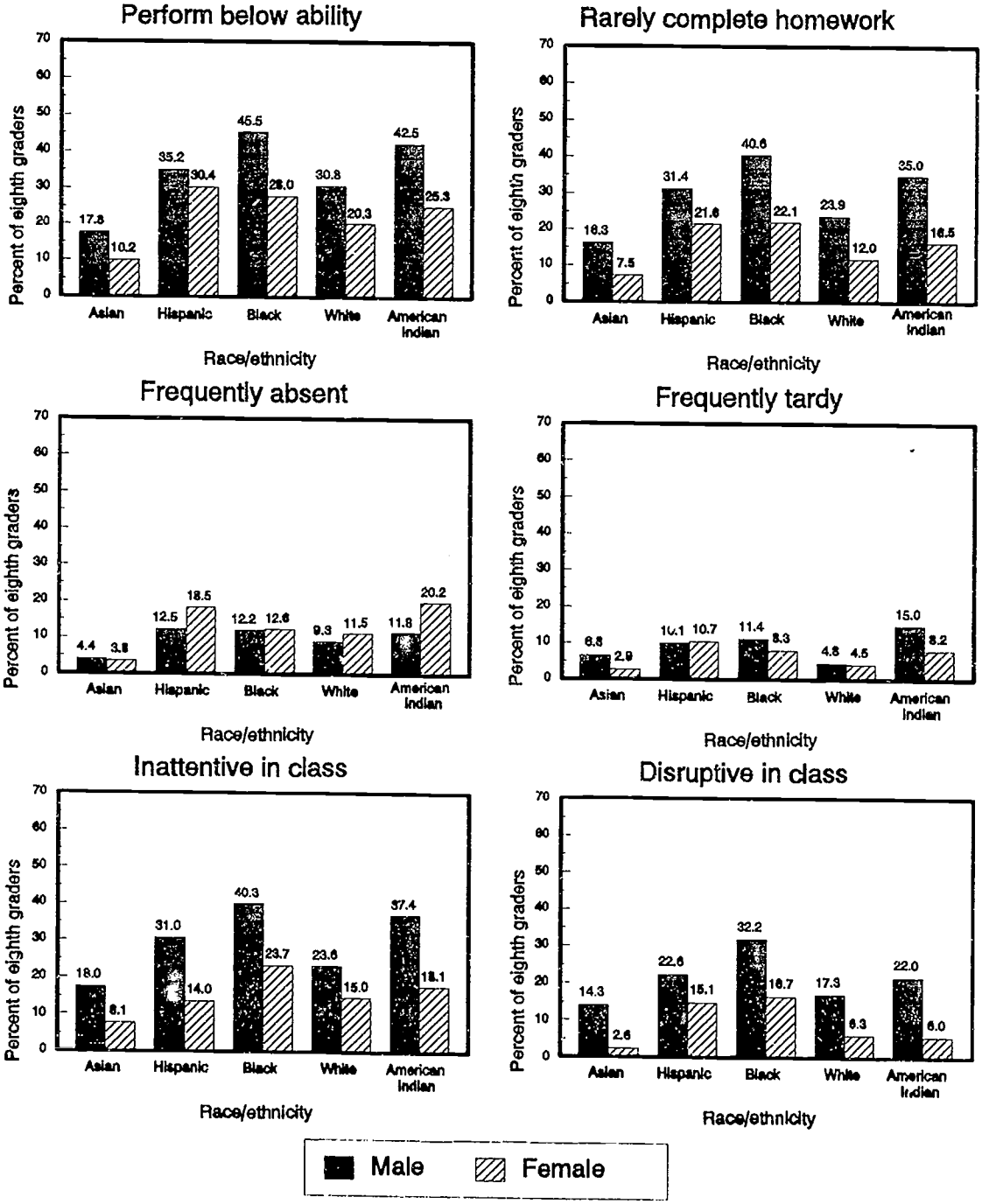
Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "First Follow-Up Student Survey."

## Figure 2.13--Percent of 1988 eighth graders with certain behavior reported by mathematics teachers, by student sex and race/ethnicity




Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Teacher Survey."

## Figure 2.14--Percent of 1988 eighth graders with certain behavior reported by science teachers, by student sex and race/ethnicity




Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Teacher Survey."

# Chapter 3. Differences in Student Achievement as a Function of Differences in Home, School, and Student Background Characteristics

In the previous chapter, a number of home, school and individual background characteristics were examined. Results show that these variables are related to student achievement and that students differ significantly on many of these variables by racial-ethnic groups. The next question then is: How do these differences in home, school, and individual variables relate to the achievement differences by racial-ethnic groups? In other words, do the differences in these variables account for some of the achievement differences among racial-ethnic groups? And if so, how much would the achievement differences be reduced after controlling for all these variables?

Results of analyses show that the racial-ethnic differences in science and mathematics achievement are related to the home, school, and individual background characteristics selected for this study. The difference in achievement between minority and other students is 45 percent less if selected home, school, and individual characteristics are equal. This finding suggests that by changing some variables such as high school curriculum and educational activities at home, student learning in mathematics and science could be improved significantly.

The analysis is based on NELS:88 data, and only those variables that differ significantly by racial-ethnic groups are retained and included in the analysis. In addition, racial-ethnic groups are re-coded into two groups; blacks, Hispanics, and American Indians as one group under-represented in science and mathematics and whites and Asians as another group because of their similarity in achievement and in most background variables. This approach simplifies the analysis model and makes the results less complicated for interpretation.

The analysis uses the regression analysis technique. Its focus is to examine the reduction of the portion of achievement predicted by race-ethnicity when background variables are added to the analysis. Description of this technique is included in Appendix E. Because the learning process involves family, school, and individual student factors, each factor is examined separately before all three factors are examined jointly.

## A. Family Resources and Learning Activities

As shown in table 3.1, achievement scores in science and mathematics can be expressed as a function of a constant value for all students (i.e., the intercept) and the unique contributions associated with the race/ethnicity and family variables. Using race/ethnicity alone in the regression analysis of science test scores, for example, the constant is 44.68, and the contribution of race/ethnicity is 7.58. Since white and Asians are coded 1 and others are coded as 0 in this study, the result means that whites and Asians have a predicted mean score of 52.26 [i.e., 44.68 + (7.58 × 1)], and others (Hispanics, blacks, and American Indians) have a mean score of 44.68 [i.e., 44.68 + (7.08 × 0)]. The difference between minority and majority students is, therefore, 7.58 as

shown by the regression coefficient for race/ethnicity. When family resource variables are added, the coefficient for race/ethnicity is reduced to 5.42, and it is further reduced to 5.35 when additional home education variables are added to the analysis. This means that when family resource variables are equal (i.e., held constant), the difference between the two groups of students is 5.35, instead of 7.58, on a scale with a mean of 50 and a standard deviation of 10. In other words, over 29 percent of the achievement difference between the two groups of students [i.e., ((7.58 - 5.35) / 7.58) × 100] is related to differences in resources and learning activities at home.

The same result is found in the analysis of mathematics achievement test scores. About 36 percent of the racial/ethnic differences in mathematics achievement are related to the differences in resources and learning activities at home.

When the home education variables are added to the regression model after family resources are considered, they hardly contribute to the explanation of racial/ethnic differences. This result is due to the fact that family resources and home education variables are highly inter-related. For example, poor families are less likely than affluent families to provide their children with learning materials, outside classes, and other education activities. If the home education variables had been entered into the analysis first, the results would have shown that family resources barely contributed to the achievement differences among racial/ethnic groups. When family resource variables are added, the coefficient for race/ethnicity is reduced to 5.42, and it is further reduced to 5.35 when additional home education variables are added to the analysis. This means that when family resource variables are equal (i.e., held constant), the difference between the two groups of students [i.e. ((7.58 - 5.35 / 7.58 × 100] is related to differences in resources and learning activities at home.

The same result is found in the analysis of mathematics achievement test scores. About 36 percent of the racial/ethnic differences in mathematics achievement are related to the differences in resources and learning activities at home.

When the home education variables are added to the regression model after family resources are considered, they hardly contribute to the explanation of racial/ethnic differences. The result is due to the fact that family resources and home education variables are highly interrelated. For example, poor families are less likely than rich families to provide their children with learning materials, outside classes, and other education activities. If the home education variables had been entered into the analysis first, the results would have shown that family resources barely contributed to the reduction of racial/ethnic differences.

To determine the relative importance of each variable in predicting student achievement, one could compare the standardized regression coefficients which place all variables on the same scale. Results show that, for example, parents' educational expectations for their children and parent-child communication are relatively more important than poverty status, confirming the previous finding that what a family does is more important to student learning than what a family has.

It is interesting to note that homework assistance is negatively related to student achievement. This result does not necessarily mean that assisting students in their homework lowers their test scores; it could reflect the possibility that parents are more likely to assist students who have learning problems.

**B. School Climate and Learning Opportunities**

As shown in table 3.2, when school variables are added to the regression analysis, the coefficient for race-ethnicity is reduced from 7.61 to 5.77 for science and from 6.67 to 4.58 for mathematics -- a reduction of 24 percent and 31 percent, respectively. The reduction for science test scores is slightly smaller, indicating that school variables are less critical for reducing racial/ethnic differences in science than in mathematics achievement.

As for the relative importance of school variables, most school variables remain significant. Mathematics groupings and high school program have the highest coefficients, followed by students placing a priority on learning, school type and school SES.

**Table 3.1–Regression coefficients of family resources and home education variables with achievement test scores**

| Family resources and home education variables | Achievement test scores | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Science | | | | | Mathematics | | | | |
| | Model 1 | Model 2 | | Model 3 | | Model 1 | Model 2 | | Model 3 | |
| | Non-Stand. | Non-Stand. | Stand. | Non-Stand. | Stand. | Non-Stand. | Non-Stand. | Stand. | Non-Stand. | Stand. |
| Intercept | 44.68 * | 40.36 * | | 34.18 * | | 45.56 * | 40.94 * | | 32.38 * | |
| Race/ethnicity | 7.58 * | 5.42 * | 0.23 * | 5.35 * | 0.22 * | 6.53 * | 4.21 * | 0.18 * | 4.32 * | 0.18 * |
| Not in poverty | | 2.55 * | 0.10 * | 1.11 * | 0.04 * | | 3.23 * | 0.13 * | 1.47 * | 0.06 * |
| Father's occupation | | 2.43 * | 0.12 * | 1.63 * | 0.08 * | | 2.55 * | 0.12 * | 1.52 * | 0.07 * |
| Mother's occupation | | 1.10 * | 0.04 * | 0.69 * | 0.03 * | | 1.04 * | 0.04 * | 0.52 | 0.02 |
| Father's education | | 2.51 * | 0.12 * | 1.60 * | 0.08 * | | 2.41 * | 0.12 * | 1.19 * | 0.06 * |
| Mother's education | | 2.67 * | 0.13 * | 1.74 * | 0.09 * | | 2.66 * | 0.13 * | 1.50 * | 0.07 * |
| Family composition | | 0.88 * | 0.04 * | 0.97 * | 0.04 * | | 0.75 * | 0.03 * | 0.88 * | 0.04 * |
| Parent/child communication | | | | 1.5[illegible] * | 0.07 * | | | | 1.53 * | 0.07 * |
| Learning materials | | | | 0.35 * | 0.07 * | | | | 0.37 * | 0.08 * |
| Classes outside of school | | | | 0.16 | 0.02 | | | | 0.28 * | 0.04 * |
| Educational activities | | | | 0.48 * | 0.08 * | | | | 0.39 * | 0.06 * |
| Homework assistance | | | | -1.46 * | -0.15 * | | | | -1.49 * | -0.15 * |
| Parents' educational expectations | | | | 0.63 * | 0.17 * | | | | 0.95 * | 0.26 * |
| $R^2$ | 0.10 * | 0.22 * | | 0.30 * | | 0.10 * | 0.21 * | | 0.33 * | |

Note: * indicates that regression coefficient is significant at the .05 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student and Parent Surveys."

**Table 3.2–Regression coefficients of school variables with achievement test scores**

| School variables | Achievement test scores | | | | | |
|---|---|---|---|---|---|---|
| | Science | | | Mathematics | | |
| | Model 1 | Model 2 | | Model 1 | Model 2 | |
| | Non-Stand. | Non-Stand. | Stand. | Non-Stand. | Non-Stand. | Stand. |
| Intercept | 44.54* | 39.71 * | | 45.30 * | 39.83 * | |
| Race/ethnicity | 7.61* | 5.77 * | 0.24 * | 6.67 * | 4.58 * | 0.20 * |
| School SES | | 2.38 * | 0.09 * | | 2.41 * | 0.09 * |
| School type | | 2.35 * | 0.08 * | | 2.98 * | 0.10 * |
| Students face competition for grades | | 0.74 * | 0.04 * | | 0.56 * | 0.03 * |
| Discipline is emphasized | | -0.99 * | -0.03 * | | -1.06 * | -0.03 * |
| Students place a priority on learning | | 1.82 * | 0.09 * | | 2.17 * | 0.11 * |
| Teachers encourage students to do their best | | 0.62 | 0.02 | | 0.99 * | 0.03 * |
| Teacher morale is high | | -0.66 * | -0.03 * | | -0.74 * | -0.03 * |
| Teachers have positive attitudes toward students | | -0.29 | -0.01 | | -0.35 | -0.01 |
| Teachers do not have difficulty motivating students | | 0.86 * | 0.04 * | | 1.11 * | 0.06 * |
| Teachers respond to students' individual needs | | 0.11 | 0.00 | | -0.17 | -0.01 |
| High school program | | 3.62 * | 0.17 * | | 3.58 * | 0.17 * |
| Mathematics achievement level grouping | | 4.90 * | 0.23 * | | 7.38 * | 0.35 * |
| Science achievement level grouping | | 2.18 * | 0.09 * | | 1.35 * | 0.06 * |
| $R^2$ | 0.10 * | 0.27 * | | 0.28 * | 0.33 * | |

Note: * indicates that regression coefficient is significant at the .05 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year and First Follow-Up School Surveys."

## C. Student Characteristics

The third analysis examines students' individual characteristics in four categories: gender, aspirations, coursework, and learning behavior. These are added to the regression analysis model in sequence in order to examine how they reduce the racial/ethnic differences in achievement. The results are shown in table 3.3.

First, educational and occupational aspirations and gender of students barely reduce the racial/ethnic differences in science and mathematics achievement -- about 6 percent for science and 5 percent for mathematics (e.g., [7.63 - 7.14] / 7.63 x 100 = 6 for science). Second, when coursework is added, the reduction of racial-ethnic differences increases to 6 percent for science and 20 percent for mathematics. The sharp reduction for mathematics achievement indicates that coursework is an important factor in understanding the lower achievement of minority students as they are less likely to take advanced mathematics courses. Third, with the addition of classroom behavior to the model, there is about an additional 6 percent reduction in the racial/ethnic difference for science and a 4 percent reduction for mathematics beyond what is accounted for by aspirations and coursework.

On the basis of standardized regression coefficients, both educational and occupational aspirations, as well as chemistry, algebra II, and geometry, are important factors in predicting achievement. Consequently, minority students' lower aspirations and fewer advanced courses are potential factors leading to their lower achievement in science and mathematics.

## D. Family, School, and Student Variables Analyzed Jointly

Based on the results presented in the preceding sections, 12 home variables, 13 school variables, and 13 student characteristics are included in a regression analysis. These variables together reduce the racial/ethnic differences in achievement by 46 percent for science and 45 percent for mathematics (table 3.4). In other words, much of the observed differences in science and mathematics test scores between minority and majority students are attributable to the differences in family, school, and individual characteristics.

As expected, many variables become statistically non-significant after other variables are considered in predicting achievement. Among those variables remaining significant, algebra II and geometry coursework and mathematics achievement level grouping have relatively high coefficients. Other variables with significant coefficients are high school program, school SES, parental educational expectations, and educational activities. Many of these variables are process variables, indicating that family and school learning opportunities are significantly related to racial/ethnic differences in science and mathematics achievement.

**Table 3.3--Regression coefficients of student characteristics with achievement test scores**

| Student characteristics | Achievement test scores | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Science | | | | | Mathematics | | | | |
| | Model 1 | Model 2 | Model 3 | Model 4 | | Model 1 | Model 2 | Model 3 | Model 4 | |
| | Non-Stand. | Non-Stand. | Non-Stand. | Non-Stand. | Stand. | Non-Stand. | Non-Stand. | Non-Stand. | Non-Stand. | Stand. |
| Intercept | 44.41 * | 37.04 * | 36.91 * | 39.36 * | | 45.36 * | 37.21 * | 35.50 * | 37.37 * | |
| Race/ethnicity | 7.63 * | 7.14 * | 7.12 * | 6.63 * | 0.28 * | 6.62 * | 6.26 * | 4.98 * | 4.70 * | 0.20 * |
| Gender | | 2.99 * | 2.96 * | 3.31 * | 0.18 * | | 1.08 * | 0.98 * | 1.47 * | 0.07 * |
| Educational aspirations | | 5.57 * | 5.15 * | 4.21 * | 0.13 * | | 7.24 * | 4.15 * | 3.77 * | 0.12 * |
| Occupational aspirations | | 3.82 * | 3.52 * | 2.95 * | 0.14 * | | 4.27 * | 1.96 * | 1.87 * | 0.09 * |
| Algebra I | | | | | | | | 1.98 * | 1.59 * | 0.08 * |
| Algebra II | | | | | | | | 6.12 * | 5.71 * | 0.25 * |
| Geometry | | | | | | | | 7.27 * | 6.78 * | 0.34 * |
| Chemistry | | | 4.28 * | 3.63 * | 0.13 * | | | | | |
| Perform below ability | | | | -1.80 * | -0.07 * | | | | -2.16 * | -0.09 * |
| Rarely complete homework | | | | -3.00 * | -0.11 * | | | | 0.23 | -0.01 |
| Frequently absent | | | | 0.18 | -0.01 | | | | -0.27 | -0.01 |
| Frequently tardy | | | | 1.18 | 0.02 | | | | -1.70 * | -0.04 * |
| Inattentive in class | | | | -0.89 * | -0.04 * | | | | -0.95 * | -0.04 * |
| Disruptive in class | | | | -1.81 * | -0.06 * | | | | -1.20 * | -0.04 * |
| $R^2$ | 0.10 * | 0.19 * | 0.22 * | 0.26 * | | 0.08 * | 0.20 * | 0.44 * | 0.46 * | |

Note: * indicates that regression coefficient is significant at the .05 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year and First Follow-Up Student and Base Year Teacher Surveys."

**Table 3.4--Regression coefficients of family resources, home education variables, student characteristics, school variables, with achievement test scores**

| Family resources, home education variables, student characteristics, and school variables | Achievement test scores | | | | | |
|---|---|---|---|---|---|---|
| | Science | | | Mathematics | | |
| | Model 1 | Model 2 | | Model 1 | Model 2 | |
| | Non-Stand. | Non-Stand. | Stand. | Non-Stand. | Non-Stand. | Stand. |
| Intercept | 44.55 * | 34.61 * | | 45.59 * | 33.50 * | |
| Race/ethnicity | 7.60 * | 4.14 * | 0.17 * | 6.49 * | 3.59 * | 0.15 * |
| Gender | | 3.26 * | 0.16 * | | 1.10 * | 0.06 * |
| Not in poverty | | 0.41 | 0.02 | | 0.61 | 0.02 |
| Father's occupation | | 1.17 * | 0.06 * | | 0.94 * | 0.04 * |
| Mother's occupation | | 0.47 | 0.02 | | 0.15 | 0.01 |
| Father's education | | 0.69 | 0.03 | | 0.55 | 0.03 |
| Mother's education | | 0.81 * | 0.04 * | | 0.73 | 0.04 |
| Family composition | | 0.42 | 0.02 | | 0.40 | 0.02 |
| Parent/child communication | | 0.64 | 0.03 | | 0.48 | 0.02 |
| Learning materials | | 0.15 | 0.03 | | 0.12 | 0.03 |
| Classes outside of school | | 0.29 * | 0.04 * | | 0.04 | |
| Educational activities | | 0.39 * | 0.07 * | | 0.26 * | 0.04 * |
| Homework assistance | | -1.19 * | -0.12 * | | -0.82 * | -0.08 * |
| Parents' educational expectations | | 0.20 * | 0.06 * | | 0.39 * | 0.11 * |
| Educational aspirations | | 0.61 | 0.02 | | 1.38 * | 0.04 * |
| Occupational aspirations | | 0.84 * | 0.04 * | | 0.47 | 0.02 |
| Algebra I | | 0.60 | 0.03 | | 1.76 * | 0.08 * |
| Algebra II | | 2.22 * | 0.10 * | | 3.82 * | 0.17 * |
| Geometry | | 3.55 * | 0.18 * | | 4.37 * | 0.22 * |
| Chemistry | | 0.05 | | | 0.16 | 0.01 |
| Perform below ability | | -0.79 | -0.03 | | -1.76 * | -0.07 * |
| Rarely complete homework | | -1.54 * | -0.06 * | | 0.64 | 0.02 |
| Frequently absent | | 0.90 | 0.03 | | 0.23 | 0.01 |
| Frequently tardy | | 1.26 | 0.03 | | -1.55 * | -0.03 * |
| Inattentive in class | | -0.18 | -0.01 | | -0.95 | -0.04 |
| Disruptive in class | | -1.21 * | -0.04 * | | -1.48 * | -0.05 * |
| School SES | | 1.96 * | 0.07 * | | 1.81 * | 0.06 * |
| School type | | -0.22 | -0.01 | | 0.36 | 0.01 |
| Students face competition for grades | | 0.51 | 0.03 | | -0.07 | |
| Discipline is emphasized | | -0.84 | -0.03 | | -0.85 | -0.03 |
| Students place a priority on learning | | 0.16 | 0.01 | | 1.22 * | 0.06 * |
| Teachers encourage students to do their best | | 0.53 | 0.01 | | 0.52 | 0.01 |
| Teacher morale is high | | -0.31 | -0.01 | | 0.10 | |
| Teachers have positive attitudes toward Ss | | 0.38 | 0.01 | | -0.55 | -0.02 |
| Teachers do not have difficulty motivating Ss | | 0.54 | 0.03 | | 0.26 | 0.01 |
| Teachers respond to students' individual needs | | 0.49 | 0.02 | | -0.05 | |
| High school program | | 1.09 * | 0.05 * | | 1.20 * | 0.06 * |
| Mathematics achievement level grouping | | 2.10 * | 0.10 * | | 3.50 * | 0.16 * |
| Science achievement level grouping | | 1.17 * | 0.05 * | | 0.54 | 0.02 |
| $R^2$ | 0.10 * | 0.43 * | | 0.08 * | 0.54 * | |

Note: * indicates that regression coefficient is significant at the .05 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Parent and Teacher and Base Year and First Follow-Up Student and School Surveys."

## Chapter 4. Summary and Discussion

This study was designed to address two basic issues relating to the under-representation of blacks, Hispanics, and American Indians in science and mathematics-related fields: Why are these minorities under-represented in these fields, and why do students of these minority groups have lower achievement in science and mathematics than other students? Based on national data provided by the National Center for Education Statistics, U.S. Department of Education, this study has yielded many findings related to these issues. Some major findings are summarized and discussed below.

### A. Underrepresentation in Science and Mathematics-Related Fields

Two hypotheses are tested about the underrepresentation of blacks, Hispanic, and American Indians in science and mathematics-related fields. One relates to their career aspirations and choice of field, and the other relates to their academic preparation prior to college education. This study found that at early ages all students have equally positive attitudes toward science and mathematics learning in school, and they have similar aspirations for science and mathematics-related careers. As they get older, however, more black, Hispanic, and American Indian students become unprepared to enter these fields as they fall behind in mathematics and science learning. In general, they have lower achievement test scores and have taken fewer advanced courses in science and mathematics than white and Asian students by the time they finish high school. As a result, without additional assistance, these students would be handicapped in taking rigorous science and mathematics courses at the college level. It is much harder for black, Hispanic and American Indian students to become scientists or engineers.

These findings support the general notion that the underrepresentation of blacks, Hispanics, and American Indians in science and mathematics-related fields reflects in large part the outcomes of their education. Therefore, the improvement of learning at all education levels is critical for increasing the participation of these minorities in these fields.

### B. Possible Reasons for Minority Students' Low Achievement in Science and Mathematics Education

It is clear that black, Hispanic, and American Indian students have lower achievement in science and mathematics than other students, which hampers their opportunities for careers in related fields. The question then is: Why do these students first have lower achievement? Results of this study show that the achievement gap among racial-ethnic groups is related to the dissimilar learning conditions and opportunities at home and in school. Some major findings are summarized below.

1. A large percentage of these minority students lack adequate learning resources and education activities at home. More black, Hispanic, and American Indian students than white and Asian students come from families in poverty which have fewer learning materials such as books and computers and fewer visits to museums and public libraries. Their parents are more likely than others to have low educational levels and to be unemployed,

and they are less likely to provide adequate mentoring or role models for science and mathematics learning -- a factor found to be related to students' achievement (Johnson, 1983). Their parents also are more likely to have lower educational aspirations for them and are less likely to provide the kind of assistance and support needed. In summary, students of such backgrounds face multiple disadvantages at home and probably require a greater effort in school to reach the same level of achievement attained by other students.

2. The effect of home inadequacies is compounded by the fact that these minorities are more likely to attend disadvantaged schools than white and Asian students. Their schools have lower student achievement scores and more discipline and safety problems than non-disadvantaged schools although they offer similar courses and have equally qualified teachers. These schools do not (or cannot) place as much emphasis on learning and grade competition as other schools. Overall, the environment is less conducive to learning and students receive fewer positive learning opportunities. Many of the disadvantaged schools are also unable to offer advanced courses such as calculus and physics II (National Science Foundation, 1992c).

3. A higher proportion of black, Hispanic, and American Indian students suffer from lack of persistent effort and active involvement in school. In comparison to other students, they are perceived more often by teachers as being inattentive and frequently disruptive in class. They are also more likely to fail to complete homework and to perform below their ability. While these behaviors may be the results of poor educational environments and opportunities, they nevertheless are consistent with a common notion that students will not learn if they do not spend time on learning tasks.

4. Black, Hispanic, and American Indian students are more likely than other students to be in low-track achievement groups and non-college preparatory programs. Although this phenomenon may reflect the lower achievement scores of minority stud the preceding grade levels, it does confirm the previous findings that these minority students have received less rigorous academic training and failed to obtain enough competence to study higher level courses (Bradley, 1983; Chipman & Thomas, 1984), and that they lack preparation for taking more courses (Johnson, 1983). In fact this study found that these students are less likely than white and Asian students to have advanced courses such as algebra II, geometry, calculus, and chemistry.

5. Because many black, Hispanic, and American Indian students attend disadvantaged schools where the average achievement is low and there are discipline and safety problems, they are more likely to face stressful environments and less likely to have a strong peer group or community support to encourage them to work hard in school. While they might have the skills and desire to succeed, they might have difficulty in finding peer groups who value study, hard work, and academic success--a value system that is typically found among Asian students (Marlowe & Culler, 1987). As found by Boyd (1981), minority students need to see more examples of the opportunities and successes their efforts could produce, such as hearing about other minority students who are high achievers.

**C. Reducing the Achievement Gap: Suggestions for Further Studies**

Results of this study suggest a number of potential ways for improving students' learning in science and mathematics. However, many related questions are not fully answered. Thus, they are suggested below for further research.

1. The use of holistic approaches. The study found that student learning is related to multiple factors of family, school, and individual, and each factor accounts for only a small proportion of the differences in science and mathematic achievement. Therefore, is it sensible to conclude that any education improvement program will require a systematic approach involving these factors jointly? How likely is it that student achievement can increase significantly simply by improving classroom instructional techniques without improving the support systems outside the classroom?

2. Start improvement programs early. The study results show that all students regardless of race/ethnicity exhibit similar interests in and positive attitudes toward science and mathematics-related career, and aspire equally to higher education at early ages. They begin to withdraw and become less interested in science and mathematics when they become aware of their lack of adequate preparation in the later stages of their education. Would programs which work to reduce the achievement gaps at early ages be helpful? What could be done to reduce the achievement gaps at early ages?

3. Improvement programs begin at home. This study further supports the findings of other studies that parents play an important role in student learning. Many of the activities related to student learning require the commitment of parents rather than extra resources. For example, activities such as having frequent talks with children to discuss school work, visiting the public library with children, and monitoring children's activities after school are found to be related to student learning. Consequently, what could be done to help parents become their child's first teacher, as many educational improvement programs emphasize? How can parents help improve the quality of school education?

4. Focus on disadvantaged schools. Since a larger percentage of black, Hispanic, and American Indian students attend disadvantaged schools, and since the quality of these schools is lower than advantaged schools, should improvement efforts be concentrated or emphasized on improvement of the overall quality of these schools? Would such improvement significantly narrow the achievement differences among social/ethnic groups? For example, if these schools work with parents and other authorities to place higher emphasis on safety, discipline, and learning, if these schools improve course offerings and quality of instruction in science and mathematics and if schools establish programs to help students increase their engagement in learning, would students' motivation to learn further be increased and the achievement gaps among racial-ethnic groups be removed?

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# Appendix A
# Achievement in Science and Mathematics

**Table A.1--Percent of 1988 eighth graders at each mathematics proficiency level, by race/ethnicity**

| Race/ethnicity | Mathematics proficiency level | | | |
|---|---|---|---|---|
| | Below basic | Basic | Intermediate | Advanced |
| **All races** | 18.8 | 40.2 | 22.1 | 18.8 |
| Asian | 13.4 | 30.7 | 21.2 | 34.7 |
| Hispanic | 27.6 | 46.8 | 16.9 | 8.7 |
| Black | 28.9 | 49.4 | 16.5 | 5.3 |
| White | 15.5 | 37.9 | 24.3 | 22.4 |
| American Indian | 32.3 | 49.8 | 13.0 | 4.8 |

Note: Details may not add up to 100 percent due to rounding.

Source: Hafner, A., Ingels, S., Schneider, B., & Stevenson, D. (1990). A profile of the American eighth grader. Washington, DC: U.S. Government Printing Office. p.29.

**Table A.2--Percent of 1988 eighth graders at each science quartile, by race/ethnicity**

| Race/ethnicity | Science quartile | | | |
|---|---|---|---|---|
| | Quartile 1 | Quartile 2 | Quartile 3 | Quartile 4 |
| Asian | 21.1 | 23.0 | 24.9 | 31.1 |
| Hispanic | 37.7 | 30.7 | 20.6 | 11.0 |
| Black | 47.7 | 30.1 | 15.9 | 6.3 |
| White | 19.2 | 22.4 | 28.8 | 29.7 |
| American Indian | 47.3 | 24.0 | 19.4 | 9.3 |

Note: Details may not add up to 100 percent due to rounding.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student Survey."

**Table A.3--Average mathematics proficiency and percent of students at or above three achievement levels, by grade and race/ethnicity**

| Race/ethnicity | Average proficiency | Percent of students at or above proficiency level | | |
|---|---|---|---|---|
| | | Advanced | Proficient | Basic |
| **Grade Four** | | | | |
| Asian | 231 | 5 | 30 | 76 |
| Hispanic | 201 | 0 | 6 | 37 |
| Black | 192 | 0 | 3 | 24 |
| White | 227 | 3 | 23 | 72 |
| American Indian | 209 | 2 | 10 | 46 |
| **Grade Eight** | | | | |
| Asian | 288 | 14 | 44 | 80 |
| Hispanic | 246 | 1 | 8 | 39 |
| Black | 237 | 0 | 3 | 27 |
| White | 277 | 4 | 32 | 74 |
| American Indian | 254 | 0 | 9 | 47 |
| **Grade 12** | | | | |
| Asian | 315 | 6 | 31 | 81 |
| Hispanic | 283 | 1 | 6 | 45 |
| Black | 275 | 0 | 3 | 34 |
| White | 305 | 2 | 19 | 72 |
| American Indian | 281 | 0 | 4 | 46 |

Source: Mullis, Ina V. S., Dossey, J. A., Owen, E. H., & Phillips, G. W.(1993). NAEP 1992 mathematics report card for the nation and the states. Washington, DC: National Center for Education Statistics, U.S. Department of Education., p.93.

**Table A.4--Average science proficiency and percent of students at or above four proficiency levels, by grade and race/ethnicity**

| Race/ethnicity | Average proficiency | Percent of students at or above proficiency level | | | |
|---|---|---|---|---|---|
| | | Level 200 | Level 250 | Level 300 | Level 350 |
| **Grade Four** | | | | | |
| Asian | 233 | 88 | 29 | 2 | -- |
| Hispanic | 212 | 66 | 10 | -- | -- |
| Black | 205 | 58 | 5 | -- | -- |
| White | 242 | 93 | 40 | 1 | |
| American Indian | 226 | 81 | 20 | -- | -- |
| | | | | | -- |
| **Grade Eight** | | | | | |
| Asian | 271 | 96 | 71 | 23 | 1 |
| Hispanic | 241 | 87 | 42 | 5 | -- |
| Black | 231 | 80 | 31 | 3 | -- |
| White | 273 | 97 | 74 | 23 | 1 |
| American Indian | 252 | 92 | 54 | 8 | -- |
| **Grade Twelve** | | | | | |
| Asian | 308 | 99 | 90 | 60 | 17 |
| Hispanic | 273 | 98 | 70 | 23 | 3 |
| Black | 256 | 94 | 57 | 12 | 1 |
| White | 303 | 100 | 91 | 53 | 12 |
| American Indian | 286 | 100 | 89 | 33 | 2 |

-- 0 or less than .5 percent.

Source: Jones, L. R., Mullis, Ina V. S., Raisen, S. A., Weiss, I. R., Weston, E. A. (1992). The 1990 science report card. Washington, DC: National Center for Education Statistics, U.S. Department of Education., p.52.

**Table A.5--Bachelor's, master's, and doctor's degrees conferred in 1990-91 by institutions of higher education, by major field of study and race/ethnicity**

| Major field | Race/ethnicity | | | | | |
|---|---|---|---|---|---|---|
| | Total | Asian | Hispanic | Black | White | American Indian |
| **Bachelor's degrees** | | | | | | |
| Engineering | 61,632 | 6,361 | 2,057 | 2,279 | 46,192 | 161 |
| Health sciences | 59,268 | 2,028 | 1,715 | 4,220 | 50,041 | 286 |
| Life sciences | 39,530 | 3,634 | 1,503 | 2,154 | 30,094 | 180 |
| Mathematics | 14,661 | 926 | 380 | 825 | 11,908 | 45 |
| Physical sciences | 16,344 | 1,004 | 390 | 772 | 13,500 | 70 |
| **Master's degrees** | | | | | | |
| Engineering | 23,984 | 2,129 | 472 | 421 | 13,400 | 42 |
| Health sciences | 21,228 | 628 | 445 | 1,049 | 17,772 | 95 |
| Life sciences | 4,765 | 242 | 101 | 144 | 3,514 | 13 |
| Mathematics | 3,615 | 199 | 71 | 105 | 2,171 | 9 |
| Physical sciences | 5,309 | 268 | 86 | 80 | 3,351 | 14 |
| **Doctoral degrees** | | | | | | |
| Engineering | 5,262 | 372 | 53 | 47 | 2,053 | 7 |
| Health sciences | 1,614 | 63 | 29 | 59 | 1,159 | 3 |
| Life sciences | 4,093 | 206 | 66 | 46 | 2,764 | 5 |
| Mathematics | 978 | 39 | 13 | 10 | 401 | 1 |
| Physical sciences | 4,290 | 177 | 67 | 38 | 2,566 | 9 |

Source: U.S. Department of Education, National Center for Education Statistics, Digest of Education Statistics.
Note: The figures include only U.S. citizens and legal residents who receive degrees.

# Appendix B
# NCES Databases for Studies of Science and Mathematics Education

## High School and Beyond

High School and Beyond (HS&B) was the second longitudinal study sponsored by the National Center for Education Statistics. It provides information on the educational, vocational, and personal development of young people as they move from high school into postsecondary education or the workforce, and then into adult life. HS&B began in 1980 with a base year sample of more than 30,000 seniors and 28,000 sophomores and their parents, teachers, and school administrators. There was an 82 percent response rate. Follow-ups of the two cohorts were conducted in 1982, 1984, and 1986 with another follow-up of the sophomore cohort occurring in 1992.

In the base year of 1980, students took cognitive tests to measure both verbal and quantitative abilities. Also, tests for the senior cohort measured abstract and nonverbal abilities, and tests for the sophomore cohort included brief achievement measures in science, writing, and civics. The student questionnaires focused on individual and family background, high school and work experiences, and future plans. The parent questionnaire elicited information about how family attitudes and financial planning affect educational goals. The teacher comment checklist provided teacher observations on students participating in the survey. The school questionnaire gathered information about enrollment, staff, educational programs, facilities, services, dropout rates, and special programs for handicapped and disadvantaged students.

The first follow-up of the sophomore cohort in 1982 provided insights into the school dropout problem and the influence of the last two years of high school on student attitudes and aspirations. Later follow-ups of this cohort made it possible to trace the consequences of dropping out and the extent to which dropouts later return and complete high school. Details about the study design and database are found in the HS&B User's Manual (Sebring et al., 1987).

## National Education Longitudinal Study of 1988

The National Education Longitudinal Study of 1988 (NELS:88) is the third major longitudinal study sponsored by the National Center for Education Statistics. It began with a base year sample of about 25,000 eighth graders from over 1,000 schools across the nation. Information from students, their parents, teachers, and school administrators was collected through the use of a self-administered questionnaire. Students completed their questionnaires in their school classrooms. Students hand-delivered questionnaires to their parents/guardians with a written request instructing the most knowledgeable parent or guardian to complete the questionnaire. Teachers were asked to respond to questionnaire items in relation to a specific list of sampled eighth grade students enrolled in their classes. The school administrator questionnaire was completed by the school principal, headmaster, or other knowledgeable school administrator designated by the principal.

A mixed mode follow-up design was used in pursuing individuals who failed to return a completed questionnaire several weeks after the questionnaire should have been received. Following a telephone prompt, telephone and personal interviews were attempted. This intensive follow-up procedure helped to achieve a high survey response rate of over 93 percent. Details about the study design and data base are referred to in the *NELS:88 User's Manual* (Ingels et al., 1990).

NELS:88 was designed to provide nationally representative trend data about critical transitions experienced by young people as they develop, attend school, and embark on their careers. It complements and strengthens state and local efforts by furnishing new information on how school policies, teacher practices, and family involvement affect student educational outcomes (academic achievement, persistence in school, and participation in postsecondary education).

In the base year of 1988, four cognitive tests (reading, science, history/ government, and math) were administered in addition to the student, parent, teacher, and school administrator questionnaires. The First Follow-Up Survey was conducted in the spring of 1990 and included student, dropout, teacher, and school administrator questionnaires. Students also took cognitive tests in reading, science, history/government, and math. The tests were designed to reflect 10th grade coursework and contained enough overlapping items with the eighth and 12th grade tests to permit measurement of academic growth. Conducted in the spring of 1992, the Second Follow-Up Survey included student, dropout, parent, teacher, and school administrator questionnaires with students and dropouts also taking cognitive tests in reading, science, social science, and math. The Third Follow-Up Survey was conducted in 1994.

## National Assessment of Educational Progress

The National Assessment of Educational Progress (NAEP) was begun in 1969 as a result of a Congressional mandate to continuously monitor the knowledge, skills, and performance of the nation's elementary and secondary students. Current legislation requires assessments in reading and mathematics at least every two years, in science and writing at least every four years, and in history or geography and other subjects selected by the National Assessment Governing Board (NAGB) at least every six years. In addition to performance results in subject areas, NAEP collects basic descriptive information about students, teachers, administrators, schools, and communities.

Currently, NAEP is conducted in even-numbered years with a sample drawn from:

1. The universe of fourth, eighth, and 12th graders for the elementary and secondary school students survey and assessments;

2. The teachers of those students for the teacher survey; and

3. The school administrators at those students' schools for the school characteristics and policy survey.

A variation of matrix sampling (balanced

incomplete block spiraling) is used in packaging and administering assessment booklets so the results from a large number of items can be generalized to an entire population. Approximately 2,600 students respond to each block of items.

Since 1983, NAEP has utilized "scale scores" in reporting assessment results. These scores summarize into a single number both the proficiency or level of understanding of a subject and the nature of that understanding. For example, in mathematics, the proficiency levels are described as follows:

- Level 150 -- simple arithmetic facts;
- Level 200 -- beginning skills and understanding;
- Level 250 -- basic operations and beginning problem solving;
- Level 300 -- moderately complex procedures and reasoning; and
- Level 350 -- multi-step problem solving and algebra.

In 1993, NAEP began reporting results by achievement levels rather than proficiency levels.

NAEP has been designed to produce a representative sample at the national level. In the 1990 assessment, data were collected from a national probability sample of more than 45,000 students per grade for a total of about 146,000 students in nearly 2,100 schools. Also, for mathematics at the eighth grade level, representative state-level data were produced for the first time for participating states from the 1990 trial state assessment. In 1992, state level data were collected in fourth grade reading and mathematics and eighth grade mathematics.

For the 1992 Mathematics Assessment, there was a 93 percent completion rate for fourth graders, 89 percent for eighth graders, and 81 percent for 12th graders. Details about the database and design of the mathematics assessment can be found in the *NAEP 1992 Mathematics Report Card for the Nation and the States* (Mullis et al., 1993).

## National Household Education Survey

The National Household Education Survey (NHES) uses telephone interviewing to collect detailed information on educational issues from the non-institutionalized civilian population residing in households with a telephone in the 50 states and the District of Columbia. Households are selected using Random Digit Dialing (RDD), and data are then collected from household members using Computer Assisted Telephone Interviewing (CATI). In each NHES, between 60,000 and 75,000 households are screened to identify persons eligible for one of the topical components. Generally, each collection covers two topical components, and between 12,000 and 15,000 interviews are obtained for each component. Current plans for the NHES call for an annual data collection with topical components being repeated on a three- to four-year cycle so educational activities can be monitored over time.

The 1991 NHES collected information on adult education and early childhood program participation. For the early childhood component, approximately 60,000 households were screened to identify a sample of about 14,000 children three- to eight-years old. The parents of these children were interviewed in order to identify household members and collect detailed information about their

demographic and household characteristics, their children's educational activities, and the role of the family in their children's learning. There was an 81 percent response rate for the screener and a 95 percent completion rate for the early childhood interviews. Details about the survey design and data base are found in the *1991 NHES User's Manual* (Brick et al., 1992).

## Schools and Staffing Survey

The Schools and Staffing Survey (SASS) was designed to meet the need for information on the characteristics of teachers and administrators and their work places. It is a comprehensive public and private education survey that was first administered in the 1987-88 school year and conducted at three-year intervals.

For SASS, schools are the primary sampling unit with a sample of teachers selected from each school. The sample also includes public school districts when one or more of their schools is selected. Both the 1987-88 and 1990-91 SASS drew a stratified probability sample of approximately 12,800 schools (9,300 public and 3,500 private), 65,000 teachers (52,000 public and 13,000 private), and 5,600 public school districts. The survey is conducted by mail with a telephone follow-up.

The 1990-91 public school sample had a 90 percent response rate and was selected from the 1988-89 Common Core of Data--a comprehensive, annual, national statistical database maintained by NCES of all public elementary and secondary schools and school districts. All public schools in the file were first stratified by the 50 states and the District of Columbia and then by three grade levels (elementary, secondary, and combined). A special sample of schools serving large numbers of American Indian students was also drawn to provide national estimates of their schools, teachers, and principals.

The 1990-91 private school sample had an 84 percent response rate and was selected from the NCES 1989-90 private school universe file--a list of all private elementary and secondary schools in the United States, primarily based on the 1989 Quality of Education (QED) private school list, that meet NCES' criteria of a school. All schools on the file were stratified by the four census regions, and within each region, schools were further stratified by three grade levels (elementary, secondary, and combined) and by 18 categories of association membership.

SASS provides insight into teacher supply and demand including district and school policies on teacher salaries, compensation, retirement, and hiring. With regard to schools, it provides information on student characteristics, staffing patterns, teacher turnover, and school programs, policies, and conditions. For school administrators (i.e., public school principals and private school heads), SASS provides information on their demographic characteristics and qualifications as well as their perceptions of school climate and conditions. To profile public and private school teachers, SASS gives data on teacher demographic characteristics, preparation, qualifications, career history and plans as well as their teaching assignments, working conditions, and perceptions of school environment and the teaching profession. Details about the survey design and data base can be found in *Schools and Staffing in the United States: A Statistical Profile* (Choy et al., 1993).

# Appendix C

## Specification of Variables Used in the Study

### 1. Home resources and activities

From the NELS:88 database, the following home variables were selected: poverty level, father's and mother's occupation and education, family composition, parent/child communication, learning materials, classes outside school, educational activities, homework assistance, and parents' educational expectations for their children. These variables were defined and coded as follows:

- Poverty level. Based on family income, students were classified into "poverty" and "not in poverty" groups. Those students with a family income below $15,000 were in the poverty group (coded 0); otherwise, they were in the not-in-poverty group (coded 1). If the family income information was missing, it was imputed with the mean income of the matched parental educational level.
- Father's and mother's occupation. For simplicity, the occupation categories were sorted into two groups: high and low-skilled. The low-skilled group, coded 0, includes clerical, homemaker, craftsperson, laborer, operative, sales, service, never worked, and those who did not provide information. The high-skilled group, coded 1, includes manager/administrator, farm manager/farmer, professional, military, proprietor/owner, protective service, school teacher, and technician.
- Father's and mother's education. There were two levels of education: those with education beyond high school were coded 1, and those with high school or below were coded 0.
- Family composition. Students living with two parents (or guardians) were coded 1; otherwise, they were coded 0.
- Parent/child communication. Students were asked how often since the beginning of the school year they had done the following things with their parents: (a) discussed the selection of courses or programs at school; (b) discussed school activities or events of particular interest to them; (c) discussed things they had studied in class; (d) talked to their father about planning their high school program; and (e) talked to their mother about planning their high school program. For each item, their responses were coded from 0 (not at all) to 2 (three or more times). Since not every item was applicable to every student, this composite measure was the average response of the non-missing (or applicable) items.
- Learning materials. Students were asked whether they had the following items in their home: a daily newspaper, regularly received magazine, an encyclopedia, an atlas, a dictionary, typewriter, computer, more than 50 books, VCR, and pocket calculator. Their responses were coded as 0 (don't

have) or 1 (have). The sum of responses to these items was the measure of learning materials available at home.

- Classes outside school. Parents were asked if their child took any of the following classes outside of their regular school: art, music, dance, language, religion, history, computer, and other. The answer yes was coded 1, and no was coded 0. The sum of the responses was the measure of this variable.
- Educational activities. Parents were asked if their child: (a) borrowed books from a public library; (b) attended concerts or other musical events; (c) went to art museums; (d) went to science museums; and (e) went to history museums. The answer yes was coded 1, and no was coded 0. The sum of the responses was the measure of this variable.
- Homework Assistance. Parents were asked how often they helped their child with his or her homework. The responses ranged from seldom or never (coded 1) to almost every day (coded 4).
- Parents' education expectations for children. Parents were asked to indicate how far in school they expected their child to go. The responses ranged from less than high school (coded 1) to Ph.D. or other advanced degree (coded 12).

**2. School Context and Processes**

From the NELS:88 data base, certain school variables were identified on the basis that a) they differed between minority and majority students, and b) they had been found to be related to student learning. A complete selection of school variables was not possible, however, because some desirable variables were not available from the NELS:88 data base. The selected variables were defined and coded as follows:

- School SES. Based on percentages of students participating in free or reduced-price lunch programs, schools were grouped into two categories: "disadvantaged" if more than 50 percent of the students participated in the programs (coded 1), and "not disadvantaged" otherwise (coded 0).
- School type. Schools were coded 1 if they were public; otherwise, they were coded 0.
- School climate and teacher attitudes. These characteristics were measured by the following variables: (a) students face competition for grades; (b) students place a priority on learning; (c) discipline is emphasized; (d) teachers encourage students to do their best; (e) teachers have positive attitudes toward students; (f) teachers do not have difficulty motivating students; (g) teachers respond to students' individual needs; and (h) teacher morale is high. They were all coded in two categories: yes (coded 1) and no (coded 0).
- Teacher qualification and background. This was measured by three variables: certification, education degree, and tenure of teaching. Teachers were asked to indicate whether they held a certificate to teach in mathematics and science. Moreover, teachers were asked to indicate their highest academic degree held, ranging from "less than a bachelor's degree" to "doctorate" and "first professional

degree," and they were asked to indicate the major and minor fields of study for their bachelor's and graduate degrees. Teachers' tenure in teaching was measured by the total number of years taught at either the elementary or secondary level.

- Course requirements. School administrators were asked to indicate the amount of instruction required for the eighth graders in science and mathematics. The responses ranged from "no specific amount" to a "full year."
- High school program. Students were coded 1 if they were in an academic, college-preparatory program; otherwise, they were coded 0.
- Ability grouping. Students were coded 1 if they were in the high ability group in class (science and mathematics classes were separately coded); otherwise, they were coded 0.

3. **Student Characteristics**

- Social background. Sex was included in the analysis because male (coded 1) and female (coded 0) students differ significantly on achievement. Race/ethnicity was included as a control variable to partition out some of the effect of variables that were not included in the analysis. Minority students (blacks, Hispanics, and American Indians) were coded 0, and Asians and whites were coded 1.
- Educational and Occupational Aspirations. Students were asked how far in school they expected to get. Responses ranged from "won't finish high school" (coded 1) to "will attend a higher level of school after graduating from college" (coded 6). Students were asked the kind of work they expected to be doing when they were 30 years old. There were 14 categories of responses, ranging from "craftsperson or operator" to "don't know." In the descriptive analysis, they were grouped into four major categories: (1) professional, business or managerial; (2) technical; (3) science or engineering professional; (4) other. In the regression analysis, they were further coded in two categories: professional, business or managerial, science or engineering professional were coded 1; otherwise they were coded 0.
- Degree of engagement in learning. This aspect was measured by courses taken (i.e., taking algebra I, algebra II, geometry, physics, and chemistry) and learning behavior (i.e., performing below their ability, failing to complete homework, frequently absent, frequently tardy, inattentive in class, and disruptive in class). The course-taking information was provided by the students themselves, and learning behaviors were obtained from teacher ratings. All these variables were coded in two categories: yes (coded 1) and no (coded 0).

4. **Dependent variables**

- Science and mathematics achievement test scores. The achievement scores came from tests that were specially designed by the Educational Testing Service for the NELS:88 study. The science test was a 20-minute test, consisting of

10 items assessing declarative knowledge, seven items measuring comprehension ability, and eight items for problem solving. The mathematics test was a 30-minute test, consisting of 17 items assessing skills and knowledge, 19 items measuring understanding/ comprehension, and four items for problem solving. The scores used in the regression analysis in this study were standard scores with a population mean of 50 and a standard deviation of 10. These tests were reasonably reliable and valid as discussed in the report, *Psychometric Report for the NELS:88 Base-Year Battery* (Rock, Pollack, Owings, & Hafner, 1991).

# Appendix D: Correlation Coefficients for Contextual and Process Variables

**Table D.1–Correlation coefficient matrix (Spearman Rho) of family resources and home education variables**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Race/ethnicity | 1.00 | | | | | | | | | | | | |
| 2. | Poverty | 0.27 | 1.00 | | | | | | | | | | | |
| 3. | Father's occupation | 0.19 | 0.23 | 1.00 | | | | | | | | | | |
| 4. | Mother's occupation | 0.10 | 0.16 | 0.24 | 1.00 | | | | | | | | | |
| 5. | Father's education | 0.19 | 0.27 | 0.40 | 0.23 | 1.00 | | | | | | | | |
| 6. | Mother's education | 0.13 | 0.23 | 0.29 | 0.32 | 0.52 | 1.00 | | | | | | | |
| 7. | Family composition | 0.19 | 0.31 | 0.15 | 0.04 | 0.13 | 0.05 | 1.00 | | | | | | |
| 8. | Parent/child communication | 0.09 | 0.16 | 0.18 | 0.12 | 0.24 | 0.20 | 0.13 | 1.00 | | | | | |
| 9. | Learning materials | 0.29 | 0.35 | 0.32 | 0.21 | 0.36 | 0.33 | 0.21 | 0.27 | 1.00 | | | | |
| 10. | Classes outside of school | 0.17 | 0.22 | 0.23 | 0.18 | 0.28 | 0.28 | 0.10 | 0.22 | 0.29 | 1.00 | | | |
| 11. | Educational activities | 0.13 | 0.22 | 0.21 | 0.17 | 0.26 | 0.26 | 0.08 | 0.21 | 0.29 | 0.38 | 1.00 | | |
| 12. | Homework assistance | 0.05 | 0.07 | 0.05 | 0.05 | 0.08 | 0.08 | 0.06 | 0.09 | 0.08 | 0.09 | 0.16 | 1.00 | |
| 13. | Parents' educational expectations | 0.05 | 0.22 | 0.27 | 0.22 | 0.34 | 0.32 | 0.07 | 0.27 | 0.28 | 0.30 | 0.30 | -0.00 * | 1.00 |

Note: * indicates that correlation coefficient is not significant at the .01 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Survey of 1988, "Base Year Student and Parent Surveys."

**Table D.2--Correlation coefficient matrix (Spearman Rho) of school variables**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. School SES | 1.00 | | | | | | | | | | | | | |
| 2. School type | 0.17 | 1.00 | | | | | | | | | | | | |
| 3. Students face competition for grades | 0.12 | 0.02 | 1.00 | | | | | | | | | | | |
| 4. Discipline is emphasized | -0.00 | -0.07 | 0.10 | 1.00 | | | | | | | | | | |
| 5. Students place a priority on learning | 0.11 | 0.22 | 0.25 | 0.11 | 1.00 | | | | | | | | | |
| 6. Teachers encourage students to do their best | 0.08 | 0.12 | 0.19 | 0.30 | 0.30 | 1.00 | | | | | | | | |
| 7. Teacher morale is high | 0.11 | 0.13 | 0.09 | 0.23 | 0.32 | 0.42 | 1.00 | | | | | | | |
| 8. Teachers have positive attitudes toward students | 0.09 | 0.15 | 0.05 | 0.03 | 0.21 | 0.20 | 0.27 | 1.00 | | | | | | |
| 9. Teachers do not have difficulty motivating students | 0.11 | 0.30 | 0.09 | -0.12 | 0.31 | 0.05 | 0.14 | 0.36 | 1.00 | | | | | |
| 10. Teachers respond to students' individual needs | 0.08 | 0.19 | 0.17 | 0.18 | 0.28 | 0.45 | 0.38 | 0.22 | 0.15 | 1.00 | | | | |
| 11. High school program | 0.15 | 0.22 | 0.10 | -0.00 | 0.13 | 0.02 | 0.05 | 0.06 | 0.11 | 0.06 | 1.00 | | | |
| 12. Mathematics ability grouping | 0.09 | 0.10 | 0.08 | 0.01 | 0.15 | 0.09 | 0.08 | 0.07 | 0.08 | 0.10 | 0.32 | 1.00 | | |
| 13. Science ability grouping | -0.03 | -0.17 | 0.04 | 0.05 | 0.05 | 0.01 | 0.02 | 0.00 | 0.02 | -0.02 | 0.19 | 0.39 | 1.00 | |
| 14. Race/ethnicity | 0.42 | 0.20 | 0.13 | -0.01 | 0.17 | 0.09 | 0.07 | 0.10 | 0.20 | 0.08 | 0.21 | 0.11 | -0.05 | 1.00 |

Note: Correlation coefficients greater than .03 (absolute value) are significant at the .01 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988: "Base Year and First Follow-Up School Surveys."

**Table D.3--Correlation coefficient matrix (Spearman Rho) of student backgrounds and classroom behavior rated by mathematics teachers**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Males | 1.00 | | | | | | | | | | | | |
| 2. | Asian & whites | 0.01 | 1.00 | | | | | | | | | | | |
| 3. | Educational aspirations | -0.04 | 0.05 | 1.00 | | | | | | | | | | |
| 4. | Occupational aspirations | -0.12 | 0.04 | 0.21 | 1.00 | | | | | | | | | |
| 5. | Algebra I | -0.04 | 0.05 | 0.17 | 0.05 | 1.00 | | | | | | | | |
| 6. | Algebra II | 0.00 | 0.10 | 0.14 | 0.17 | -0.04 | 1.00 | | | | | | | |
| 7. | Geometry | -0.03 | 0.15 | 0.22 | 0.23 | 0.26 | 0.29 | 1.00 | | | | | | |
| 8. | Perform below ability | 0.11 | -0.10 | -0.16 | -0.14 | -0.17 | -0.17 | -0.27 | 1.00 | | | | | |
| 9. | Rarely complete homework | 0.13 | -0.14 | -0.18 | -0.14 | -0.15 | -0.15 | -0.24 | 0.61 | 1.00 | | | | |
| 10. | Frequently absent | -0.03 | -0.07 | -0.13 | -0.06 | -0.14 | -0.11 | -0.16 | 0.27 | 0.29 | 1.00 | | | |
| 11. | Frequently tardy | -0.00 | -0.12 | -0.06 | -0.05 | -0.11 | -0.06 | -0.11 | 0.23 | 0.28 | 0.27 | 1.00 | | |
| 12. | Inattentive in class | 0.12 | -0.10 | -0.15 | -0.13 | -0.14 | -0.14 | -0.22 | 0.56 | 0.57 | 0.22 | 0.25 | 1.00 | |
| 13. | Disruptive in class | 0.16 | -0.08 | -0.09 | -0.10 | -0.09 | -0.10 | -0.15 | 0.32 | 0.33 | 0.09 | 0.24 | 0.46 | 1.00 |

Note: Correlation coefficients greater than .03 (absolute value) are significant at the .01 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year and First Follow-Up Student and Teacher Surveys."

**Table D.4--Correlation coefficient matrix (Spearman Rho) of student backgrounds and classroom behavior rated by science teachers**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Males | 1.00 | | | | | | | | | | | | |
| 2. | Asians & whites | 0.02 | 1.00 | | | | | | | | | | | |
| 3. | Educational aspirations | -0.06 | 0.06 | 1.00 | | | | | | | | | | |
| 4. | Occupational aspirations | -0.12 | 0.05 | 0.22 | 1.00 | | | | | | | | | |
| 5. | General science | 0.03 | -0.03 | -0.07 | -0.09 | 1.00 | | | | | | | | |
| 6. | Physics | 0.05 | -0.04 | 0.00 | 0.02 | 0.07 | 1.00 | | | | | | | |
| 7. | Chemistry | 0.02 | 0.06 | 0.11 | 0.13 | -0.07 | 0.25 | 1.00 | | | | | | |
| 8. | Perform below ability | 0.11 | -0.10 | -0.19 | -0.15 | 0.09 | 0.00 | -0.12 | 1.00 | | | | | |
| 9. | Rarely complete homework | 0.14 | -0.12 | -0.19 | -0.16 | 0.07 | -0.01 | -0.12 | 0.63 | 1.00 | | | | |
| 10. | Frequently absent | -0.04 | -0.06 | -0.16 | -0.09 | 0.00 | -0.02 | -0.07 | 0.29 | 0.32 | 1.00 | | | |
| 11. | Frequently tardy | 0.01 | -0.09 | -0.09 | -0.06 | 0.05 | -0.00 | -0.04 | 0.25 | 0.29 | 0.30 | 1.00 | | |
| 12. | Inattentive in class | 0.10 | -0.11 | -0.16 | -0.13 | 0.09 | -0.01 | -0.11 | 0.56 | 0.56 | 0.24 | 0.30 | 1.00 | |
| 13. | Disruptive in class | 0.16 | -0.11 | -0.07 | -0.08 | 0.05 | -0.01 | -0.06 | 0.32 | 0.35 | 0.11 | 0.25 | 0.47 | 1.00 |

Note: Correlation coefficients greater than .03 (absolute value) are significant at the .01 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year and First Follow-Up Student and Teacher Surveys."

## Table D.6--Correlation coefficient matrix (Spearman Rho) of family resources and home education variables with student characteristics

| Family resources and home education variables | Student characteristics | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Poverty | 0.04 | 0.27 | 0.17 | 0.10 | 0.13 | 0.12 | 0.21 | -0.06 | -0.01 | 0.09 | -0.10 | -0.13 | -0.13 | -0.08 | -0.09 | -0.06 |
| Father's occupation | 0.01 | 0.19 | 0.16 | 0.14 | 0.06 | 0.16 | 0.24 | -0.09 | 0.02 | 0 14 | -0.10 | -0.12 | -0.09 | -0.05 | -0.09 | -0.06 |
| Mother's occupation | 0.01 | 0.10 | 0.11 | 0.12 | 0.04 | 0.11 | 0.16 | -0.06 | 0.01 | 0.09 | -0.06 | -0.06 | -0.05 | -0.02 | -0.06 | -0.03 |
| Father's education | 0.03 | 0.19 | 0.23 | 0.19 | 0.08 | 0.19 | 0.28 | -0.10 | 0.02 | 0.16 | -0.12 | -0.13 | -0.10 | -0.06 | -0.11 | -0.06 |
| Mother's education | 0.01 | 0.13 | 0.21 | 0.18 | 0.07 | 0.17 | 0.25 | -0.09 | 0.03 | 0.14 | -0 10 | -0.10 | -0.09 | -0.05 | -0.08 | -0.04 |
| Family composition | 0.01 | 0.19 | 0.06 | 0 05 | 0.07 | 0.08 | 0.12 | -0.02 | -0.02 | 0.05 | -0.09 | -0.11 | -0.10 | -0 07 | -0.08 | -0.06 |
| Parent/child communication | -0.09 | 0.09 | 0.26 | 0.20 | 0.11 | 0.15 | 0.20 | -0.09 | 0.01 | 0.12 | -0.16 | -0.17 | -0.10 | -0.08 | -0.14 | -0.08 |
| Learning materials | 0.04 | 0.29 | 0.24 | 0 16 | 0.11 | 0.17 | 0.27 | -0.07 | 0.02 | 0.14 | -0 11 | -0.13 | -0.12 | -0.06 | -0.10 | -0.05 |
| Classes outside of school | -0.12 | 0.16 | 0.18 | 0.15 | 0.09 | 0.15 | 0.23 | -0.09 | 0.01 | 0.12 | -0.12 | -0.13 | -0.09 | -0.06 | -0.10 | -0.08 |
| Educational activities | -0.03 | 0.13 | 0.19 | 0.14 | 0.08 | 0.13 | 0.22 | -0.08 | 0.02 | 0.13 | -0.11 | -0.12 | -0.08 | -0.06 | -0.10 | -0.08 |
| Homework assistance | 0.00 | 0.05 | 0.01 | -0.02 | -0.00 | -0.03 | -0.02 | 0.03 | -0.01 | -0.02 | 0.04 | 0.01 | -0.01 | -0.01 | 0.01 | 0.01 |
| Parents' educational expectations | -0.03 | 0.05 | 0.35 | 0 30 | 0.14 | 0.28 | 0 38 | -0.15 | 0.03 | 0.21 | -0.22 | -0.22 | -0.14 | -0.09 | -0.20 | -0.11 |

**Student characteristics:**

1. Males
2. Asians & whites
3. Educational aspirations
4. Occupational aspirations
5. Algebra I
6. Algebra II
7. Geometry
8. Ceneral science
9. Physics
10. Chemistry
11. Perform below ability
12. Rarely complete homework
13. Frequently absent
14. Frequently tardy
15. Inattentive in class
16. Disruptive in class

Note: Correlation coefficients greater than .03 (absolute value) are significant at the .01 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student, Parent, and Teacher and First Follow-Up Student and Teacher Surveys."

**Table D.5--Correlation coefficient matrix of family resources and home education variables with school variables**

| Family resources and home education variables | School Variables | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Poverty | 0.24 | 0.17 | 0.07 | -0.01 | 0.13 | 0.06 | 0.06 | 0.08 | 0.12 | 0.05 | 0.13 | 0.12 | 0.08 |
| Father's occupation | 0.16 | 0.21 | 0.06 | -0.04 | 0.16 | 0.07 | 0.08 | 0.08 | 0.14 | 0.06 | 0.14 | 0.14 | 0.08 |
| Mother's occupation | 0.10 | 0.15 | 0.09 | -0.05 | 0.09 | 0.03 | 0.03 | 0.04 | 0.08 | 0.04 | 0.12 | 0.10 | 0.09 |
| Father's education | 0.16 | 0.22 | 0.10 | -0.04 | 0.17 | 0.06 | 0.06 | 0.10 | 0.14 | 0.06 | 0.19 | 0.17 | 0.13 |
| Mother's education | 0.15 | 0.21 | 0.09 | -0.04 | 0.14 | 0.06 | 0.07 | 0.08 | 0.12 | 0.06 | 0.17 | 0.15 | 0.11 |
| Family composition | 0.10 | 0.06 | 0.04 | 0.01 | 0.06 | 0.02 | 0.02 | 0.03 | 0.06 | 0.02 | 0.06 | 0.07 | 0.04 |
| Parent/child communication | 0.10 | 0.11 | 0.05 | -0.01 | 0.09 | 0.03 | 0.04 | 0.05 | 0.09 | 0.03 | 0.25 | 0.17 | 0.13 |
| Learning materials | 0.23 | 0.23 | 0.11 | -0.02 | 0.16 | 0.08 | 0.08 | 0.10 | 0.15 | 0.07 | 0.18 | 0.18 | 0.13 |
| Classes outside of school | 0.14 | 0.12 | 0.09 | -0.03 | 0.12 | 0.05 | 0.04 | 0.06 | 0.09 | 0.04 | 0.13 | 0.15 | 0.11 |
| Educational activities | 0.13 | 0.19 | 0.06 | -0.02 | 0.12 | 0.04 | 0.05 | 0.06 | 0.12 | 0.04 | 0.15 | 0.12 | 0.10 |
| Homework assistance | 0.04 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.00 | 0.00 | 0.01 | -0.04 | -0.05 | -0.03 |
| Parents' educational expectations | 0.08 | 0.23 | 0.08 | -0.05 | 0.16 | 0.04 | 0.06 | 0.08 | 0.14 | 0.06 | 0.30 | 0.27 | 0.13 |



**School Variables:**

1. School SES
2. School type
3. Students face competition for grades
4. Discipline is emphasized
5. Students place a priority on learning
6. Teachers encourage students to do their best
7. Teacher morale is high
8. Teachers have positive attitudes toward students
9. Teachers do not have difficulty motivation students
10. Teachers respond to students' individual needs
11. High school program
12. Mathematics achievement level grouping
13. Science achievement level grouping

Note: Correlation coefficients greater than .03 are significant at the .01 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year Student, Parent, and School and First Follow-Up School Surveys."

## Table D.7--Correlation coefficient matrix (Spearman Rho) of school variables with student characteristics

| School variables | Student characteristics | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| School SES | 0.00 | 0.35 | 0.07 | 0.05 | 0.06 | 0.05 | 0.11 | -0.04 | -0.01 | 0.01 | -0.06 | -0.09 | -0.04 | -0.06 | -0.06 | -0.04 |
| School type | 0.01 | 0.11 | 0.12 | 0.12 | 0.05 | 0.13 | 0.24 | -0.07 | 0.06 | 0.12 | -0.09 | -0.11 | -0.08 | -0.03 | -0.09 | -0.04 |
| Students face competition for grades | 0.01 | 0.08 | 0.05 | 0.05 | 0.02 | 0.05 | 0.07 | -0.01 | 0.00 | 0.16 | -0.02 | -0.03 | -0.02 | -0.01 | -0.03 | -0.02 |
| Discipline is emphasized | 0.00 | 0.02 | -.01 | -.01 | 0.01 | -.02 | -0.06 | 0.00 | -0.02 | -.03 | -0.01 | -0.01 | -0.00 | -0.01 | -0.01 | -0.01 |
| Students place a priority on learning | 0.01 | 0.10 | 0.08 | 0.08 | 0.05 | 0.07 | 0.16 | -0.06 | 0.02 | 0.11 | -0.08 | -0.09 | -0.05 | -0.03 | -0.07 | -0.06 |
| Teachers encourage students to do their best | 0.00 | 0.06 | 0.04 | 0.03 | 0.02 | 0.04 | 0.04 | -0.03 | 0.01 | 0.02 | -0.04 | -0.05 | -0.02 | -0.02 | -0.04 | -0.03 |
| Teacher morale is high | -0.00 | 0.05 | 0.05 | 0.03 | 0.01 | 0.04 | 0.02 | -0.04 | 0.02 | 0.04 | -0.04 | -0.05 | -0.02 | -0.01 | -0.03 | -0.02 |
| Teachers have positive attitudes toward students | -0.00 | 0.07 | 0.06 | 0.04 | 0.01 | 0.02 | 0.06 | -0.04 | 0.00 | 0.03 | -0.04 | -0.05 | -0.03 | -0.03 | -0.04 | -0.02 |
| Teachers do not have difficulty motivating students | 0.01 | 0.11 | 0.10 | 0.07 | 0.03 | 0.06 | 0.13 | -0.05 | 0.02 | 0.06 | -0.07 | -0.08 | -0.05 | -0.02 | -0.05 | -0.02 |
| Teachers respond to students' individual needs | 0.00 | 0.03 | 0.03 | 0.04 | 0.02 | 0.04 | 0.05 | -0.03 | 0.01 | 0.03 | -0.04 | -0.05 | -0.02 | -0.03 | -0.04 | -0.04 |
| High school program | 0.01 | 0.09 | 0.20 | 0.27 | 0.05 | 0 21 | 0.25 | -0.13 | 0.02 | 0.17 | -0.16 | -0.15 | -0.10 | -0.07 | -0.14 | -0.08 |
| Mathematics ability grouping | 0.03 | 0.11 | 0.15 | 0.18 | -0.03 | 0.35 | 0.33 | -0.13 | -.00 | 0.21 | -0 18 | -0.17 | -0.11 | -0.08 | -0.17 | -0.10 |
| Science ability grouping | 0.06 | 0.05 | 0.11 | 0.13 | 0.01 | 0 19 | 0 19 | -0.10 | 0.02 | 0.18 | -0.10 | -0.10 | -0.08 | -0.05 | -0.10 | -0.05 |



**Student characteristics:**

1. Males
2. Asians & whites
3. Educational aspirations
4. Occupational aspirations
5. Algebra I
6. Algebra II
7. Geometry
8. General Science
9. Physics
10. Chemistry
11. Perform below ability
12. Rarely complete homework
13. Frequently absent
14. Frequently tardy
15. Inattentive in class
16. Disruptive in class

Note: Correlation coefficients greater than .03 (absolute value) are significant at the .01 level.

Source: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988, "Base Year and First Follow-Up Student, Teacher, and School Surveys."

# Appendix E -- Technical Notes for Chapter 3

One approach to answering the questions posed for this study is to examine the reduction of the impact of race/ethnicity on achievement by adding new variables to a regression analysis model in which race-ethnicity is a predictor. As illustrated below, the analysis begins with a model that the achievement score of a student is a function of the intercept ($B_0$) (i.e., the point on the achievement axis where the regression line starts) and the difference due to race-ethnicity ($B_1$) plus sampling error. In the second model, a new variable (e.g., poverty) is added, and the $B_1$ becomes the measure of the difference in achievement associated with race/ethnicity after the new variable is considered. By comparing the two models, one may test whether the two $B_1$'s differ. If $B_1$ from the second model is smaller than $B_1$ from the first model, the difference attributable to race-ethnicity narrows when the new variable is held constant, and thus the difference in the new variable partially accounts for the observed difference among racial-ethnic groups. The same interpretation applies when the model is expanded to include a set of new variables.

(1) Achievement = $B_0$ + $B_1$(race/ethnicity) + e

(2) Achievement = $B_0$ + $B_1$(race/ethnicity) + $B_2$ (contextual and process variables) + e

where $B_0$ is the intercept, $B_1$ is the difference due to race/ethnicity, $B_2$ is the difference due to poverty, and e is random error with a mean of 0.

It is possible to conduct an analysis for each variable to determine its importance in explaining the observed racial/ethnic difference in achievement. However, due to the large number of variables involved, this is a laborious task that could also be misleading because many of these variables are inter-related (tables D.1 to D.7 in Appendix D). For example, poverty is related to family composition ($r = .31$), meaning that students in poverty are more likely to be from single-parent families and vice versa. Poverty is also related to learning materials at home ($r = .34$) and educational activities provided by parents ($r = .21$). The father's education level is also related with learning materials at home ($r = .31$) and educational expectations ($r = .30$). Similarly, many school variables are related to each other, and many student characteristics are also related to each other. Therefore, unless other related variables are considered, it is difficult to determine the relative importance of a single variable in explaining the difference in achievement among racial-ethnic groups.

One approach to determining the importance of inter-related variables is to use standardized regression coefficients. Based on the relative size of these coefficients, one can determine the relative power of each variable in predicting achievement scores (i.e., the unique contribution of a variable to an achievement score). When a set of variables significantly reduces the racial/ethnic differences in achievement, it is then appropriate to examine whether some of these variables are more important than others. Because of this, both non-standardized and standardized regression coefficients are presented in this study. Non-standardized coefficients were used to determine the extent of racial/ethnic differences explained by the other variables, and standardized coefficients were used to determine the relative importance of these variables.

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